# Design communicating space tech innovation

J ADLER

PhD 2022

# Design communicating space tech innovation

## JANETT ADLER

A thesis submitted in partial fulfilment
of the requirements of
Manchester Metropolitan University
for the degree of
Doctor of Philosophy

Manchester School of Art
Department of Design
in collaboration with
Red Ninja, Asteroid Mining Corporation,
ManSEDS, EnviroSAR and 4wardFutures

2022

# Abstract

This thesis explores the value of visual design in the UK space technology sector. It develops a bespoke design thinking model that supports the communication of innovation in satellite and space technology organisations. Its primary research question considers 'How can design thinking communicate the values of space tech organisations in order to foster an innovation culture?' Through a hybrid of case study and grounded theory methodologies, design practice and theory combine to clarify, produce and advocate solutions that increase collaboration between design and the space technology industry. Case studies of practice-based collaborations with industry partners explore the use of a bespoke design thinking model that facilitates brand creation and development including the generation of lo-and hi-fi visual prototypes. With divergent and convergent aspects, the design thinking model is structured around five key stages: 1. knowing, 2. pace, 3. crescendo, 4. reflect, and 5. recover. The model provides a holistic approach where individual elements can overlay and intertwine, generating a complex structure, unique to the organisation it is applied to. The five industry partners in the North West of England specialise in Intelligent Transport, Asteroid Mining, Space Engineering, Remote Sensing and Space Settlement. Case studies draw upon expert interviews to demonstrate and verify improved brand image reflecting the innovation culture of these organisations. These improvements led to new business models, new markets reached, improved stakeholder engagement, and establishment of impactful visual design. Findings indicate that the bespoke design thinking model positively transformed the organisations' identities and enhanced the communication of innovation culture in the satellite and space technology sector. The research provides recommendations on the use of the bespoke design thinking model in design practice.

# Declaration

I hereby certify that the work of my thesis 'Design communicating space tech innovation' is original and produced by myself under the guidance of my supervisors, Professor Martyn Evans and Dr Jea Hoo Na at the School of Art, except where other contributors are stated. Neither parts nor the whole of my thesis were previously presented for a higher degree award or similar title of recognition at the Manchester Metropolitan University or any other institution. To the best of my knowledge, it does not include previously published materials written by others, except where appropriately acknowledged through referencing.

Chapters 2-10 include content, figures and tables that I previously showed at conferences and submitted as conference papers, promoting my research and type of collaboration to inspire fellow students and prospective stakeholders, detailed below:

- conference poster 'Design value in future tech innovation' presented at the NWCDTP conference, Human Technologies, Digital Humanities at the University of Salford, Manchester, UK in October 2018 (first case study, Chapter 5)
- conference paper 'Design value in future tech organisations – How can design communicate innovation?' presented at 4D Designing Development, Developing Design, Ritsumeikan University, Osaka, Japan. October 2019 (summary of my first two case studies, Chapters 5 and 6; Adler et al., 2019; Appendix 9)
- paper presentation 'Design Thinking for Space Tech Innovation' at NWCDTP workshop in November 2020 (online; summary of all five case studies, Chapters 5-9)
- conference presentation 'Design thinking x space innovation' at Postgraduate Conference on Interdisciplinary Learning, Lingnan

University, Hongkong in March 2021 (abstract available online; summary of all five case studies, Chapters 5-9; Adler et al., 2021)

- conference paper 'Design communicating space tech innovation' presented at Design Thinking Research Symposium, Technion, Israel Institute of Technology, Haifa, Israel in March 2022 (summary of all five case studies, Chapters 5-9; Adler et al., 2022; Appendix 9).

I further presented my research as guest lectures for Master's degree students in Design Innovation during the Design Thinking module in 2020 and 2021 and at a number of meetings with the Transformation North West (TNW) Cohort, supervisors and stakeholders, serving as a platform for knowledge exchange. All the above-mentioned followed university guidelines and used permissions from co-authors.

# Preface

On a Christmas Eve over 50 years ago the crew from Apollo 8, whilst exploring the lunar orbit, took the first picture of Earth from space that appreciated life as we know it (NASA, 2021). This photograph 'Earthrise' has been and continues to be an inspiration for future generations, changing our perspective of how we perceive the meaning of existence. Increasingly relevant in a time of pandemic, wars between neighbours, countries building walls instead of taking them down, concerns about our environment, our communities and inner worries, it is rewarding to look up, to explore that which gives us hope, inspires, and encourages. The interest in space has continued to increase, with new developments breaking through on a daily basis and with collaborations across industries becoming more and more rewarding. Installation artist Luke Jerram's 'Gaia', pictured below, is a depiction of Earth as seen from space for an audience that wants to reflect on what is going on in the world (Gaia, 2022).

Different authors established a varied understanding of the value that space brings. The 'Little Prince' pondered: The stars mean different things to different people. For some they are nothing more than twinkling lights in the sky. For travellers they are guides. For scholars they are food for thought. For my businessman they are wealth (Saint-Exupéry, 1944: 100).

My own motivation for this research is to grasp this different perspective, to use my visual design skills to raise organisations' brand images that use satellite and space technologies to help developments on Earth and in space. As a graphic designer, I apply design thinking for accurate user insight, assisting branding processes that are my specialism.

Gaia
(Art installation by Luke Jerram, image taken by
author on 9 March 2022, Warrington Parr Hall)

# Acknowledgements

First of all, I want to thank the Arts and Humanities Research Council (AHRC) that, via the North West Consortium Doctoral Training Partnership (NWCDTP), funded my and my cohort's doctoral training programme 'Transformation North West' (TNW) focused on design and creativity crossing over into various sectors. I want to thank my fellow researchers and cohort supervisors, extending across five universities in England's North West that enabled collaboration with organisations in response to the UK Government's Industrial Strategy.

Thank you to my director of supervision Professor Martyn Evans for always providing fitting advice, even to the smallest of problems and sharing from your wealth of experience. To my supervisor Dr Jea Hoo Na, thank you for being a mentor to me and for your time and valuable feedback from when we started meeting halfway through my second year.

Thanks to my collaborators Red Ninja, Asteroid Mining Corporation, ManSEDS, EnviroSAR and 4wardFutures for being the best project partners I could think of, for providing interesting work and fantastic feedback. And a special thanks to Meta Platforms for the knowledge exchange and showing me and my associates around.

I would like to thank my family. Kiran, thank you, for badgering me and loving me and pushing me to 'do this thing'. Thanks, Levi, for being an inspiring young man, always ready to help. Thank you, Micah Lily, for caring so much, and for your generous heart and aspiration. Noelle Marie, thanks for your interest in my numerous presentations, your creativity and curiosity. Thank you, Oliver, for giving me company and sharing your empathy. I thank my parents, my mother-in-law, sisters, brothers and cousins for your uplifting messages and your persisting support when I needed your help.

Finally, thank you to my friends and former teachers, and for the hours of talks and phone calls, I appreciate your advice and you being there for me.

Thanks also to those who did not believe in me, so I could try even harder to prove you wrong.

Thank you everyone, I treasure your support and your insight.
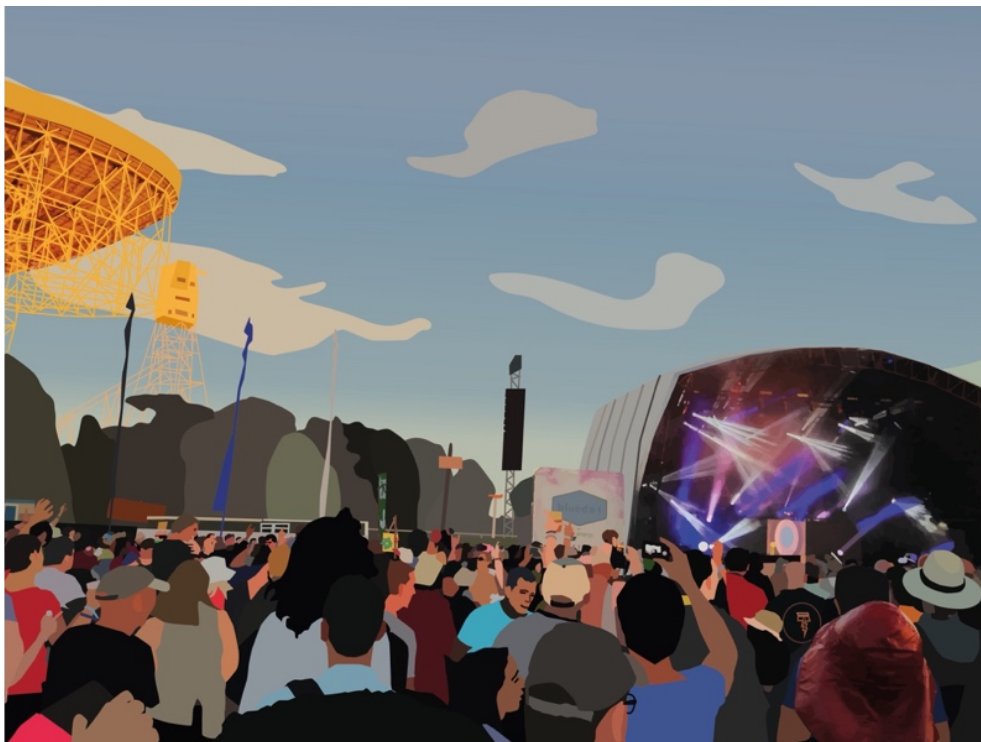


Figure 1 Jodrell Bank: the Lovell Telescope
in use at the Bluedot Festival 2017, Cheshire

# Table of contents

# List of figures

# List of tables

# Glossary

*Author*
the author is the researcher and design practitioner, the originator who wrote this thesis and its interpreter.

*Case study*
means practice-based research undertaken as mini projects within different organisations in the satellite and space industry for this research.

*Co-design*
is intentional collaboration with project partners, encouraging design thinking through design critique and iterations, allowing active involvement in ideation and inclusion of low-fidelity prototypes to output combined artefacts of the author and the project partner.

*Communication*
is knowledge exchange that can be balanced or heavy on either the receiving or giving side and includes various media such as spoken or written language as well as visual artefacts as this research's primary tool to examine the meaning of that visual language and its relevance for this thesis.

*Concepts*
are ideas actively brought forward into the design thinking process, used as a platform to consult with partner organisations any course of action that determine the point in design iteration. Concepts can come in shape of what the author refers to as 'creative orientation' or 'design route' during PACE and CRESCENDO stages of her design thinking model.

*Creativity*
is the origin of ideas. This research explores creativity in depth as the foundation of design thinking. The creative industries are examined alongside the space

technology sector to understand valuable links.

*Design*
fulfils a purpose for a person or group. Design can be the first visual prototype that maps out an idea or a completed product or service. It uses the author's design thinking model with ideation and making stages to investigate elements of design.  Design is one four areas, alongside and overlapping Economy, Innovation and Technology that are researched throughout contextual review.

*Design framework*
or theoretical framework is called 'design thinking activity map' for this research as it presents a summary of the various activities with partner organisations and how analyses were conducted, using 'input, actors, activities and outputs' to measure the author's design thinking stages for each case study.

*Design thinking*
helps build a process with the possibility to go back and forth and iterate. For this research design thinking is concerned with multiple layers of ideas and making that create innovative solutions tailored to each partner organisation to then review design application and investigate its impact.

*Deductive research approach*
assists grounded theory in this thesis by creating clusters and specific patterns by removing ideas that are classed as unsuitable and organising themes to make sense of an idea, testing and confirming or rejecting it.

*Flexible branding*
refers to the dynamic way of identity creation or development with the various partner organisations that entails adaptable logotypes and brand language that is not static but can vary to suit different environments or situations.

*Focus groups*
are smaller groups of interviewees
or workshop participants that are
equally interested in the success
of a project.

*Future technologies*
are emerging sectors and new
technological developments as
compared to high-tech, cutting-
edge technology that is already
available.

*Graphic design*
is visual communication of ideas
and a problem-solving process.
Graphic design creates visual
elements from the beginning to
the end of a design thinking
process. Graphic design is one of
the author's fields of expertise
that she applied in this thesis'
case studies.

*Identity*
is concerned with the DNA of the
brand of an organisation, what it
is made of and wants to be seen
and thought of as.

*Industrial Strategy*
is the UK Government's plan to
create an economy with increased
productivity and earning power
that this research is examining
(BEIS, 2017).

*Innovation*
implements new ideas and
approaches challenges in novel
ways and one of four areas
investigated through contextual
review.

*Insight*
draws out opportunities and
recommendations from findings
that aim to present an ideal future
state. It is strategic foresight that
helps understand the relationship
of gathered data using the
methods for this research: focus
group discussions, interviews and
feedback and prototypes.

*Open coding*
helps build a sophisticated
narrative by categorising various
concepts, aiding grounded theory.

*Product*
can be a physical thing or
something intangible (e.g. digital)
that answers a user need or
desire.

*Prototype*
can be a visual outline or a first
model that explains concepts to
users and enables testing with
them prior to launching a
completed product. This research
explores the use of low- and high-
fidelity prototypes throughout the
iterative design thinking process.

*Value*
is something of worth, useful or
practical; something that makes
sense.

*Visual design*
translates and makes something
tangible by applying graphic
design elements, such as shape,
colour, typography etc. Visual
design involves actively in design
thinking. This research explores
visual design as a meaning and
value creator, as a language that
can be understood easily and as a
tool to develop and create brands.

*User experience*
describes how people engage with
an organisation or its product or
service. Its success is measured by
people-driven design thinking
approaches from organisations
that want to know who the users
are and what they are trying to
achieve.

# 1 Introduction

"... one of the first things that people will do is google – us, google the company... that's all visual" (ITCEO, 2019).

At a time when 'space' remains a topic of interest across various media outlets with new developments surging, it is rewarding that it is moving away from solely government-based platforms to collaborations across industries to explore the universe and life on Earth. This research aims to demonstrate how innovation culture within space and satellite organisations can be represented through a visually rich design thinking model. The research investigated the value of visual design in space technology organisations and its role in communicating their innovation, and ultimately, the societal and economic impact it has.

Linking practice and theory, as a researcher with a professional graphic design background, the author used visual design techniques to advance innovation in the space tech industry, beneficial to individuals and organisations who want to learn how to enhance their brand through design thinking. As a researcher, and concurrently a designer, the author employed visual language that draws from elements such as images, form and colour that does not need translating per se, to tell a chosen audience, that may be (prospective) users or stakeholders of a product, a project partners' message to connect their needs with the passion that goes along with their brand. The way the author approached this research was to rethink apparently natural sequencing, with visual design expertise, in order to create something that belongs – to technological advancement, to growth and ultimately to people.

Through graphic design expertise the author can translate data into visual language. Concurrently a design researcher employing design thinking, the author begins the process with insights from research that develop into less defined and more defined ideas. Sometimes the research is very structured, sometimes ideas flow freely. Drawing from findings that

come from a research loop, as an inquiring individual, the author continually talks to partners and users during the iterative design thinking process. Grounded in gathered data from observation, interviews, workshops and feedback – at first seemingly random ideas take shape, loosely related to user wants, then concepts manifest through clustering initial ideas, taking some away and talking to partners again, drawing out ideas together. During design iteration, through what the author calls 'creative orientation', concepts are presented to partners and then tested before developing or creating brands as high-fidelity prototypes. Through the visual comparison of the various fonts, colours and overall elements of brand language as well as shapes, patterns and choice of layout where applicable, the author can explore what these might convey. All of these brand elements contain a certain meaning and the combination of any of these may have new meaning. Through synthesising, thinking, grouping; working closely, co-designing and consulting with partners, ideas develop further and can be narrowed down. Brand variations suitable for further iteration within the design thinking process and also for flexible branding, help make concepts more tangible. Engaging with teams made up of different experts, the author tailors methods to user needs to develop and create brands. With valuable findings on the way, always evaluating them, the author looks after the design thinking process from start to finish to drive impactful outcomes.

This research focused on brand development and brand creation through a design thinking model tailored to five organisations in combination with tools and techniques from a design thinking activity map. The five project partners are all based in the North West of England in the UK and engage with satellite and space technologies, either for space exploration or improving conditions on Earth. These include sensor technologies used in transport systems for smarter cities; mining for space resources; aerospace equipment including rovers, rockets, space balloons and satellites; landscape protection through remote sensing; and space settlement scenarios. The practical projects took place between March 2018

and March 2020. Time for practical work was restricted because of the onset of the COVID-19 pandemic, resulting in an unfinished design thinking loop of the last case study, which was nevertheless included with lo-fi prototypes as outcomes. All the case studies were restricted to the region and even though a number of the partner's projects reach out nationally, internationally and beyond, they have their base in the North West of England. Applying creative approaches to the space industry, working together across industries to improve innovation, turned out to be an economic booster in relation to the UK Government's Industrial Strategy, positively influencing the region. As the research focus was on visual design in the space tech industry, the scope did not include creative approaches from other design disciplines or research of other future technologies than those concerned with project partners through the collaboration.

A bespoke design thinking model is used to develop and create brands for space tech organisations to represent their innovation which addressed challenges identified in the Industrial Strategy. The model was built on agency and in-house experience and supported by acknowledged processes and approaches in the design field and interview participants' own models. The speciality of this research was to look at the overlaps of various fields of visual design and space technology and how these sit in terms of economic impact and innovation, and therefore propose a new understanding of the design topic. Captivating people's interest in the space sector by implementing visual design is successful in cultivating growth and prosperity.

Research questions (RQ, Qs) and objectives (OBs) can be found in Figure 3.1, Section 3.2, where the relationship between the various research elements is illustrated, informing the research aim (RA).

RA:     This research aims to demonstrate how innovation culture within space and satellite organisations can be represented through a visually rich design thinking model.

The primary research question states:

RQ:    How can design thinking communicate the values of space tech organisations in order to foster an innovation culture?

This can be broken down into four smaller questions addressing the research objectives.

Q1:    How can the values of space tech organisations be communicated effectively?

Q2:    How can a design thinking model advance innovation culture in space tech organisations?

Q3:    What is the role of brand creation and development in innovation in space tech organisations?

Q4:    How can iterative visual design activities link research and practice and drive a culture of innovation?

OB1:   Contextual review – to develop an understanding of the relationship between innovation and design value in space tech industries in the North West of England (with reference to the UK Government's Industrial Strategy) through a contextual review involving a combination of primary and secondary research.

OB2:   Design thinking model – to identify a design thinking process that can be tailored to space tech organisations and enables brand creation and development.

OB3:   Projects with partners – to undertake a series of projects with partners in the satellite and space tech industry (case studies) that develop, test and evaluate the potential for creative design tools and techniques to identify new and novel ideas that may result in brand development and creation. The work will provide the organisations with a professional identity, help to build business cases to take the project into the market and attract funders.

OB4:   Design framework – to develop and validate an analytical framework for the application of creative design approaches, employing design tools and techniques (design thinking activity map).

The research questions were addressed through the objectives using case study and grounded theory methodologies. This research provides a platform for qualitative research, theory and practice to flow into each other through the choice of methodologies utilising methods to reach the research aim. During brand creation and development, focus group discussions (method 1), interviews and feedback (method 2), and prototyping (method 3) allowed an in-depth understanding of the insight into project partners' perceptions. The data collection and subsequent analysis through various stages of the design thinking process were useful to evaluate the societal and economic impact of the visual design outcomes.

The thesis is structured thus: the literature review, methodologies, design thinking, the five study chapters, and discussion and conclusion. Each chapter contributes to the research aim through the objectives. The literature review explores the research gap by studying various topics ranging from design, innovation and satellite and space technologies sector in the context of the UK economy. The methodologies chapter includes the research structure with questions, objectives, methodologies, and methods used. This chapter also discusses how this research's theory and practice are addressed and complement each other. The design thinking chapter synthesises currently used design thinking processes and approaches in literature. The design thinking model is further explored with interviews with designers and researchers of a social network technology organisation. From these data, the author's own design thinking model is created alongside the design activity thinking map as a theoretical framework for this research. There are five stages of the non-linear process including: the KNOWING stage that serves as a platform to better understand the organisation to create approachable and tangible lo- and hi-fi prototypes in the PACE and CRESECENDO stages. The REFLECT stage sets out to review the process and its iterations to develop design applications, and lastly, the RECOVER stage that analyses the impact in relation to the Industrial Strategy and the feedback gathered from each project partner. As findings shown in the study chapters, the author

applied the design thinking process to the collaborative work to create brand identities. This process is not fixed but quite flexible with layered stages that iterate in a loop and then intertwine in different ways depending on the specific needs of the collaborating organisations. The findings from collaborative projects are shown in the study chapter. The project partners include the Intelligent Transport, Asteroid Mining, Space Engineering, Remote Sensing and Space Settlement. The specific background of the individual project partners, the milestones from the design thinking processes valuable to this research, and the findings from interviews with professionals from each project partner can be found in these study chapters. The author communicated the idea of lo- and hi-fi prototypes within the case studies with project partners to maximise user applicability. The discussion and conclusion chapter synthesises the key findings from the study chapters more clearly, interpreting them and showing implications of milestones and interviews, their limitations, and recommendations, ending with this research's conclusion. It provides evidence that the crossover of visual design and innovation within space technology organisations enhances the practicality of UK Government's Industrial Strategy. For the research findings, branding plays a large part in communicating project partners' innovations through the application of design thinking. With the help of visual design, space technology can be understood by new audiences; hence, the emphasis is on design being able to capture breakthroughs more clearly for wider audiences and stakeholders. The visibly improved brand value mirrors the project partners' innovation, influencing the local economy long-term. Therefore, visual design has the ability to symbolise space tech innovation by employing a bespoke design thinking model.

# 2 Literature review

## 2.1 Overview

The literature the author reviewed varied from design and innovation to satellite and space technologies relevant to key topics of this research, all in the context of the UK economy. The relationship between these areas was carefully analysed to illustrate a gap to help generate new knowledge.
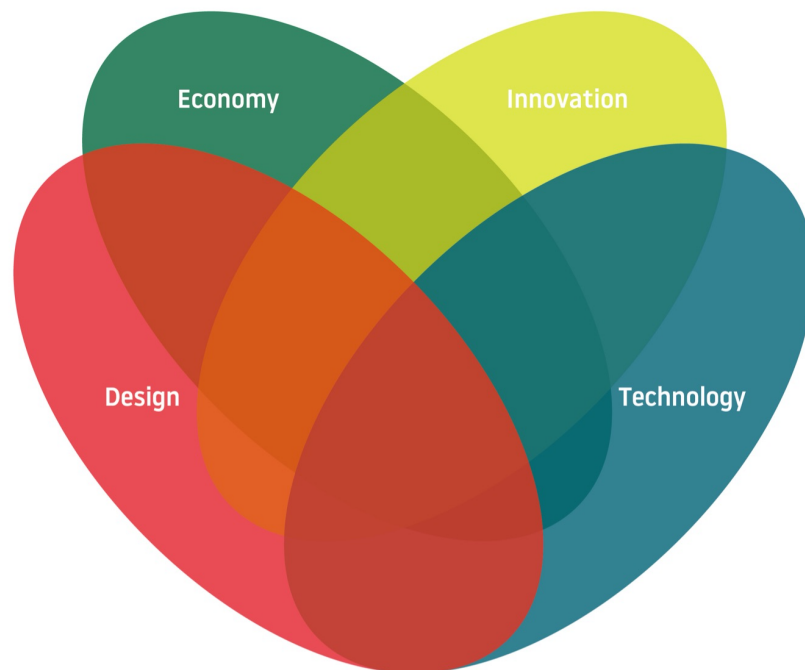


Figure 2.1 Overlapping areas: with possible emerging themes

This research aims to demonstrate how innovation culture within space and satellite organisations can be represented through a visually rich design thinking model. Therefore, the intention was to establish the effect design can have on innovation and technology and vice versa; chiefly the impact design can create in the industry. Hence, the objective of this secondary research was outlined as contextual review with the literature search directed

at the presented overlapping areas, see Figure 2.1 and Table 2.1 for keyword matrix.

Table 2.1 Keyword matrix: the literature review organised into the areas of design, economy, innovation and technology

| | | | | | | |
|---|---|---|---|---|---|---|
| **Design** brings together the pieces to create new meaning (Noble and Bestley, 2011) | ideas are the consequence of creativity (Transformation North West Cohort, 2018b) | design helps organisations become more productive and profitable (Benton et al., 2018) | through strategy, design is associated with branding (Verganti, 2009) | evident link of design and innovation and how people assign meaning to design (Hernandez et al., 2017) | design drives innovation focused on the user (The European Design Leadership Board, 2012) | satellite data makes space accessible to all and want to explore more (Maclenan, 2019) |
| design thinking equips non-designers with creativity (IDEO Design Thinking, 2020) | 'designerly' thinking (Cross, 2011) and 'silent design' (Gorb and Dumas, 1987) | strengthens internal and external communication (Scozzi et al., 2005) | brands are active agents for innovation and economic success (Design Council, 2012) | great innovation is a result of genuine design (Cooper et al., 2016) | technologies create more employment than cancelling it (Stewart, 2015) | everlasting loop, pitching in ideas and prototypes (Rothwell and Gardiner, 1985) |
| design enhances productivity (Design Council, 2020a) and business turnover (Design Council, 2012) | design skills key to professional and interpersonal development (Bakhshi et al., 2017) | **Economy** productivity and competitive markets (BEIS, 2017) | how work is addressed creatively shapes innovation (Davids, 2018) | design is a decisive change for progress (Abernathy et al., 1978) | link of design and technology with prior market research for prosperity (Dougherty, 1992) | UK space sector £300 billion worth, with 40,000 professionals employed (GOV.UK, 2020b) |
| design thinking is the foundation that comprehends and engages users (Long, 2021) | authorship can be with both, user and designer (Baldwin and Roberts, 2006) | a crossover of user experience design and research is effective when working together (Sheppard et al., 2018) | leave employees to innovate (Mills-Scofield, 2012) | where resources, techniques and motivation come together, creativity and innovation culminate (Amabile, 1988) | organisations planting design into innovation processes (Bason, 2015) | 'innovative approach to innovation' (Bazalgette, 2017) |
| design creates meaning (Verganti, 2009) | design is a small radical, surmounting frontiers for positive change (Design Council, 2020a) | innovation is tangible, purposeful and accessible (Leonard-Barton et al., 1999) | organisations require new innovative patterns that create value, develop and implement ideas, motivate leaders (Parmar et al., 2014) | **Innovation** is a process applying new ideas that transform into something tangible (Cox, 2005) | unconstrained thinking and undiscovered possibilities (Dosi, 1990) | initial outcomes and small technological innovations (Suárez et al., 1995) |
| space launch and exploration is a lasting inspiration (London Economics, 2020) | private companies work with governments to deal with big challenges (ESA, 2020) | cultivates change, pushes productivity (Oslo Manual, 2005) | low-fidelity prototypes and horizontal management (Rothwell, 1994) | fruitful innovation is not necessarily starting out revolutionary (Drucker, 2002) | advances in progressive conditions (Leeuwis et al., 2011) | hybrid across sectors for day-to-day digital solutions (Kalama, 2019) |
| visual language makes space research accessible (Spacegovuk, 2021) | hybrid between future tech and design serves as a pioneering instrument (Transformation North West Cohort, 2018a) | for businesses, space is wealth (Saint-Exupéry, 1944) | private sector space race becomes reality (Grossman, 2020; Virgingalactic, 2021; Blueorigin, 2021) | determined NW space hub (Cross, 2020) | satellites map Earth (Satellite Applications Catapult, 2021) | **Technology** space technology key sector for UK growth (BEIS, 2017) |

The keyword matrix (Table 2.1) helps navigate the literature search into workable elements with their references complementing the various themes and their crossovers.

## 2.2 Design

The author employed brand creation and development as a creative tool to communicate organisations' innovation, and consequently, this review is primarily concerned with visual design. Brands consist of visual design elements that together have the ability to communicate the value of partner organisations to their users (Lupton, 2011: 132). At the same time, visual design as part of graphic design can deliver visual communication of ideas and a problem-solving process (McCarthy, 2013: 23; Lupton, 2011: 15, 174;

Cross, 2011: 71). A visual element can complement a written piece of work but it can also act as a stand alone communication element, connected yet free from where it is set in (Kress and van Leewen, 2006: 17-19). A graphic designer maps out meaning by gathering specific data and addresses this data to highlight new meanings and correlate disparate elements (Noble and Bestley, 2011: 23-76). Visual design denotes translating and making something tangible through the use of shape, colour, typography etc. To this extent, certain visual elements can also create or highlight new meanings. It is the designer's task to communicate the proposed meaning (Baldwin and Roberts, 2006: 23-38) of the partner organisation. Proposing how a future state may look like is essential to design (Cross, 2011: 27). Visual communication is also used to create meaning in society (Kress and van Leewen, 2006: 17-19), bringing together wider audiences to participate in the discussion of the created meaning and messages. Furthermore, design could alter meaning as it moves through various applications and circumstances to achieve distinctive goals in unprecedented times of economic and societal change and in response to industrial development, e.g. automation. Design is, therefore, art in its ultimate practicability, it is coherent, and as an endeavour to make sense of things, design creates understanding (Krippendorff, 2006: iii-iv). It is tapping into the unfamiliar, drawing out and articulating a course of actions, and coming back with something of value.

With 'designerly' thinking using insightful mapping, evaluating, refining and finally producing something new (Cross, 2011: 135), visual practice can be a foundation of design thinking (Noble and Bestley, 2011: 23-76; Bresciani, 2019: 92-124) as it reflects the design process through different approaches, including drawing, creating diagrams, maps, and models. These approaches help generate and organise ideas, shape the outcome, and are therefore able to solve problems (Bresciani, 2019: 92-124).

Designer Ellen Lupton (2011) explains how 'Graphic design thinking' aids 1) problem definition, 2) ideation and 3) making stages in the design

process. 1) When talking to users, their needs, wants and current challenges can be extracted, and further brainstorming and mind mapping techniques all help define the problem and guide design direction. 2) During ideation, visual tools and techniques such as transforming an original visual idea through actions as well as clustering and synthesising visual elements e.g., typography, organise thinking patterns and support concept development. 3) Ways for user interaction can be explored collaboratively during the making stage. Based on previously developed ideas, colours, shapes and images can help create a tangible, visual prototype (Lupton, 2011: 6-11, 15-16, 22, 61-62, 74, 92, 113, 136).

The value of visual language is not new, visual communication is consistently made up of code but as its audience has learned to read visual language just as written one, it is widely acknowledged and understood (Kress and van Leeuwen, 2006: 32-34). Compared to other professions, design has a much more visual perspective on everything. Visual thinking is, therefore, a substantial part of design thinking (Goldschmidt and Smolkov, 2006: 549-569). Insights drive the design direction and thinking out loud by visually communicating and reframing the problem leads towards solving it (Cross, 2011: 69-75).

The literature demonstrated visual design as a problem-solving process (McCarthy, 2013: 23; Lupton, 2011: 15, 174; Cross, 2011: 71) with a graphic designer's ability to communicate meaning (Noble and Bestley, 2011: 23-76; Cross; Kress and van Leewen, 2006: 17-19) by synthesising elements and creating something tangible (Baldwin and Roberts, 2006: 23-38; Lupton, 2011: 113). Further discussion encompassed brands that are made of visual design elements to communicate value to users (Lupton, 2011: 132), that they can read intuitively as visual language does not require translation intrinsically (Kress and van Leeuwen, 2006: 17-19, 32-34). Design thinking iteration helps define problems using mapping techniques as it enables ideation and making (Lupton, 2011: 6-11; Cross, 2011: 135). Visual design is part of the design process (Bresciani, 2019: 92-124) and as it fosters the

finding of solutions (Cross, 2011: 69-75; Goldschmidt and Smolkov, 2006: 549-569), it can also create economic and societal change (Krippendorff, 2006: iii-iv).

There is a general consensus that recognises visual design as an important factor in solving a given problem as a key part of the process as well as the solution by bringing together ideas and communicating the value of the meaning it creates.

### 2.2.1 Design and technology in practice

With the previous section presenting the usefulness of visual design, the synergy design brings when working with science and technology will be explored here. This research specialised in satellite and space technologies because of their distinctive processes and sequences when working with designers. The literature sources validated that design creates a language that is far more universal and emotive than any other.

With design processes helping to link design and technology industries (Lupton, 2011: 6), the author tailored an own design thinking model to specific products or services with project partners based in the space technology sector. Starting with mapping out ideas, taking away, keeping, and fine-tuning them, then iterating to get to a more sophisticated stage within the design thinking process, still allowing new ideas to shape the final brand creation or development (Cross, 2011: 51).

Two of the partner organisations the author engaged with use space technologies that address issues on Earth. A literature source is concerned with the same: speed, efficiency, and sustainability. They are a combination of creativity and space exploration with noteworthy innovative results. Space is not only a driver for technology but also a focus back to life on Earth. It is design's role to help overcome big current and future societal and environmental challenges (Rawsthorn and Antonelli, 2022: 85-93). The mutual goal of creativity and science is to look thoroughly to cultivate approaches of observation and presentation (Zachry et al., 2004: 447-462).

It is essential for ideas to develop into workable design outputs. Science and technology products could be evaluated with a lot less effort than those using design, where feedback and involvement of partners in the industry are necessary as well as user testing. Design brings the energy that visualises, forms and studies ideas and can uproot seemingly persistent elements and move their boundaries (Krippendorff, 2006: 27-29). Design can bring in value by making gradual changes to challenges based on evidence from gathered data.

A different perspective helps make sense holistically – visually mapping out various forms of knowledge (Rawsthorn and Antonelli, 2022: 94-103). A fitting example of this is how NASA's image of 'Earthrise' (NASA, 2021) significantly increased people's environmental awareness as they saw the world as a whole, one that is ultimately vulnerable. Similarly, an interview with Sue Horne from the UK Space Agency, reflected on how the scientist collaboration with an installation artist Luke Jerram has helped visualise the Mars project to reach all kinds of audiences. Sue Horne then added that in an interrelationship, art and science inspire each other. Creativity brought through visual design can convey messages and emotions in a language that words cannot (Spacegovuk, 2021). In this context visual conceptualisation was pivotal and further emphasised the link of design and technology as a great opportunity for creative people to visualise ground-breaking discoveries in order to help create solutions that push the limits of the ordinary.

### 2.2.2 Design value

The author based the literature search on the UK government's Industrial Strategy (BEIS, 2017) as the research is founded on this policy, and the government's later Plan for Growth uses the Industrial Strategy as its basis. Both sources present evidence that design increases productivity and turnover. As a result, competitive markets are created, which is a prerequisite in a global world.

For strategic economic growth, the UK government outlined a number of policies on which this research was built. The Industrial Strategy is a policy that addresses the productivity as well as the performance of the economy. Its aim was to drive UK innovation and make markets competitive with other countries. The 2017 Industrial Strategy (BEIS, 2017) changed into a Plan for Growth due to the pandemic highlighting the link of creative ideas and innovation as being essential for navigating the economy, acknowledging creativity as one of the principal drivers for growth in digital and AI technologies, as well as proposing a strategy for the space sector (GOV.UK, 2021).

Evidence suggests that people skills are among the most important factors to grow healthy markets that are ready to compete. Design inspires people to face challenges and to emerge stronger over the long term (Transformation North West Cohort, 2018b). The number of professions where accuracy is key highlight the importance of the incorporation of expertise of design tools, techniques and processes. Design is considered as an asset, with 40% of the industry looking for design tools and techniques. If these are included professionally, they benefit the UK economy by adding £209bn in GVA. Design increases productivity. Employees that apply design are 47% more productive than the average, bringing an additional £10 in GVA per working hour. These skills are not limited to designers; if non-designers exploit its tools and techniques in everyday practice, design can further help the economy to prosper, with currently 2.5m workers making use of this (Design Council, 2020a: 7-18). Design helps the economy to grow. If £1 is spent on design, businesses are boosted by £20 in turnover, £4 is achieved in net profit, and £5 more in exports (Design Council, 2012: 2). Investment in design creates a value that outperforms all input, given increased, more central, commitment, leading to renewed interest in the expansion of design as a discipline (Gorb and Dumas, 1987: 150-156; Davids, 2018). Design has still not achieved an indisputable place in organisations even with evidence of the benefits of design-oriented strategies and its

contribution to business concepts from idea finding through to production. Feedback from industry partners, however, concluded that if innovation is good, it is because of development as a consequence of good design (Cooper et al., 2016).

Professions in the creative, digital, design and engineering sectors embody significant career prospects, all enhanced with design tools. Studies confirmed that the ability to be imaginative, to create concepts, and the passion to learn are all crucial for discernment, understanding relationships, and taking and verifying decisions crucial to processes at work (Bakhshi et al., 2017: 14).

The data from literature in this section indicates that design contributes to the growth of the UK economy. The value of design in this context expands beyond the generation of designed outputs (e.g., creation and development of products or services). The use of design tools and techniques within various government strategies will help companies to advance markets, boost productivity and business growth.

## 2.3 Design and innovation

Innovation rapidly becomes a key instrument for growth and prosperity. It applies novel ideas in the most practical way. The following sections explore its meaning and valuable links it has to design and technology in the context of the UK economy.

Innovation can be defined as the successful application of new ideas, a process that develops these ideas to become new products or services, novel approaches of carrying out and leading business (Cox, 2005). The Organisation for Economic Cooperation and Development (OECD) explained that innovation goes far beyond the confines of Research and Development (R&D), reaching across borders, sectors and institutions (OECD, 2018). Nesta's Bas Leurs (2018) created the landscape of innovation approaches that challenges individual preferred methods to consider different practices from a variety of areas including talent, intelligence,

solution and technology (Leurs, 2018). This research was directly informed by frequently used and emerging approaches to innovation covering issues around leadership, entrepreneurism, digital and data.

Getting to the point as to how innovation can be made to work, Peter Drucker (2002), author and management consultant, appropriated innovation as a discipline, based on knowledge rather than performance. Considering innovation as 'functional inspiration', the successful systematic practice involves an effort in order to create purposeful, focused change in the economic or social future of an organisation. Whilst innovation might originate from a stroke of genius, successful organisations consciously search for innovation opportunities, eventually finding them in a number of situations which might overlap and be located in more than one area at a time. According to Drucker (2002) innovation opportunities include: i) unexpected success or failure that can result in an unintended source of productivity; ii) the incongruity of a logical or rhythmic process from idle times; iii) minor social inventions or marketing activities; iv) changes in the industry or market structure for emerging organisations that get a head start whilst established businesses focus on their own growth issues; v) exploit changes in demographics, e.g. the usefulness of A.I. (Harari, 2017); vi) trigger user emotions; and vii) new knowledge in the areas of science, technology, and the social, public and monetary arenas. With the careful analysis of different types of knowledge, innovation can be a success. In the beginning there is a great deal of dialogue and only limited activity. But when all parts suddenly combine, huge excitement and action takes place. This is then followed by guesswork, collapse and, ultimately, recession (Drucker, 2002). Innovation processes are challenged by and rely on a matrix of synergies (Leeuwis et al., 2011: 21-36). A number of authors have considered the effects of tangible processes that significantly generate hands-on innovation, that are applicable to all kinds of business endeavours. Associated with the link of design, innovation, and economic activities, in relation to this research, it is important to acknowledge that thriving brands distinguish themselves

31

from their competitors. They advance novel concepts, generate something new, launch into new markets, and drive change in current processes and activities, while strengthening and evaluating them (Design Council, 2012: 2). The ability to take risks differentiates a designer who implements innovation to one who does not (Cross, 2011: 69). The innovative market is resilient and amplifies capability. Companies exploiting design achieve better results, 91% of those who did, were still in business after a five-year study in contrast to 49% of those companies who did not (Design Council, 2020b: 4). Design and innovation are both key to economic resilience, both are needed for progress, synthesis, and distinction in the marketplace. In a continual loop, design and innovation come into effect and produce new ideas, generating initial prototypes and resulting in final products (Rothwell and Gardiner, 1985: 167-186). The emerging revelation that ideas instigate innovation is one of the key takeaways in this research.

### 2.3.1 Role and value of design in innovation

The relationship of design and innovation plays a crucial role for organisational success. Evidence in this section suggests that the strategic use of design boosts original development by creating new patterns and structures and giving meaning to objects. In this context, good design is visionary and driving innovation.

Design thinking emphasises the role of design in various strategic functions to create a practical direction for organisations (Venkatesh et al., 2012: 289-309). The design thinking process also places users as a key source of information to be able to understand and empathise with their needs. Creating user insight helps the organisations to make better decisions strategically and to improve the quality of their products and services (Cooper et al., 2016). In the case of visual design, which is a core focus of this research, the design thinking process can be used to build more innovative brands. Design visualisation creates a conversation in the context of innovation (Hernandez et al., 2017: 1-14). Visual tools also foster creativity

32

and innovation (Goldschmidt and Smolkov, 2006: 549-569) where creativity is the origin of ideas and innovation implements these new ideas and approaches and challenges them in novel ways. Design joins the two together.

Design creates a certain energy, a passion that deals with a problem at its roots. Design is a 'small radical' that is confident, enticing a vision of future circumstances instead of only adapting to current situations. Working together with equal ambitions to find multiple ways to solve a problem is one of the drivers of design. It allows boundaries to be moved for societal change and participation that lead to encouraging progress in areas as yet untouched (Design Council, 2020a: 7-18). A significant link exists between design skills and innovation, with the same expertise being used for both (Design Council, 2017: 6-13). To make it possible for organisations to innovate, design can be empowered by creating an object, differentiating it and linking it to users or other things. Design helps to declutter, making things practicable. The interchange of meaning is the aim of design. With a history of individuals assigning meaning to objects, they can symbolise a purpose, establish expertise and steer user personality (Verganti, 2009: 5, 11-12, 24-29).

The role of design in innovation is the indicator for market engagement and prosperity. Design generates competitive advantage; it contributes to the success of new products and adds value to businesses (Hernandez et al., 2017: 1-14; Verganti, 2009: 5, 11-12, 24-29). Design helps to give meaning to a product and make sense of a task (Verganti, 2009: 5, 11-12, 24-29). Design skills achieve long-term productivity and portray innovation (Design Council, 2017: 6-13). Businesses are in need of new patterns in innovation with value creation, idea generation and implementation, motivated leadership and commitment (Parmar et al., 2014: 2). Design is differentiating to advance markets, developing new products, creating business opportunities, and managing change, improving brand value that is inclusive. As a result, growth can be exponential, needs and desires can be understood, employees satisfied, and new markets positioned. Collaboration

allows interaction and informal communication, both conducive to innovation. Design thinking is capable of evaluating organisations' challenges (Borja de Mozota, 2006). As such, there is a growing body of literature that recognises the value of design and its impact on innovation. Design helps businesses in the UK develop innovation opportunities, become more productive and profitable (Benton et al., 2018). With applied design thinking, businesses can grow. Products can reach new users and the workplace becomes more effective as people are at the heart of design. As an adaptable, powerful tool, the implementation of design results in a 20 times increased business revenue (AHRC, 2013). Design is at the heart of innovation, the 43% of people that use design in their work undertake original ideation and analytic abilities to generate creative concepts and practical solutions. Design helps understand complex and unfamiliar ideas, it moves the boundaries of opportunities and motivates the discovery of new possibilities. Genuinely new approaches can be developed that are progressive and profound by nature and do not just adapt to environments but instigate and advocate change (Design Council, 2017: 6-13). Design not only relates to innovative but also to more productive and resilient businesses over the long term. Notwithstanding, the agonising shortage in design skills at present is reducing the economy's value by £5.9bn per year (Design Council, 2020a: 7-18).

In a larger-scale study, design educators Cooper et al. (2016) discussed design value in innovation. The study demonstrated that, while being very challenging, design's contribution can be measured through the relationship it has to innovation. Design is focused on successfully developing confidence in products and services through understanding its strategic position, nuances, and through identifying its factors. It helps to make sense and take decisions. As an iterative process, design directly advances innovation whilst also supporting marketing, building brand awareness and loyalty (Cooper et al., 2016). Inspiration drives an idea through to conclusions. Design represents an iterative problem-solving approach. Users act as co-creators.

Design is innovation-friendly, eases adoption, creates relationships, and helps transform organisations (Hernandez et al., 2017: 1-14; Tech City, UK 2017).

The impact design has on innovation is not easy to prove as it is already interconnected with other business activities. However, as this literature review suggests, design provides value for enhancing innovation in organisations in a variety of ways.

### 2.3.2 Design intertwined with innovation processes

Literature sources in this section imply that designers, as well as non-designers that can be the user or creator, are concerned with design tools and techniques that can ultimately lead to innovation. Communication both inside and outside an organisation is a crucial plan of action.

Design is a pursuit of individuals. All people design, always, and it is a substantial part of a number of professions. Design is everywhere where individuals practise, ideate, outline, arrange, make, create, and showcase, where new processes and disciplines emerge that have not been seen before. Prospective ideas are imagined, verified, shaped, and exploited. Day-to-day design means interconnected perception, development, communication, and prototyping are made accountable for any work (Krippendorff, 2006: 27-29). The concept of silent design (Gorb and Dumas, 1987: 150-156) broadens the concept of individual contribution of design and leads to further understanding of the role of design within innovation processes, which is a core focus of this research. Design authors, Baldwin and Roberts, furthered this idea that communication generates meaning rather than simply moving it around various locations. Both user and designer can be authors (Baldwin and Roberts, 2006: 23-38).

With a set of ideas and principles involving users, a diverse test evaluation was explored for innovation processes in early development. The creative process as an interface of users' needs helped to make sense of a problem and ultimately assisted in making decisions. Design is not only

aesthetic but useful in this perspective; it can serve as a strategy (Cooper et al., 2016). The design thinking process applied to the case studies in this research exploited user-centred design and the strategic use of design.

The following literature focussed on innovation used strategically, feeding into previous paragraphs on how design is closely woven into innovation processes. Barbara Scozzi, an Associate Professor in Business and Management Engineering and her co-authors (2005) suggested that innovation development processes (IDP) are sophisticated, requiring understanding and experience, yet are not easy to explain before they happen. Strategic processes within IDP manifest in solving problems in business communication, that originate in innovation, enabling organisational benefit. Scozzi indicated that business culture is often responsible for a lack of motivation.

Creative processes can help overcome the problem with their capacity to generate novel ideas from perceived patterns and relationships. A shortfall of communication structure internally and externally can be improved through IDP with its ability to help information flow and intensify communication (Scozzi et al., 2005: 120-137). Technological equipment combined with diverse thinking and social development techniques can create a new practical tool for enhancing communication. Acquiring knowledge through leading processes is conducive to innovation, e.g., R&D, as well as through the appropriation of user-centred studies, meaningful communication, and circular processes such as the collaboration of people with technology as well as co-design to support intuitive participation and determine goals. Key objectives include novel elements in community and business structure, e.g., guidelines, insights, policies, characteristics, and interactions, which are all essential to processes contributing to innovation (Leeuwis et al., 2011: 21-36). Innovation and the management of innovation is of crucial tactical concern to practitioners and researchers beyond their areas of discipline (Baregheh et al., 2009: 1323-1339). Innovative thinking

empowers improved communication inside and outside of organisations and co-design activities with users.

### 2.3.3 Design, creativity, and innovation

In a never-ending design loop, novel ideas can launch and generate innovation. With ideas as the consequence of creativity, the way challenges are approached creatively directs innovation. It starts without pretension that is associated with some design activities and does not operate with rebellion. Instead, it starts with not yet defined thinking and possibilities that are still to be explored.

Teresa M. Amabile, Professor of Business Administration, observed that: "Figuratively, it is impossible to escape the reality that corporations must be innovative in order to survive" (1988: 124). Creativity in individuals and innovation in organisations are profoundly interconnected. Amabile defined creativity as the generation of original, practicable ideas of a person or small team, whereas organisational innovation is the effective execution of creative ideas in that organisation (Amabile, 1988: 123-167). Drucker established systematic innovation as deliberate and structured inquiry for transformation (Drucker, 1985), whilst Van de Ven looked at the specific person in the context of organisational structures who applies novel ideas and then becomes immersed in collaborative activities in a set time (Van de Ven, 1986: 590-607). Kanter appropriated innovation as a process that develops, evaluates, and applies a new idea that can solve problems (Kanter, 1983).

Almost every paper on innovation researched for this review, relates to the value of creativity. There is, however, discussion on how innovation is interpreted, whether it is an area of knowledge in itself or a process that builds on methods. Whilst Peter Drucker defined innovation as a discipline (Drucker, 2002), Andi Davids, at the time a Senior Strategist for the design agency Superunion, interestingly insisted that creativity is not a discipline at all but rather a process (Davids, 2018). She describes creativity as producing

ideas – which help solve problems, inspire humankind, and contribute to new or novel inventions. The application of ideas to solve business problems is a creative process. Creative thinking exhibits skill, and a person can learn to approach problems with flexibility and imagination. Davids further pointed out that there is a difference between creative work and of the way of approaching work creatively, of which the latter is exclusively a driver for innovation. She added that what matters is not a person's job description, but the creative methods used to solve organisations' problems which guarantee a clear competitive advantage. The creative process is a tool for change, it encourages collaboration and cultivates empathy. Challenges can be overcome if approached in new or novel ways (Davids, 2018). Ideas are the result of creativity (Transformation North West Cohort, 2018b) and creativity is a channel for finding answers to big challenges (IDEO, 2020).

According to George Cox, design is the link between creativity and innovation. "It shapes ideas to become practical and attractive propositions for users or customers. Design may be described as creativity deployed to a specific end" (Cox, 2005:2). He proposes that creativity is the way to new products and services and to greater productivity. When considering people-centred design, design thinking comes to mind for various authors. By drawing on the concept of design thinking, a number of sources have been able to show that it serves as a foundation for innovative activities. This is design value at work that can bring about innovation and therefore grow in the market. Design thinking is core to understanding and captivating users. The value of design translates as recruiting innovative approaches for business growth and positive change that empowers its momentum (Long, 2021). It is essential to study the needs, expectations, and values of potential users. Design is a user-centred approach that constantly refers back to the individuals (IDEO, 2020). With research being a continuous iteration of the process, another important aspect is the ability to venture out and keep improving. User experience design and research are crossing boundaries through collaboration, where all kinds of professions come together from

different areas within an organisation to overcome bias and division (Sheppard et al., 2018).

In several studies the relationship of design and innovation is as important as the way individuals allocate meaning to design. It becomes clear that innovation itself requires novel approaches to stay competitive to ever changing markets and user needs. In the review 'Design, the Language of Innovation', Hernandez et al. (2017) have looked into the competitive advantage design generates, its contribution to successful new products, and its value to business. The research thoroughly examines how innovation contributes to business success, its connection to design performance, indicating specific input of design to innovation processes, its combination (design innovation) and results, e.g., products and services. What design does to innovation is closely related to meanings people give to design as an integrator of functional, emotional, or social utilities. Design is one of the main drivers of innovation and productivity, it advances economies and proposes clusters (Hernandez et al., 2017: 1-14). Design skills achieve long-term productivity and portray innovation (Design Council, 2017: 6-13).

Design affects a variety of areas across organisations, helping interpret work in novel ways through innovating and creating new market opportunities by going beyond the usual. For example, a company that creates health technologies asked a toy designer for tangible forms and a designer from online dating portals for practicable interfaces. The combination of these different ideas helped improve the medical equipment and create a user-friendly application that understands the user's needs, is engaging, and does not the user at risk, all whilst earning investment returns of over 4% points at the time of the product launch. Value can be nurtured that comes through encouraging low-fidelity knowledge exchange and honouring first ideas without the shadow of idealism (Sheppard et al., 2018).

### 2.3.4 Technology steered by design

The background literature presented in this section suggests that in order to drive the industry's growth, design can be used as a catalyst to enhance innovation in space technology organisations. This combination of future technologies and design serves as an original tool beneficial to steadily improving the quality within organisations. It fuels people-centred innovation by communicating future technologies to new users. The literature provides important sources relating to the significance that brands have in organisations, their strategic use, and the role silent design plays. Some references draw on extensive situations where organisations are putting on an armour of creativity in order to create positive change. When design, research and technology come together, a connection between the user and the market is created. A spiral of ideas and prototypes translate into tangible structures, blending together new understanding and commitment to grow business value and prosperity.

Much of the available literature on the four overlapping topics of design, economy, innovation, and technology deal with the question of how to create the best value for businesses, exploiting a design thinking model. Design is increasingly recognised as a driver of user-centred innovation (The European Design Leadership Board, 2012: 46), and organisations are advancing by embedding design into their innovation processes (Bason, 2015). The hybrid between future tech and design serves as a pioneering instrument and concurrently as a consistent quality asset. Design can enhance productivity by: combining digital and analogue ideas; cross-industry collaboration; encouraging funders to lend to emerging tech businesses; entering new markets; helping people get into employment; improving access to information; and by communicating future technology to new users more effectively. It overcomes challenges and encourages collaboration with intelligent systems (Transformation North West Cohort, 2018a).

Design is progressively linked to branding. It is capable of learning about new audiences and working strategically, breaking through to new markets (Verganti, 2009: 5, 11-12, 24-29). For this research, branding plays a large part in visualising space technology innovations. And with the help of visual design through branding, future technology can be understood by new audiences; hence the emphasis is on design being able to capture the breakthroughs of space technology innovation. How design and creativity are linked to innovation is an ever-evolving theme throughout the literature studied for this research.

The role of non-designers is also recurrent in the literature, highlighting the importance of *doing* design rather than *being* a designer. Design Thinkers, Gorb and Dumas, (1987) have investigated design contribution to business profitability, and identified design as a problem-solving and decision-making process, something not to be confused with an end product. The creative process can change circumstances into a preferred one, with the production of 'material artefacts' through intellectual activity. Their study compared design for organisations to medicine for the ill. As an information system, design can become a communication tool within different parts and functional departments, identifying activity. Through commitment, a person with any job description can surmount a variety of traditionally functional areas. This covert activity can arguably be called 'silent design' (Gorb and Dumas, 1987: 150-156). For the optimum balance within a particular business context the study looked at the effectiveness of design activities in organisations with and without design policies and discipline control, undertaken by professional and silent designers, and whether or not success was restricted and design increased profits. As a conceptual framework, the complex problem-solving system helped specify, demonstrate, and implement design which required integration and growing awareness by the individual contributor in the design process or the input of the professional designer (Gorb and Dumas, 1987: 150-156).

Design thinking permits non-designers to work with creative tools to devote extensive energy to problem solving as a consequence of initially generating opportunities and then driving distinctive and valuable decisions (IDEO, 2020). It creates the ability to see new opportunities. To drive innovation, design has to be woven into business characteristics. Non-designers with the mindset of designers can leverage key market openings (Verganti, 2009: 5, 11-12, 24-29).

There is a growing body of literature that recognises that innovation processes in organisations are highly successful if all levels of teams and individuals are determined to support them. Organisations creating innovations that are driven by design generate meaning by using a different angle, retreating for a brief period from the user focus and augmenting the outlook to develop user life conditions. In the furtherance of initiating change, unprecedented stories are vital, the introduction of a debate on meaning from brands and products for users in an ever-changing life cycle is necessary. A loop of ideation and prototyping with interpreters that use technology creates bigger change than technology alone with added meaning. An active approach to innovation through design generates fundamental transformation in meaning (Verganti, 2009: 5, 11-12, 24-29).

### 2.3.5 The unfinished strategy

This section explores literature sources about innovation with a number of authors who discuss that innovation cannot be strictly scheduled, and that small organisations that are agile and leave people to innovate may be more innovative. Despite some of the authors of the previous section highlighting the importance of structure, an unrestricted approach can advance an enthusiastic workplace and create a platform for strategy. An organisation profits from highly principled, well-prepared employees who are then entrusted to do the job. With the productivity that comes with innovative activities, markets can advance despite various major global issues and in different local communities. Other sources highlighted the importance of a

bottom-up approach joining forces with rapid prototyping as some in-between ideas presented quickly and early on can help produce innovations in the technology sector that may be less important at the time but that sustain over the long term.

As innovation and innovation processes are characteristically elaborate, they would be unsuccessful if overly planned ahead. The possibility to change can accelerate in a dynamic environment with current techniques sufficiently accommodated for competitive advantage. If a process is promoted strategically, e.g., effective building of networks and management of conflicts etc., a matrix of routine exchange becomes viable in diverse areas, levels, and interest groups without institutionalised engagement (Leeuwis et al., 2011: 21-36).

Roy Rothwell thinks that smaller companies assume the largest part in innovation. Since a significant element for a new tech company is finding investors to provide adequate funding, building a sophisticated network for innovative organisations is a task that requires favourable economic and local conditions (Rothwell, 1982: 361-369). Connecting to this sophisticated network, when talking about individual contribution innovation, authentic involvement as well as physical and abstract information develops confidence in a person, in activities or new technologies, which then uses this 'hope' strategically and makes a beneficial outcome possible. A practical, positive attitude is a much-needed element to foster innovation (Mills-Scofield, 2012). An organisation would ideally employ people with strong virtues, equip them reasonably well, and leave them to it.

The issue of entering new markets has received considerable critical attention, with existing sources of research suggesting that innovation and emerging technologies go hand in hand. New technological developments are regarded as a process of making technological change 'market ready'. Innovation processes in the industry are broadly understood to advance linearly from experimental findings by augmenting technology in companies into new markets (Rothwell, 1994: 7-31). The Oslo Manual for measuring

innovation describes it as a major driver of productivity that can strengthen economic growth and development, a progress facing several social challenges, many of which are global in nature (Oslo Manual, 2005: 11-20).

In terms of economic benefit, a number of studies have proposed a convergence between technological and innovative advancement, exploiting research to tap into markets strategically. As a response to the emerging market needs, research and development (R&D) links to operating units. With a varied take on business, technological change and advances in marketing strategy, the market need is determined, and product development, manufacturing and sales then undertaken (Rothwell, 1994: 7-31). R&D is coupled with strategic marketing as an interactive endeavour, connecting different professions from the inside with the extensive experimental, high-tech network outside the organisation as well as to the industry in carrying out projects on a corporate level (Rothwell et al., 1985: 167-186). Shorter product life cycles drive product development, while suppliers and a variety of in-house departments integrated into the corporation add value and increased productivity, allowing a functional crossing point of concentrated exchange of information to emerge. In order to adapt and accelerate, progress is established with process automation, strategic collaboration, open innovation, and product value in quality (Rothwell, 1994: 7-31).

It is well accepted in a variety of sources that if innovation is used strategically in the early stages, technology products will thrive. The success of a new product cannot be taken for granted, but considering the return of an effective innovation strategy sufficiently rationalises further awareness of methods employed to form, advance and exploit new products (Cooper et al., 1986: 71-85).

With fast innovation – being first enables greater market share and exclusive rights, contented users, an uncompromising, short-term versus long-term perspective, and a process of integrated, cross-functional systems and networks. A horizontal approach to management and efficient, low-

fidelity prototyping advocates products and real time processing of information (Rothwell, 1994: 7-31). When users adapt and evaluate early products, smaller technological innovations are incorporated into a design already. The prospect for survival in the market is higher for organisations who started before a dominant design came to life than those who started business afterwards (Suárez et al., 1995: 415-430).

## 2.4 Technology

With the key focus on satellite and space technologies for this research, a number of sources backed the huge commercial advantage the industry has to offer. Navigating with a diversity of other sectors, space technologies find intelligent everyday solutions. From a commercial point of view, space endeavours have already become very much a reality. Space has monetary resources to offer to businesses, with value coming through as billions in profit and employment with several authors pointing to a trend of job creation rather than its termination. Various references identified the making of a local North West space hub as a pioneering strategy. Literature findings provided evidence for the satellite and space technologies sector to present as one of the core industries for growth; hence, the author decided to help local satellite and space tech organisations to communicate their innovation more effectively as a means of adding value to the region.

### 2.4.1 Space innovation for growth

Developments in space create enthusiasm in an unsuspecting audience and raise awareness of its expansive economic benefit. Northern Sky Research projects that the satellite and space industry can earn $225 billion over the next ten years. According to Innovate UK, there has been a steady growth of 3.3% per year and a revenue of £14.8 billion from the UK space industry in 2016 and 2017. The specialist policy consultancy London Economics was looking into how the digital industrial revolution profits from manufacturing for the space industry and through the Industrial Strategy Challenge fund

(Manufacturing Made Smarter) that helped nearly half the cost of manufacturing satellites. The space sector provides conditions for cross-collaboration with various industries to come up with digital answers for everyday life (Kalama, 2019).

The UK Government is funding a variety of projects in the UK space industry that take place around the world, offering £5 million for organisations involved in building space robotics, helping in big challenges like crises and reducing debris, with a variety of satellite applications. Such earth observation (EO) technologies can monitor climate change. Innovation is at the heart of the UK Space Agency's programme that provides assistance to new space technologies in response to commercialisation, export, scientific breakthroughs and to protect the UK from threat. The UK engages in international trade by exploiting space launch technologies and building spaceports (GOV.UK, 2020b). However, some researchers have analysed the discrepancy between the UK government's promises and sustaining commitments. This is of particular interest because there was lack of involvement by the UK government for a long time, including not partaking in the International Space Station and not sending a human crew into space. Though collaborations with other space agencies around the world are ongoing, they are outside the public view. Greater interest was sparked at the beginning of the 21st century when the private industry space race developed something tangible (Grossman, 2020).

Some figures revealed that the cooperative benefit is already of great significance. Economically, the UK space sector has grown by more than 60% since 2010. With the UK's involvement in projects using satellite technologies, over 40,000 people are currently in employment, which is made possible by an industry that is worth £300 billion. Furthermore, the number of opportunities is increasing as the UK space sector is valued to be worth an additional £60 billion, entering new markets with earth observation and communication technologies. And even though it is now

independent of the EU, the UK remains a leading member of the European Space Agency (GOV.UK, 2020b).

Aiming the attention to local endeavours, sources provided evidence that point to a prosperous future. In particular, England's North West is gaining importance in this fast-growing sector as the UK Government is subsidising a new 'space hub' specialised in digital applications and advanced manufacturing (Cross, 2021). The projects allow space clusters to develop, attract investors to help advance space technologies and increase local interest, which are all valuable to the North West's economy and beyond. The Chairman of the Northern Space Consortium (NSC), Bob Morris, supported the bid for the space hub as it is not only beneficial for England's North West but for the UK as a whole. The NSC was established to advance the abilities and specialisms in the North West that reflect back into the industry overall. The NSC highly anticipates the collaboration with the Science and Technology Facilities Council (STFC) and numerous space tech organisations in the region to develop the sector further (Cross, 2020). The Director of Clusters and Campus Development at UKRI-STFC, Dr Barbara Ghinelli, indicated that the North West space hub is creating significant opportunities with its established connections to the Harwell Space Gateway, and its partnership with the UK Space Agency and Satellite Applications Catapult. In a joint effort, the space hub will benefit the region, reinforce the space sector nationally, and grow into a substantial competitor internationally (Sci-Tech Daresbury, 2020).

With local councils backing the proposal of strengthening the space sector in the North West, the digital applications and advanced manufacturing markets would hugely benefit the UK, gaining a £15 billion profit annually (Cross, 2020).

The Industrial Strategy offers information about economic growth, depicting benefit across industries. The UK government has identified important sectors for growth where it has a competitive advantage, including artificial intelligence and satellite technology. Adapting emerging

technologies, new techniques, methodologies, and novel processes applied in the production of services and products, are fundamental for prosperity and growth. The North West contributes to aerospace and satellite technology, with Lancashire having the highest concentration of aerospace production in the UK, with over 20,000 employed in the sector across 120 companies (BEIS, 2017).

Moreover, the space industry offers a great variety of opportunities to help grow the UK economy, by e.g., generating specialist careers, and by addressing climate change and pandemics. Space technology has been identified as a main sector to advance the UK economy (BEIS, 2017). Through the UK's capability of launching nanosatellites that monitor and communicate, useful data and applications investigate and project meaningful insights that help take decisions and reduce risks in order to control disasters and concurrently benefit the Industrial Strategy (GOV.UK, 2020a).

This research, therefore, chose to explore satellite and space technologies, and therefore the literature sources were selected to match technologies used in a number of areas with a wider impact across industries, all in relation to the UK government's Industrial Strategy and plan for growth. A tailored review of background literature that is fitting to a certain category of space technology can be found in each individual project's findings.

### 2.4.2 Satellite and space sector development

This research has a potential impact, fitting to a time of new space exploration. It is reflected by the desire to further the enthusiasm for the sector through design. Thus, the literature review was conducted to investigate the current commercial space race and the collaboration of government and private sector. Additionally, satellite activities that tackle issues on Earth, and the withdrawal of government support of local rocket

manufacturers, were also researched to identify the contextual issues surrounding the sector.

What seemed to be impossible has become reality: from billionaires racing to travel to space (Virgingalactic, 2021; Blueorigin, 2021) to satellites being used to map elements on Earth (Satellite Applications Catapult, 2021). Whether going to the moon and to Mars or using space data to trace diseases and prevent criminal activities, all explore possibilities to enhance life on Earth and beyond. Space travel has already made a definite impact, e.g., Sir Richard Branson can fly people to the edge of space with his space licence and other commercial space astronauts are setting off for a race (Amos, 2021). Satellite and space technologies can be categorised into upstream and downstream sectors. Upstream space technologies provide ground and space segments, research, and consultancy. The downstream sector exploits satellite communications, broadcasting, Earth observation (EO) and navigation, among others (Parliament.uk, 2007). With one-third upstream and two-thirds downstream capabilities in the UK (Cross, 2021), collaboration across sectors, private and government, including non-space sectors that are using space applications were made available.

In a number of countries and economic unions, impressive partnerships with businesses like NASA and SpaceX are creating state of the art ventures (Spacex, 2021). Moreover, the car industry is investing in rocket technology, e.g., Porsche became a stakeholder in Isar Aerospace, a collaboration that triggers innovation in advanced manufacturing with a prospective growth factor, making it possible to launch satellites by using automated processes (Porsche, 2021). Satellites such as the Sentinel-6 are also increasingly launched by private sector rockets, whilst working together with various governments to tackle big issues such as change in climate patterns (ESA, 2020).

One major issue came to light, with the UK perhaps not being as forward as other countries. Jarvis (2021) disagrees with the government's excitement and points out the lack of government support, particularly in the area of

rocketry. Supplementary to potential launch activities, rockets can likely turn out to be a real driver for growth. With a small but significant amendment in the government's statement in September 2020, the mention of rockets and launchers made in the UK have silently gone off the record of the government's space strategy. Now, resources primarily go to satellites and spaceports that result in a less effective motivation for the future economy. The new UK aim suggests that only satellites built in the UK would take off from local spaceports, which means that 90% less profit can be achieved through the UK space network. Derived from the original schedule, UK built rockets have been removed from the list, which would indicate an unfavourable outcome that is unable to translate into a gain in expertise and an innovative future generation (Jarvis, 2021).

### 2.4.3 Satellite data and space launch

Various sources in this section have pointed to the importance of data from space, making space accessible and one of the main motivators with digital solutions to untangle complex issues on Earth and provide room for more research. Space activities that revolve around the key areas including global navigation system (GNSS), earth observation (EO), communications and new use of space data include artificial intelligence (AI), launch and exploration. These pursuits are a constant inspiration for future generations (London Economics, 2020). As a catalyst for cutting edge technology, the space sector materialises as society's inspiration with infinite emerging opportunities across sectors.

When looking at EO, the extent of it has increased strikingly ever since it first started a few decades ago when only a small number of countries were financially and technically able to launch satellites, which then comprised the dimensions of a large car. The size of satellites has shrunk considerably with sensor technology being able to provide space images useful for analysis. Importantly, the partnership between commercial organisations and governments to monitor the universe and feed information to eager scientists

and watchers back on Earth helped with the advancement of the satellite technology to enable the reduction of its size. Practicable hardware components, combined with advanced software and AI to tackle extensive data and provide insight instantly, make up the critical aspect for accessibility into space (Maclenan, 2019).

Along with the advancement of satellite technology, a number of inspiring developments to some are emerging with the ability to launch spacecraft and ensuring possibilities of furthering space clusters within the UK as well as it becoming a recognised hub internationally. Cornwall is partnering with Virgin Orbit to make spaceflight from the UK possible (Spaceportcornwall.com, 2020). Not long after this, Shetland Space Centre aims to create over 600 employment opportunities within the centre as well as in manufacturing and support, and is already collaborating with Lockheed Martin to move its space activities (GOV.UK, 2020a). Many more locations have applied to follow this example, helping the UK establish itself as a preferred venue for launching into space.

With much business-related movement proceeding, the UK represents an excellent model of launch prospects. As specified by Robin Hague, Head of Launch at Skyrora, the general opinion does not expect the UK to retain space tech start-ups. More remarkably, amidst nascent growth, space start-ups are already a far more common picture throughout the UK with more advancement including space ports with launching possibilities to come (Grossman, 2020).

## 2.5 To conclude,

The literature review depicted the notion of design as a means to generate value through communicating innovation in the satellite and space technology sector, reaching across industries and ultimately benefitting the UK economy. Specific attention was paid to the Industrial Strategy for the North West of England and its national and international impact.

This research aims to demonstrate how innovation culture within space and satellite organisations can be represented through a visually rich design thinking model. How visual design affects innovation was implied alongside the importance of strategy for both design and innovation. The relationship between the areas researched stood out with compelling links found between design, economy, innovation, and technology.

The keyword matrix (Table 2.1) can help navigate the literature search into workable elements with their references complementing the various themes and their crossovers. The literature discussed design as a meaning creator (Noble and Bestley, 2011: 23-76; Verganti, 2009: 5, 11-12, 24-29; Hernandez et al., 2017: 1-14); a helper for more productivity and profitability (Benton et al., 2018; Design Council, 2020a: 7-18); and as a key to professional and interpersonal development (Bakhshi et al., 2017: 14), with brands in particular accounting for innovation and economic success (Design Council, 2012: 2). Economy was then laid out as the link to making design a valuable resource for innovation in technologies of the future, with organisations being encouraged to plant design into their innovation processes (Bason, 2015); market research as a stepping stone to prosperity (Dougherty, 1992: 179-202); design thinking as the foundation to understanding and engaging users (Long, 2021; Sheppard et al., 2018); and the synergy of resources, techniques and motivation as the summit of creativity and innovation (Amabile, 1988: 123-167). The process of applying new ideas to create something tangible (Cross, 2011: 27, 51, 69-75, 135; Cox, 2005) has been validated as innovation. Further literature review presented innovation as a driver for change and productivity (Oslo Manual, 2005: 11-20; Leeuwis et al., 2011: 21-36); a small radical (Design Council, 2020a: 7-18; Drucker 2002; Suárez et al., 1995: 415-430); and as the result of genuine design (Cooper et al., 2016). A selection of literature sources addressed technology useful to this research with space technology determined as a key sector for UK growth (BEIS, 2017; GOV.UK, 2020b) and identifying the North West of England as one of the UK's space hubs (Cross, 2020), with

space generating wealth for businesses (Saint-Exupéry, 1944) and its exploration as a lasting inspiration (London Economics, 2020; Maclenan, 2019). The literature search highlighted how visual language allows accessibility to space research (Spacegovuk, 2021) and, in this relation, how innovation takes shape at work through creativity (Davids, 2018).

An emerging interwoven body of evidence was a result of several factors, encompassing the influence of design practice on diverse technologies; how all-embracing design focusing on users and engaging with partners can help grow and enter new markets and feed into innovation processes strategically. In summary, this research intended to entice the audience to come on a journey of visual design promoting space technology innovations in the light of the expanding body of literature that is sharing this excitement and verifying societal and monetary gain.

# 3 Methodologies

## 3.1 Overview

The overall methodology can be understood as exploratory in the context of this empirical research. It was a hybrid of scientific inquiry with the dynamic of creative input. Research in the field of visual design can be an analytical as well as a practical tool, bringing about critical thinking and mature design practice (Noble and Bestley, 2011: 23-76). Two intertwining methodologies were used to produce holistic insight from contrasting evidence. Case study and grounded theory methodologies combined to foster exciting research that has previously received minimal attention. From an interpretivist perspective (Salmons, 2016: 17-39), involving the core question from the start, data collected during the case studies was analysed through coding concepts and categories, recognising patterns (Chun et al., 2019), concluding in grounded theory. As an ambassador for all project partners, the researcher examines the data and explains it, creating a new hypothesis that is open to change (Pettigrew, 1997: 337-348), whilst obtaining a perspective that encourages a flexible process (Mills et al., 2009). Grounded theory operates as a way of analysing all context, e.g., qualitative secondary research in form of the literature review and primary research from case studies and therein focus group discussions that include workshops and in-depth discussions with industry partners. Through design thinking, case studies generated both low- and high-fidelity prototypes. Exploratory interviews with stakeholders in person and online as well as feedback served as further primary research resources that attempted to relate back and link up to the secondary research at the beginning. The methodologies were concerned with the main aim of the research and the research question that tuned into objectives, as illustrated in the following structure.

Being drawn to the satellite and space technology sector, the author acted as an interpreter aiming to pinpoint visual design as a driver for

innovation and build the momentum that fuses different ends of one universe to create a sense of belonging in the story of an unfinished journey.

Five case studies were established with organisations working with space, of which the first two were contacted by the author, following thorough research and a personal interest in the satellite and space technology sector. The other three were pointed out to the researcher by an organisation that advocates space industry partnerships in the region. Through exploratory research, an imminent problem that needed solving was identified, as well as reflection on how the problem-solving process could be improved as a benchmark for others. The empirical and qualitative data was analysed through grounded theory to define emerging patterns, codes, and matrices, via recordings of direct observations and reflections from focus group discussions, interviews, and prototyping. These were all conducted with diverse professionals of each partner organisation, which evaluated the benefits and drawbacks of organisational innovation and visual design processes. The design thinking process was identified, and a brand strategy applied to each case study project and then compared, together with the collection of feedback. The author then mapped out and interpreted the various elements of evidence to make sense of them individually and in combination, and for careful validation fitting to this research.

## 3.2 Research elements

Q How can design thinking communicate the values of space tech organisations in order to foster an innovation culture?

Q1 How can the values of space tech organisations be communicated effectively?

Q2 How can a design thinking model advance innovation culture in space tech organisations?

Q4 How can iterative visual design activities link research and practice and drive a culture of innovation?

Q3 What is the role of brand creation and development in innovation in space tech organisations?

O1 contextual review

O2 design thinking model

O4 design framework

O3 projects with partners

MA case studies

MB grounded theory

M1 focus group discussions

M2 interviews and feedback

M3 prototypes

....... core research question and methodologies
——— subquestions, objectives and methods

Figure 3.1 Research structure: the relationship of questions (Q), objectives (O) and methodologies (MA+MB) as well as methods (M) employed in the research

This research aims to demonstrate how innovation culture within space and satellite organisations can be represented through a visually rich design thinking model. Using the sequence diagram (Figure 3.1) that serves as a

research structure, the following paragraphs detail the methodologies applied in this research with the appropriate methods that relate back to the objectives and research questions. The core question driving this research was 'How can communicating the values of space tech organisations through design thinking work towards innovation culture?' As the overall research question was made up of various elements, it was broken down into four questions that addressed the objectives that could then be fulfilled via methods to create new, thought-provoking knowledge. All questions were examined using case studies (MA) and grounded theory (MB) as this research's applied methodologies. This included initial coding; the interrogation of all collected data; and the creation of concepts, concluding in a theory to methodically establish the hypothesis (MB). The data investigated was collected in focus group discussions (FGDs), interviews, feedback, and prototypes (M1-3) through the five case studies with project partners (O3). It was generated through testing and failing (Silverman, 2017: 263, 283, 297, 475) and prototyping again in a constant loop (M3), using the design thinking model (O2). The benefits were that, through coding, data can be explained, and the interdependence of methodologies, methods and processes promoted practicable quality (Chun et al., 2019). However, when looking at data and producing theory (MB), a constraint implied that the research may lose some of its energy and become passive (Krippendorff, 2006: 27-29). The researcher's chosen combination of the two methodologies with a large amount of practical work in the form of case studies (MA) helped create a unique dynamic interrogating grounded theory (MB).

As part of the contextual review (O1) the researcher analysed background literature, worked with organisations (O3) and interviewed its employees (M2), using an interpretivist research philosophy (MB) with a focus on innovation of satellite and space technologies, design and its contribution to innovation that were anchored in the Industrial Strategy of the UK Government. Contextual research as an element of visual research

embraced the investigation of current visual design associated with the desired task being transformed into new strategies and methods (Noble and Bestley, 2011: 23-76).

To help make sense of terms used throughout this thesis for contextual review (O1), the author created a glossary that can be found before the introduction. By investigating glossaries in other theses, e.g. 'The Production of Digital Public Spaces' (Salinas, 2016: 224-225), in journals and reports such as the response document from the author's cohort (Transformation North West Cohort, 2018a: 52-53) and in books, e.g. 'Flow' (Csikzentmihalyi, 1990: 241-280), the author defined key terms to signpost the reader where a specific phrase may not be immediately clear to support easy access and understanding in a given context as well as allowed her own interpretation to shape relevant topics within this research.

This exploratory research analysed how and why certain things occur in a designated time frame, verified empirically, by observation and experience (Mills et al., 2009). A study of processes rather than events, was a result of viewing the language as a processual tool to represent research. The research methodologies allowed various perspectives that were out of the ordinary that accumulated in a nonlinear strategy (O2), for communicating ideas to project partners (Nyrnes, 2006). However, various processes can include more straightforward, on-course and accumulating elements that are less open to change, yet a diverse selection developed a dynamic and revolutionary approach (Pettigrew, 1997: 337-348), beneficial to this research.

Design can communicate and code an extensive amount of detailed, intertwined, varied, and layered approaches to generate meaning (Tufte, 1990: 38-65). Combining theoretical and practical insight within creative work and finding its links in case studies (Nyrnes, 2006), to create meaning as theory was also a part of the practice (O3; MA+MB; see also Figure 3.4).

The author ran workshops as part of the focus group discussions (FGDs; M1) in collaboration with colleagues as well as industry partners (O3) in

order to establish a design framework (O4). This was done through grounded theory (MB) that implemented primarily qualitative research and identified a matrix which served as a map as part of the design thinking model (O2).

### 3.2.1 Exploratory study of design and innovation

The exploratory qualitative study aimed to reinforce findings and conclusions that generated thorough insight through the process (O2) applied to this research. The researcher as interpreter built on data collected through FGDs, interviews, feedback and prototypes with partners and their stakeholders, see Table 3.1 in Section 3.3 below. Participatory input and viewpoints collected with these methods (M1-3) in all the projects (O3) formed the framework (Salmons, 2016: 17-39). The framework (O4) was to follow data collection that was directed at the research aim (Heaton, 2004: 58).

Semi-structured face-to-face or side-by-side and structured online interviews (e-interviews; M2) were employed to identify the role of design in innovation. The first section of the interview dealt with innovation processes within an organisation in general, and the second was about the role of design in innovation. The researcher's structured e-interview on design value of the partner organisation's innovation (O3) was a mix of qualitative open questions and quantitative questions in order to generate and compare data with longer, in-depth answers to create insight (O4). With the online interview submitted to industry partners, the author validated the answers to the questionnaire type e-interviews completed by a variety of staff in each organisation. The structured e-interview also served as a base for the semi-structured interviews (O1) with key employees from each partner organisation to get a more detailed view on challenges, opportunities and innovation processes within the organisation. Feedback (M2) was collected after each project as part of the evaluation. The answered feedback forms (M2) then provided useful insight for validation of the design thinking model (O2) that employed FGDs (M1) and prototypes (M3).

At the end of all engagements with the industry partners, study reports were created that showed the evidence of design value in innovation (O4). By creating a matrix from the answers of in-person semi-structured and online structured interviews as well as feedback (M2), the output operated as a map, with recorded activity, identified as constant or sporadic and quantified as continuous or intermittent (MB; Gorb and Dumas, 1987: 150-156).

Essentially, this research drew its existence from all five projects with partner organisations (O3; MA), which constituted the practical aspect of the research. The author aimed to involve small, medium and large, local and international organisations to gain the full scope of design value in innovation in the industry. However, despite reaching out internationally, the organisations involved were all small and medium in size with their base in England's North West. With the partners' distinctive specialisms and stakeholder professions, the research has seen rich sources of data (M1-3) to a larger extent than hoped for, see Table 3.1. Activities took place within projects with five industry partners (1-5) in the form of case studies (MA). Observations (O1; M1) as part of the research analysis (MB) played a large part alongside prototypes (M3) in projects within future technology organisations. The researcher wanted to find out whether innovation processes were formulised and how design adds value to the organisation's innovation (M1-3). A qualitative approach included coding and clustering of collected findings, which were then compared and discussed, and then generated the research analysis (MA+MB; Cooper et al., 2016).

The author designed a visual language, using the design thinking model (O2) to accelerate innovation in the prototype project (1) Intelligent Transport that uses satellite technology to improve traffic flow. The visual output (M3) in the form of a brand assisted the company to build a business case to take the project into the market (O4). The second project partner (2) was looking for funders for its first satellite launch ahead of Asteroid Mining activities. The designer developed the brand (M3) to communicate the organisation's innovation by promoting an optimal market position. A

rebrand was welcomed by the third partner (3) that is currently working to explore and develop space with four subdivisions, including lunar and Mars rovers, rocketry, space balloon and cansat. The Space Engineering organisation is aiming to attract more sponsors, partners, and potential colleagues with the enhanced presentation through new brand creation (M3). The fourth partner (4) is mapping wildfire patterns via satellite Earth observation data. By understanding and exploiting the power of visual design (O4), the Remote Sensing company was able to reach new audiences, initiate enthusiasm in the space industry and the nature of its work. The unfinished fifth project (5) with a creative orientation (M3) working towards brand development, application and guidelines was set up in the field of Education in Space Settlement that develops workshops aimed at high school children.

The role of visual design as a tool to improve communication in multi-disciplinary teams was investigated through case studies (MA) in collaboration with the five distinct partners (O3), see Table 3.1 below. In the interest of creating a detailed inquiry, the general aim was to develop a full understanding (MB) of each case study.

## 3.3 Case studies

The following table provides an overview of the five organisations, the author partnered with to develop or create brand language to communicate and conclusively accelerate their innovation.

Table 3.1 Project partners

| Project | organisation type | specialism and rationale | employees and stakeholders | value created |
|---|---|---|---|---|
| Intelligent Transport (1) | SME | smart traffic application: GPS controlled sensors ensure green light corridors | Digital Leads Animators Developers | shift in thinking, app to enter new markets, business model development |
| Asteroid Mining (2) | SME | satellite launch prior to space | Engineers Scientists | practical application ready for |

| | | mining activities targeting resources on near-Earth asteroids | Astrogeologists Investment Analysts | publication, visual recognition, increased profit |
|---|---|---|---|---|
| Space Engineering (3) | student society | explores and develops space with four subdivisions: lunar and Mars rovers, rocketry, space balloon and cansat | Project Planners Aerospace Engineers Outreach Officers Treasurers | rebrand creates new interest in prospective sponsors and members, raises image |
| Remote Sensing (4) | start-up (SME) | by interpreting radar data, satellite technology is used to prevent wildfires | Researchers Technical Leads Geologists | audience receptive to geoportal service through design, enhanced presentation, increased trust |
| Space Settlement *(unfinished)* (5) | charity | young people can take charge of their future skills through the scenario of life on Mars | Immersive Technology Developers 3D Printing Prototypers Sensor Design Engineers Space Lawyers | the creative orientation can be used for further development and collaboration, brand application to secure new participants |

Case studies were used to demonstrate and test the design thinking process in space technology organisations and thus a link between theory and practice, see also Figure 3.4. These allowed the researcher to explore the different organisations' approaches to innovation in the research context and helped introduce novel and compelling perspectives that had not been expected at the beginning.

As case studies can involve different, specialised backgrounds (see Table 3.1 above), they drew on original data that proved helpful for analysis in order to create authentic, versatile outcomes (Yin, 2014: 17). A case study is an inquiry that serves as a layered, complex methodology, exploited, and refined by the researcher in combination with involved partners that helps generate new knowledge. Multiple channels of evidence help analyse data through detailed, strategic evaluation to create practicable meaning (Yazan, 2015: 134-152).

Limitations of each case study and what prompted special excitement for this research were outlined, and the approach and details that were analysed, were explained. The aim was to preserve the coherence of all the case studies whilst also recognising each project's specialities. They were combined for a useful comparison of the various frameworks (Silverman, 2017: 263, 283, 297, 475). Research of multiple case studies allowed intelligible boundaries to conclude in purposeful inquiry (Yin, 2014: 17). The value of researching critically throughout the projects and linking details to extensive patterns resulted in different ways of looking at the context of this research through the perspectives of various employees and stakeholders within the partner organisations (see Table 3.1; Salmons, 2016: 17-39).

The following timeline (Figure 3.2) of all the case studies allows the reader to understand the time and amount of work that was done with partners in the industry for this research, and maps out the methods that were used to deliver tailored brand development and creation to these organisations in the satellite and space technology sector.
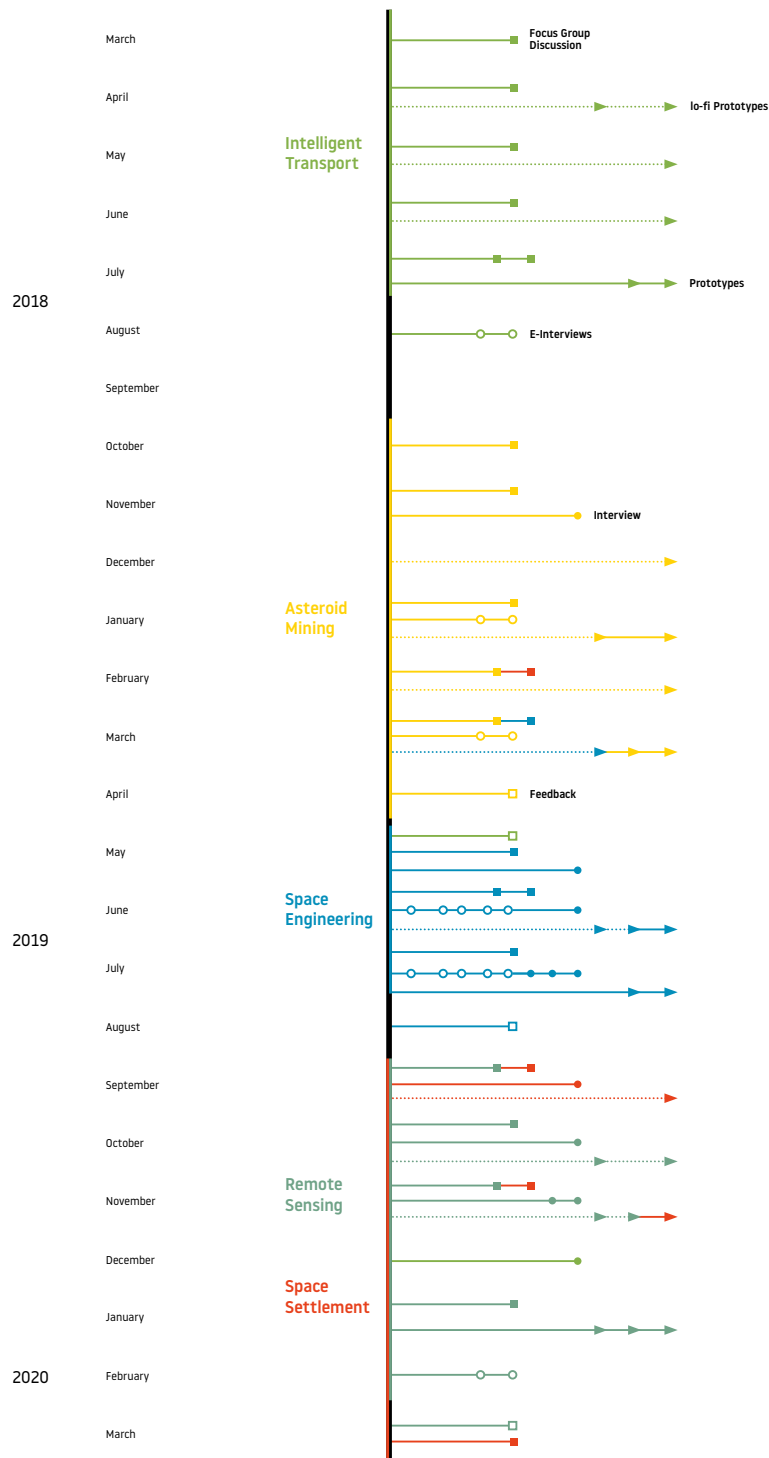
Figure 3.2 Timeline of projects: as case studies with methods used

The projects undertaken for this research were practice-based, which contributed to grounded theory, as well as the production of creative visual work. This drew on engagement with key stakeholders in organisations through focus group discussions (FGDs), including workshops and a series of interviews, e.g., to better understand the partner organisation's innovation, through co-creating ideas as well as the application of design expertise and help to visualise this (low and high-fidelity prototypes). The intention of each project was to: 1) understand the nature of innovation; 2) work with the organisation to visualise their innovation; and 3) determine, in collaboration with the project partners, the potential role of visual design to improve the innovation.

## 3.4 Grounded theory

Grounded theory uses processes in organisations that employ reasoning to link to an original theory, sort ideas from the organisations, and advance experiences. It can be compared to the lifecycle of being born, growing, shaping one's own life and that of others, changing, and finally dying (Pettigrew, 1997: 337-348). In this continuous analogy, the researcher took away and added, always compared, and analysed relevant research elements, which then became coded and turned into categories. Over time, the loop was repeated with old and new elements compared against each other that brought about new data. Something led to something else in the inductive part of the analysis, which was logical in the deductive part, and involved thinking and reasoning processes in the abductive part. By incorporating these processes, the hypothesis was established. Coherence and conflict in ideas and patterns were discovered that were shielded from mere explanatory reasoning (Chun et al., 2019). Through the eye of an interpreter, grounded theory meant creating a systematic, causal account for this research. It asked questions to produce a hands-on, new theory (Salmons, 2016: 17-39). What, how, why, and when questions were important to recognise the emergence of the study as a whole, looking at the relationship

of processes, framework and results holistically rather than through a horizontal approach. Some of the processes were still straight forward and probably less able to adapt to transformation but others had a more layered approach, with a process that can go back and forth, urging change. As this research became more layered, the process was adapted to specific needs within each case study. Exposure to a variety of actions was central to this research (Pettigrew, 1997: 337-348).

### 3.4.1 Data analysis

For this research, the design framework and the relationship of methods and processes were important to generate the final grounded theory. The researcher employed *purposive* sampling through selecting participants and in collecting data, using a variety of methods. Through focus groups, interviews, e-interviews, prototypes and feedback, data was accumulated or produced. Early code established categories relevant to this research. Initial coding created meaning; subsequent patterns started to emerge that were valuable for comparison. Midway through the analysis, transitional code helped choose the category that is central to this research. Once the data was fully immersed and engaged, the progressive code created the narrative; theoretical sampling was to establish and understand evidence through analysing, resolve divisions, and explain, test, and communicate improvements. The hypothetical code was crucial to develop the grounded theory. This whole process of constantly analysing in a comparative way together with the chosen project partners and sample data, could ultimately answer the research question (Chun et al., 2019).

Purposive sampling was the choice for this qualitative research. In the context of this study, smaller groups of participants that focused on relationships of a variety of collected data, narrowed down codes and concepts as the research went on, progressing to theories and then a final theory, determining samples in every part of the process (Miles and Huberman, 1994: 27, 57, 71, 92, 268).

Even though there were no perfect processes or stages for this type of research as such, through practical experience, a certain mix of models and methods helped navigate the central research question, giving rise to complementary questions (see Figure 3.1 research structure), accumulating exploratory data and identifying initial patterns. The iterating loop of quick and free writing, removing, or validating, highlighting questions and ideas, then collecting more data and further identification of patterns through case studies were analysed through comparatives and filtered through research language and questions in a combination of methods (Pettigrew, 1997: 337-348), all of which were valuable to this research.

### 3.4.2 The role of memo writing

Coding can be understood as a loop of continuous comparison, the abstracting of data. With the help of memo writing, sampling took place. Through continuous data analysis, new possibilities were found which then advanced sampling and refined the research questions. Through this loop, ideas were mapped out, theories began to take shape, and memos accelerated the removal of unwanted elements from emerging patterns and categories that are crucial to the quality of grounded theory.

For this research memoing was an interpretive writing process that affected the foundation that is valuable to grounded theory. Memos served as an ideas library as they communicated the synergy of the collected data. This research consisted of elements suitable for interpretation that were constantly reflected upon and revised, that looked at links in experiences; recorded thinking processes; and created a series of ideas that prompted the researcher to examine and code the data. Memos helped clarify and explain decisions taken in sampling and coding; they broke down codes; created new ones and divided them again; they generated categories; and recognised links in differentiated analysing through casual inquiry. The recording of data plus hypothetical relationships of categories was the evolving aim to establish intellectual gain, cultivate momentum through interpretive perspective, and

communicate all this in the findings. Together with readily available reports, literature, videos etc, primary data sources such as the various types of interviews used in this research, feedback letters for evaluation, focus groups that included observation notes and prototypes, all provided the opportunity for memo writing and helped build grounded theory (Chun et al., 2019). The active, participatory part in this gradual, naturally expanding, process of thinking engaged in writing allows the reader to make sense through the structured tool of interpretation (Csikszentmihalyi, 1990: 131). Industry partners co-designed data sets with the researcher, and how the data was then developed determined the conclusive grounded theory and its meaning.

### 3.4.3 The importance of coding

Pattern codes explained a variety of conditions and their relationships to each other; they helped to get organised, formed other codes, then into clusters and categories. Looking through transcripts and observational notes, the researcher highlighted relevant elements that stood out, separating them into specific subjects until they evolved into a hierarchy of layered codes. These codes were then refined, characterised, and labelled again. Pattern codes helped the research to become more accurate and explanatory. Grounded theory took shape through mapping concepts, creating pattern codes and categories, and writing brief memos. Abstraction followed through analysing, matrices, interim synopsis and classification, with causal loops, and variations across case studies that all validated the conclusions (Miles and Huberman, 1994: 96, 103, 133, 162, 211, 227, 236).

Coding was crucial to establish the theory and to clarify data halfway through accumulating and producing data. Coding in this research was open and developed categories of a variety of information that were either axial: advanced, interconnecting categories, or selective: building a storyline from core codes that connected the categories. Initial coding recognised and labelled key words or groups of words that created meaning. Patterns began to emerge during data intake: what did this data have to offer, what was its

voice and what did it depict? Here recorded responses were taken into consideration; even feelings earned a place through grounded theory (Chun et al., 2019).

In order to solve both design and research problems, the author persevered with designing. To get out of the problem zone, it was helpful to remove the unwanted and keep the needed and wanted elements, to code, cluster and compromise. This research included an advanced thinking process, that allowed the researcher to create as well as analyse, both being crucial to understand alternative angles of viewing, to comprehend the way the reader perceives, and to think divergently (De Bono, 2000: 52, 76).

Sampling determined grounded theory pointed towards the evidence found in analysing data, it established links, emphasised research needs and communicated as yet unfamiliar insights. This process repeated itself in a loop of comparing and analysing data (see Figure 3.3; Chun et al., 2019). When the process settled on the aim, satisfying the previously set number of methods, the research sustained ample diligence if a detail was requiring attention (Csikszentmihalyi, 1990: 51).
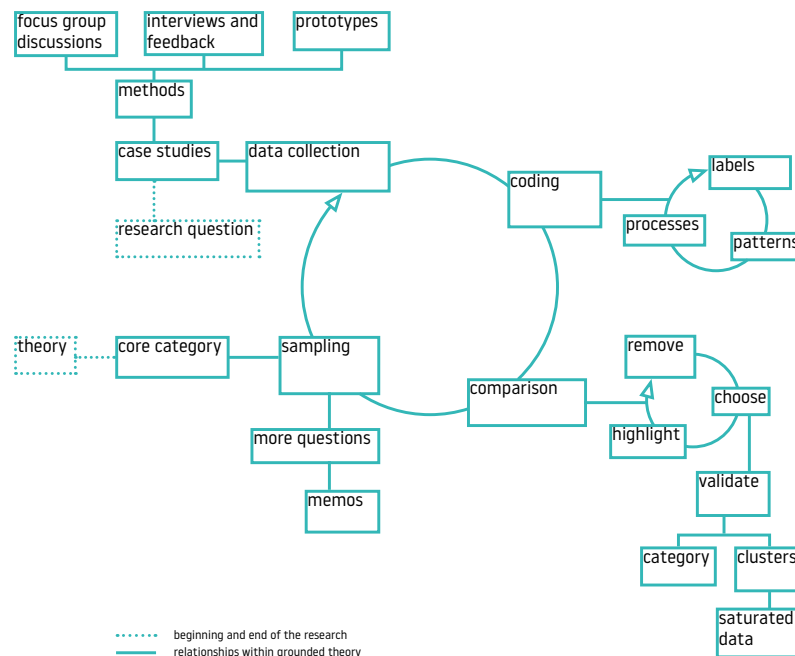


Figure 3.3 Grounded theory applied to research elements

At the intermediate stage of analysis with diagramming taking place, the researcher looked into the data, examined what was happening, and reviewed the meaning that was unfolding. The advanced stage enabled the inclusion of the final grounded theory and advocated the approaches of storytelling and theoretical coding. Outlining the narrative was fundamental to finalising the grounded theory with the data set out that included the identification of any gap(s) in the knowledge. With theoretical coding as the synthesis, the final step combined fragmented categories and knitted the story together, serving as an account, removing redundant data, then compressing into conceptual labels (Chun et al., 2019). The continuous exchange between the researcher and industry partners allowed a research environment to take shape where previous ideas were useful in helping form relevant current and emerging categories (Pettigrew, 1997: 337-348).

All the projects' findings were organised into complementary concepts. The analysis helped create accounts that feature links between categories and the core category. This narrative was the umbrella activity to present, and zoom into, the final grounded theory. The researcher as interpreter was taking time to play, whilst protecting the delicacy of the data collected. The goal was to understand the background literature in a way that created open codes and categories which were then echoed in memos and amplified in the accumulated data, as well as analysing the codes all over again in a sequential exchange of methods and processes. Ethical research managed with specific care for the process produced valuable results that were applicable to practice (Chun et al., 2019), see also Figure 3.1 research structure.

Unlike telling a linear story, grounded theory explained and ideated processes, examined and evaluated them, continuously chasing the essential methods that make the processes work. With various data being organised, the processes were recognising patterns and generating case studies (Pettigrew, 1997: 337-348).

## 3.5 Theory and practice

Through the lens of theory, stories told by data and rhythms they form, originate from a fixed belief. Most audiences may believe scientists have a head start with this sort of logical framework, hypothesis, and reports, and that there is no room for individual activity left. Creative practice however looks at a problem with an alternative perspective and it goes without saying that it is more sensitive to audiences' reactions with the ability to create value from that practice. Designers can direct towards meanings of certain products, services, or experiences for a specific branch of society. Currently, theory is something that is anticipated to be certain of particular circumstances with designers' stories and propositions being able to communicate the prototypes mapped out to the audience. Design covers the audience's activities in the face of technology. Design can help the reader improve empathy and comprehend the interrelationship of viewing and exchanging data (Krippendorff, 2006: 27-29).

When thinking about the research approach, its epistemology, theoretical perspective, methodologies, and methods were exploited (Crotty, 1998: 2-9). The epistemology in this research was constructionist – brands were created or developed through a tailored design thinking process with lo-fi prototypes along the way. To some extent the research was subjective, which means that the prototypes embodied knowledge. The theoretical perspective was in part inductive through finding processes and the final theory; but mostly deductive with patterns arising, using methods and secondary research emerging; and with some abductive research that was predictive and interpretive. Figure 3.4 below depicts the cross-fertilisation of the various methods used in this research that created a landscape of both case studies and grounded theory methodologies, all in the relationship of theory and practice.

theory

case studies

grounded theory

practice

Methods: ■ Focus Group Discussion  ● Interview  ○ E-Interviews  ▢ Feedback  ┄▶ lo-fi Prototypes  ━▶ Prototypes

Intelligent Transport    Asteroid Mining    Space Engineering    Remote Sensing    Space Settlement
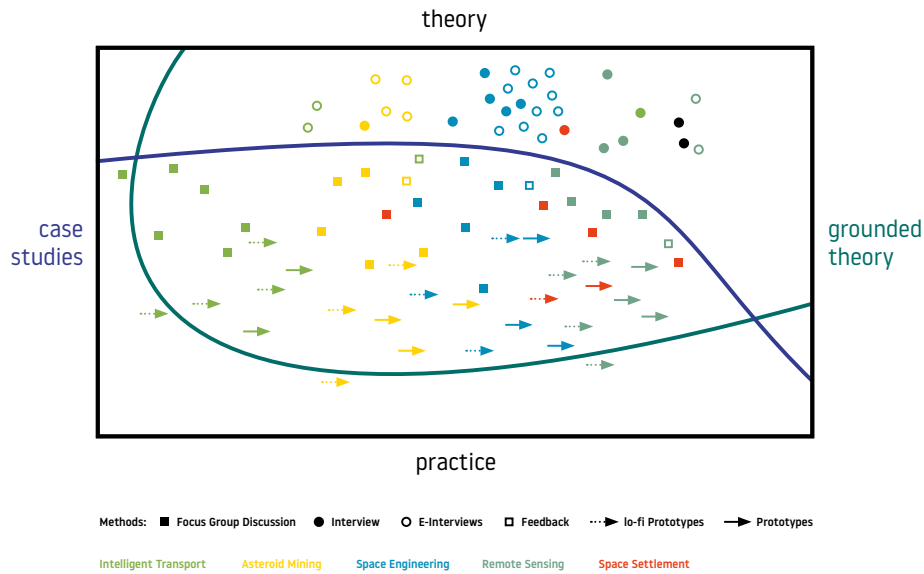
Figure 3.4 Landscape of methodologies: with methods used

Though research may seem to be remote from design practice, it can be a motivating force even for makers. Intuition rather than creating meaning? Thinking, albeit not too structured, analysing when creating visual prototypes helps evaluate new insights. This is design research in its most applicable way. Using a design process for design practice is the combination of making and thinking (Frayling, 1994).

## 3.6 Methods

### 3.6.1 Focus group data

Prompting discussion with visuals was successful in engaging participants, e.g., through sketching or scribbling stories. Card sorting was used in focus group discussions (FGDs) alongside other activities, including images as visual prompts, sketches, Post-its for mind-mapping, storyboards etc. The fairly small groups consisted of 6-8 participants, all working within a specific industry, from a certain profession or with a similar interest matching the research. Accommodating the group in an inviting environment encouraged relaxed discussion 'focused' on a chosen subject and research questions. A

particularly open plan with some structure was beneficial, concurrently leaving space for flexibility and new questions arising. FGDs were similar to the interview settings but were more interactive (Silverman, 2017: 263, 283, 297, 475) as the conversation reflected the group's energy. The discussions generated new insights via fieldnotes, observations and memos that allowed potential ideas to come through. Qualitative research was derived through a variety of views, with specialised data focused on the research aim that identified with a specific individual or with the interests of a group. *Mood boards* helped gather expressive ideas, which again encouraged discussion and further idea development in a very open and relaxed, brainstorming kind of atmosphere. Also described as group passing, mind maps were created in participatory, co-designing workshops. First concepts, patterns and lo-fi prototypes were developed in these engaging FGDs with an infinite loop of analysis, immediate feedback and design thinking generating better ideas, further prototypes and so on. *Affinity diagramming* code produced labels that provided user-friendly understanding from qualitative data. Post-its acted as notes where one element was considered at a time and where designer and industry partner interacted, together identifying clusters with another loop of removing, adding and outlining data that then helped develop new ideas in an interpretive approach when participants 'walked the wall'. *Card sorting* was another co-design activity within FGDs that took on board the industry partners' point of view, created meaning through a thinking process and again fostered discussion (Tomitsch et al., 2018: 34, 40, 64-65). Data analysis here was an explanatory review of detailed records of data. In this loop of continuous comparison, a pattern and then a theory were generated that explained the link to original ideas, overall concepts and processes used in the research. Responding back to research questions, aim and objectives, the interpretivist perspective that materialised was investigated, offering cross-practice models. Rather than doing lots of theoretical, secondary research in books, watching videos, listening to or observing events, qualitative research came alive with a group made up of a

few partners who were interested in the study's specialism and in participating in FGDs and interviews (Silverman, 2007: 37).

### 3.6.2 Co-design

Linked to focus groups as outlined in the previous paragraphs, co-design referred to encouraging active participation with the various project partners for this research. The author as designer was not in charge of a design outcome instead the user experience had final importance. Drawing user needs, wants and insights from co-design workshops involved visual communication and included re-appropriation of products and processes to create something new. Co-design was a productive and engaging method (Lupton, 2011: 96), actively inclusive of stakeholders and users of partner organisations involved with a prospective outlook of their product or service concluding in lo-fi prototypes (Tomitsch et al., 2018: 40, 84-85).

### 3.6.3 Interview data and data from feedback

What did this research need to find out? Primary data from interviews and feedback helped refine the research problem. Participants had to match the purpose of the study and were carefully selected prior to the projects (Tomitsch et al., 2018: 64-65, 78-79). The author established how many face-to-face and e-interviews were appropriate to make up the research data. An interview schedule for in-person semi-structured interviews that were then recorded and transcribed was developed, and mixed methods for e-interviews were used (Silverman, 2017: 263, 283, 297, 475). Continuous feedback from industry partners was obtained during the projects in order to generate a representative conclusion and offer a variety of options, interesting links and important leads within the study (Herr and Anderson, 2005: 4).

   All *interviews* and *feedback* employed the purposive sampling method to ensure data was collected from a range of perspectives. Asking for sampling characteristics, the semi-structured information combined a pre-

prepared list of discussion topics and questions with the flexibility to depart from the schedule determined by the interviewee's responses when conducting in person. During data collection, interviews were recorded, transcribed, and then verified against the recording. Analysis involved theoretical sampling that used the abductive method and memo writing that recorded first ideas and developed concepts, then compared in order to refine the data followed with more data collection. The designer as researcher and the industry partner as participant communicated face-to-face or side-by-side with the focus on content rather than on the verbally asked questions (Salmons, 2011: 3-20). Less structured interviews inquired deeper into the interviewee's thinking, extracting more data that led to unexpected junctions in the conversation. Observational notes were possible, and the interviewer tailored questions spontaneously for the interviewee to genuinely reflect on her or his viewpoint and understanding, following thought-provoking clues, and creating a relatable, engaging interview (Tomitsch et al., 2018: 22-23, 34, 92).

The researcher became more of an observer through the *e-interviews* that were solely digital, just like an online survey with questions for participants that were more structured and less open than the in-person interviews, although some questions were open-ended. Gantt charts were used for multiple choice answers. Each reader followed the same order which allowed the researcher to compare directly and analyse quickly, which then developed patterns and linked up theories, creating a framework of useful, intense data and a matrix with a variety of beginning and end points that referred back to research questions and helped investigate key research elements and the energy that this brings about (Salmons, 2011: 3-20). E-interviews on the basis of questionnaires (Tomitsch et al., 2018: 78-79) were useful as the research was limited to industry partners alone and there were not a large number of responses. The prospect of online interviews meant a larger turnout and that a broader audience was reached within the partner organisations.

With well-placed questions, interviewees took the opportunity to answer in more detail. Either in a relaxed, semi-structured environment with open-ended questions, or in the more structured realms of e-interviews, both interviewer and interviewee remained flexible. An agenda of activities with data, a review of literature, the various viewpoints of ideas as well as instant feedback on lo-fi prototypes were all instruments for research that were adaptable to new environments and activated deeper understanding of the industry partner's thinking. These approaches created compassion for the other and offered the opportunity for the user to design rather than the practitioner (Tomitsch et al., 2018: 22-23, 34, 40, 64-65, 84-85, 92).

After arranging interview and feedback quotes, the author explained the meaning from an interpretive perspective and outlined how issues could be improved, suggesting a variety of ways. Then the author looked to form concluding theories for each aspect, using explanatory inquiry throughout, and finished with recommendations.

Interviewees were coded as per Table 3.2 below and their interview transcripts can be found in Appendix 6.

Table 3.2 Interview codes

| Social Technology Company | Pp* 1 – Intelligent Transport | Pp 2 – Asteroid Mining | Pp 3 – Space Engineering | Pp 4 – Remote Sensing | Pp 5 – Space Settlement |
|---|---|---|---|---|---|
| UD<br>UX Designer | ITCEO<br>CEO | AMCEO<br>CEO and Founder | SEP<br>President | RSD<br>Director and Technology Lead | SSD<br>Director and Programme Delivery Lead |
| UR<br>UX Researcher | ITDL<br>Digital Lead | AMAG<br>Astrogeologist | SER<br>Head of Robotics | RSSM<br>Sales and Marketing Lead | |
| | ITA<br>Animator | AMS<br>Chief Science Officer | SEB<br>Project Leader: high altitude experiments | RSRD<br>Research and Development Lead | |
| | | AMI<br>Head of Investment | SERK<br>Rocketry Project Leader | | |
| | | | SET<br>Treasurer | | |
| | | | SELB<br>High Altitude Balloon Project Leader | | |
| | | | SEPUB<br>Publicist, Rover Project Leader, | | |

| | | | Balloonian Chief Engineer | | |
|---|---|---|---|---|---|
| | | | SECO<br>Contacts Officer | | |
| | | | SESC<br>Sponsorship Coordinator | | |
| | | | SEOO<br>Outreach Officer | | |
| | | | SEOOC<br>Co-Outreach Officer | | |
| | | | SED<br>Designer | | |

• in person interview • both face-to-face and e-interview • e-interview only
*Pp = Project partner

### 3.6.4 Prototypes

Prototypes were a method of designing practicable products, the importance of which is not yet entirely exploited but emerging workable possibilities were explored through co-design (Suchman et al., 2002: 172). The researcher organised participatory sessions with industry partners to anticipate input on visuals that were not fully completed or expected to be perfectly accurate (Bresciani, 2019: 92-124). These *low-fidelity (lo-fi) prototypes* generated a real depiction of concepts of the final design, focused on the original proposal. These rapid prototypes were a fast and none too exact inquiry of the design concept, emerging through design thinking, practicable critique, and feedback from industry partners during discussions where solutions were proposed and tested (Tomitsch et al., 2018: 84-85).

Prototypes were created via a repetitive loop, this loop or thinking process helped find solutions to design problems. Emerging questions were somewhat general at first and refined through the process within each case study. During the beginning stages lo-fi or low-resolution prototypes were quickly and easily generated, and, together with good and achievable feedback from partners, they helped draw effective conclusions. Prototypes became more refined as they went through the loop, as did the research questions. They helped partners participate and gain insight about the final proposed design, which could be ideas on Post-its, a cheap physical model, an activity, or a storyboard and so on; something the partner was able to feel,

experience and offer feedback on; something to be part of in the decision process and to engage in. For effective analysis, it made sense to involve the partners in the thinking process rather than just talk through it (Shanks, n.d.).

## 3.7 Lastly,

### 3.7.1 The advantages

The combination of two methodologies helped make the research engaging than that which had been only a little studied before. Theory building from case studies was likely to generate new insight from contrasting evidence. Therefore, disparate data collected through methods fitting to this research made it possible to generate theory from practice – from the ground up. Organised, albeit nonlinear, research allowed individuality to come through. Constant comparison, cross-examining data in a constant loop from the beginning to the end, created useful connections with data, returning back to answering the research question to show how innovation culture within space and satellite organisations can be represented via a bespoke design thinking model.

This playful, yet purposeful use of methodologies and their methods generated a fertile landscape where theory and practice come together, as shown in Figure 3.4, that can be expanded for further study.

### 3.7.2 And limitations

The interpretivist perspective of this research could represent an unpredictable factor, hence the author may have approached and reported data with confirmation bias to some extent. Consequently, the two methodologies required careful use. The author needed to clarify which one was driving the investigation at which point, validating back to data sources at all times.

# 4 Design thinking

In the design thinking chapter, the author analysed 1) secondary data in literature, comparing a number of processes employed by organisations that inquire about design thinking as a general principle, and organisations that employ branding, particularly relevant to this research; and 2) primary data from two interviewees working with their own adaptable design thinking approaches in a large social technology company to improve their everyday work; in order to help verify 3) the author's own bespoke design thinking model applied to the research findings.

## 4.1 Design thinking processes in literature and practice

Various organisations were chosen that are either based in or suitable for brand consultancy and visual design relating to the research aim. Their design thinking processes were collated and outlined and then compared, see Figure 4.1. Some organisations reject the use of design thinking processes, but still apply the principles to their brand creation and tailor it to each user just as design thinking does. Taking the various approaches together, the author defines design thinking as an iterative, nonlinear process that seeks to solve user problems.

Each design thinking process starts with understanding the user and the encompassing context by first getting to know them, then identifying their needs and problems, which all help establish insight through the designers' curiosity, creativity, and epiphany. The research element of the process is completed once the idea takes shape. The design activities then pitch in that ideally present a solution whilst retaining a feedback loop. Iteration is highlighted in all recognised design organisations, schools, and brand consultancies' design thinking approaches.

The processes of selected organisations in Figure 4.1 break down each of the applied stages, using the author's model (see Figure 4.3) as a base from which to evaluate the design thinking utilised for this research.



| | | | | |
|---|---|---|---|---|
| DESIGN COUNCIL Double Diamond | discover | define | develop | deliver |
| FITCH 4D | discover | define | design | deliver |
| LIEDTKA D4G | What is? | What if? | What wows? | What works? |
| STANFORD | empathise | define / ideate | prototype | test / access |
| IDEO | inspiration | ideation | implementation | |
| LANDOR | insight / perception | ideas | story | courage |
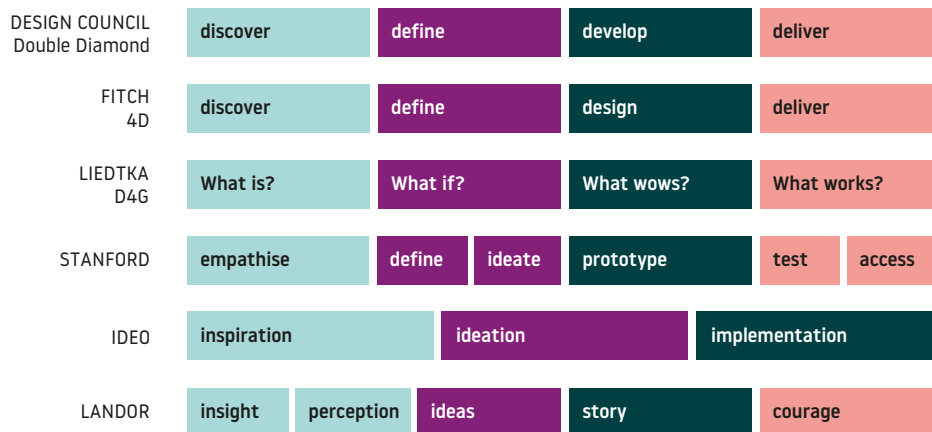
Figure 4.1 Design thinking process stages applied by a selection of organisations

The following paragraphs filter different organisations' design thinking processes that are central to the entire concept as shown in Figure 4.1 and discuss objections to such approaches as well as lay out the particular companies' arguments.

### 4.1.1 General principle of design thinking

The UK Design Council established the four stages of the 'Double Diamond' that summarises and supports most designers' processes. The first stage 'discover' depicts background information of the design problem. The second stage of the idea-finding process 'define' outlines prospective ideas brought forward from the first stage, for which design routes are generated in the third stage 'develop'. These initial solutions are repeatedly evaluated before the process is finalised with the fourth stage 'deliver' creating a working concept. A creative approach can be demystified, utilising, and iterating the Double Diamond throughout the thinking process (Design Council, 2019).

The Hasso Plattner Institute of Design at Stanford has been instrumental in individual and organisational understanding of 'design thinking' as a corresponding process. It goes through six stages: with 'empathise' focussing on the user; 'define' of the problem for which a solution is sought; 'ideate' as the core of the thinking process, where ideas are formed; 'prototype' where ideas become physical or emotional models; 'test' users for in-depth understanding; and 'assess' where guidelines are created and feedback given, received and implemented. The design process is not essentially linear and can be enacted according to organisations' or individuals' requirements, enhancing their innovation methods. Design thinking can be applied to existing challenges at work, employing design tools, while respecting collaborative approaches and personal growth in the process. The design thinking process helps develop insights through re-evaluation of perspectives. It appropriates the creation of prototypes that are then tested in relevant conditions to assess their value, with repetition and refinement of the individual stages to generate new working practices, techniques and equipment (Stanford d.school, 2019).

Tim Brown, the Executive Chair of IDEO offers supportive affirmation and explains design thinking as an activity that is focussed on the user, and an instrument to innovate and combine user needs with the potential that novel technology developments and specs bring to make a company thrive. Because of its curiosity and analytical elements, design thinking developed into a well-rooted activity. In IDEO's review, design thinking consists of three parts, 'inspiration, ideation and implementation'. It lacks zeal when set to work without depth and understanding; however, it fosters innovation when individuals are prepared to fail and get back up. Designers incorporate compassion, positivity and creativity into a continuous loop of their thinking that allows numerous possibilities (IDEO Design Thinking, 2020).

Strategist Jeanne Liedtka created the 'What is? What if? What wows? What works?' design thinking process, originated in the book '*Designing for Growth*' referred to as the D4G approach (Liedtka et al., 2011: 34). The

design thinking approach uses the previously mentioned questions as individual phases to explore present scenarios, probable development, interest, decisions and participatory design (Liedtka et al., 2013: 4). Design thinking is impartial, it excludes existing politics and pressures in society, whereas it enables creativity to run free to tackle day-to-day tasks. When thought-provoking questions arise, genuine ideas come to light. One of the key factors of user-focussed research is to consider a variety of views, though it may not be easy to find out what a user needs or wants if the product has not gone live onto the market. Even though a lot of questions and the following ideas may divert from the essential point and generate disruption, if co-workers participate in the ideation phase, authentic, workable change can be the result (Liedtka, 2018). Questions are generally useful to any design thinking approach to help define problems and find solutions. Here are some more similarities and differences in a number of organisations that appropriate design thinking suitable for brand creation and development in research findings as well as a comparison of the propositions addressed.

### 4.1.2 Branding related design thinking

Design agency Fitch has adapted a design thinking methodology, namely the '4D' process of 'discover, define, design and deliver', similar to the UK Design Council's Double Diamond, in which a brand can consequently become more of an experience to a user through a distinctive foundation of expertise and an elaborate approach of the potential to arrange a greater variety of elements than previously offered. Fitch furthers the process with the 'locating, exploring and dreaming' technique that brings the concept to the heart of a joint experience developed together. This improved process of making and testing of the target audience generates ideas through advancing design stages and the performance of abundant creative expertise, that are then combined to animate the experience (Fitch, 2012).

Pentagram's Natasha Jen criticises Stanford's design thinking, arguing that the approach should not act as a cookie cutter, 'one size fits all' solution.

She does however exploit it further through the designer's role of interacting with language, figures and pictures in order to present an idea that is engaging and easy to grasp. With 'thinking' as the core of the creative process, the individual stages are implemented to serve, once carefully combined, as a problem-solving approach, that is to study the user, ask the right questions and find, prototype and evaluate possible answers (Dawood, 2018). Jen stated that the design process is equally systematic and instinctive with design thinking right from the start. If good design helps the user as a consequence, then it is the best strategy (Sagar, 2015).

Nurturing the argument that design thinking adds practicability to brand creation and development, another of Pentagram's partners, Paula Scher, stated that a consequence of design is teaching its principles to an audience as a new visual language rather than solely as a brand (Tan, 2017). Scher states: "Theoretically, you should be able to recognize something without even seeing the logo," (Wilson, 2017). In short, she outlined graphic design and the creative process as a visual technique that identifies something and makes it tangible (The Logo Creative, 2018). Design thinking can help with brand thinking as its core ideas accelerate the conversation of design practitioners and users and vice versa.

Patrick Lopez, Senior Principal of Analytics at Interbrand also acknowledges the need to adapt design thinking to users with the advancements of brands; however, he insists that it is "...an approach, not a process...", that is determined to start with detailed insight of an organisation, appreciative that not every knowledge accumulated is of value and articulates a user's question in order to create tangible answers (Lopez, 2019). Similar to academic research, design thinking also starts with questions and in-depth research to address and define a problem and then find a solution.

Supportive of design thinking in brand consultancy, the Global President of Consumer Brands, Mary Zalla summarises Landor's design approach in five key steps 'insight, perception, ideas, story and courage'.

'Insight' uncovers patterns and motives and is crucial at the start of the design process with legitimate ideation valuable to both the organisation and its brand. 'Perception' is the interpretation of insight and creation of meaning, that takes experience and opinion into account. It is connected to new ideas, and, by exploring the state of mind that always tests current behaviour patterns to find something new, a different angle, it helps shift paradigms. 'Ideas' depict the core of the process, embedding design thinking with inspiration originating from a diverse audience in a disparate environment. 'Story' connects ideas with design; it is people-centred as stories result in users' reaction. 'Courage' is closely related to creativity; it is a risk taker and supports broad thinking. Genuine inquiry into an organisation's needs can verify the authenticity of original ideas (Zalla, 2016).

As the key issue of design thinking in brand creation, Wolff Olins' CEO Karl Heiselman talked about 'useful' concepts that have to answer questions and engage the user in an organisation's brand. 'Value creative' is a user-focused approach, including co-design for prototyping and testing activities. Organisations and audiences learn together. 'Boundaryless' is an adaptable element that allows closer and more diverse connections within and outside organisations, with partners as well as users. Too much structure contradicts innovation, hence a design process is, instead, able to be diversified, interconnecting and layered, taking unexpected turns. 'Translating all that into branding', through insight, with a meaningful and accessible approach, a brand can become an organisation's own narrative (Kuang, 2012). Design that is instigated and led through the workplace is essential (Venkatesh et al., 2012: 289-309). The influence design thinking has on day-to-day environments is an important juxtaposition that creates innovative solutions resonating with all stakeholders involved.

Graphic Designer Michael Bierut of Pentagram found his thinking more confusing and expressed his own process after frustrated attempts to get to know the project through information and conversation with the client and

through probable prior experience. Meanwhile, and this might occur before all the information is gathered, an idea takes shape – unexpectedly and difficult to comprehend – "...like magic...", for which a valid strategy is then determined, with a client who has been previously convinced proving to be helpful (Bierut, 2018: 21). This is a liberating element that can illustrate the struggle that can bring about something refined – an ingredient that cannot be taught but has been made pure.

Together, the design thinking processes and additional design principles from diverse brand consultancies, design schools, government and commercial organisations indicate aspects of how approaches are built on each other and tailored to a unique design problem. The knowledge gained through comparing the approaches is that all organisations find design thinking beneficial whether they call it a process or not. Initialised by decision-taking activities, all the design thinking approaches are pivotal to each organisation's chosen work environment.

## 4.2 Interviews

### 4.2.1 Motivation

The purpose of the interviews was to investigate the practical application of design thinking processes in practice through empirical data and to verify the design thinking model for this research. The author's motivation was to gain extensive insight into what interviewees understand by design thinking, what they would like to gain from it, and the influence it has on their work and on the people they work with. A semi-structured interview was conducted to identify the practitioners' understanding of design thinking, the purpose of using the process and the impact it has on their work. Two participants were interviewed to inquire in more depth into their rationale, applying purposive sampling to collect data and to establish code. This small-scale research allowed exploration of patterns, highlighting their relationship to one another for meaningful comparison. The participants work as a UX Designer (UD) and a UX Researcher (UR) in a large social technology company, where

the interview took place, both employing design thinking in their day-to-day work. Relevant to this research, the author was interested to explore UD's and UR's processes as they reflect the corresponding methods applied and verify the need to adapt one's own process, tailored to a given project.

UD has studied product design and her role is to support various colleagues in her company to create solutions through focus group discussion. This entails a set of tools including a plan of action, prototypes, and visual design. The largest amount of work goes to interpreting "flows, narratives and storytelling behind the experience" (UD, 2020).

UR works as a user researcher who ensures the products that are being built are a match to the needs of the user. Her focus is the user environment, the problem and the process of translating this into a product, by using qualitative and quantitative research data to draw out new knowledge and working across different job functions.

The interviewees were asked to draw a design thinking process they use in their daily work routine, see Figures 4.3 and 4.4. They were then requested to explain the key stages of their bespoke design thinking process and elaborate on each one further, which they could enhance either concurrently or after each stage of the process. The interview was semi-structured with a mixed list of conversation topics and questions that were prepared in advance and involved a relaxed agenda that could be adapted to the interviewees' responses.

### 4.2.2 Overview

The interview transcripts generated a word map (see Figure 4.2), that reveals a number of key terms coming through design thinking being used for researching the user, understanding the design problem and building solutions. The participants extensively use iteration of individual design stages to create prototypes and focus on working in teams to improve strategy and to make the most of the data collected. It shows how the tailored design stages were utilised to steer individual and collaborative aims and

techniques in which data and user needs were interpreted, and challenges addressed. Both interview participants agreed that they use design thinking to *increase productivity* in day-to-day communication. The colours are used in line with Figure 2.1 in the literature review that link to the overlapping themes, related to design, economy, innovation, and technology.



Figure 4.2 Interviews – word map of key terms

The word map highlighted important key words that emerged in conversation with the interviewees; it visualised ideas that helped analyse the data through categorisation, see Figure 4.2.

The interviews showed that everyone in the team has a purpose in the design process, and though techniques may differ, work is not in isolation as UD pointed out: "It is very flowy. If there is a need... I can jump into something that is more visual design heavy and if there is a need, I can jump into something that is more user research heavy because we got the context. Obviously, we are all focused on what we are strong with" (UD, 2020). And UR added: "Yeah it is very fluent... we enjoy this together" (UR, 2020). The different roles are all engaged in user activities, designing prototypes together one step at a time with an emphasis on strategy, ensuring the alignment of data, product and final outcome. Different roles in the team help tackle challenges in each other's design thinking stages.

### 4.2.3 Bespoke design thinking process

The various stages of the design thinking process employed by each interviewee were chosen based on individual priorities and the role for which each element was assigned.

UD focused on gathering information about the user in her first stage 'understand', which involved user interviews, and qualitative as well as quantitative research discerning a distinct user in place and time: "How do you make sure that this product that you are building is made for this specific type of user?", (UD, 2020).
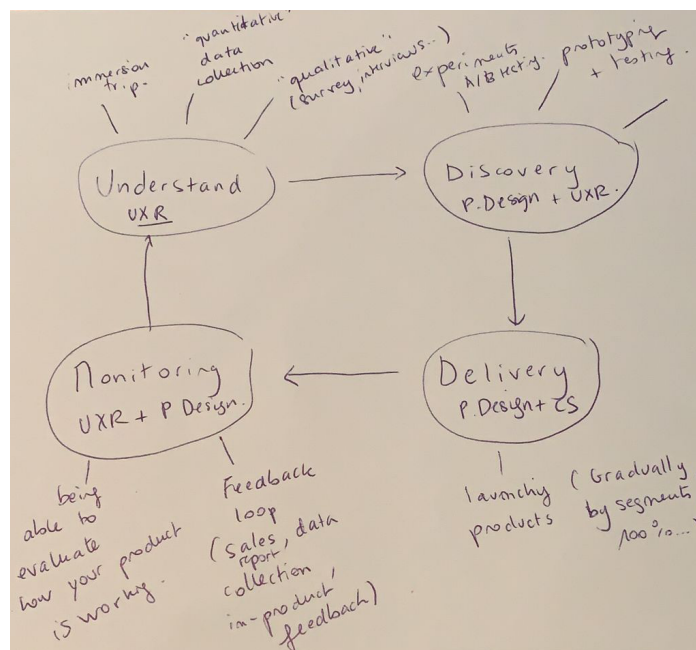


Figure 4.3 UD's bespoke design thinking process

The 'discovery' stage included the building of prototypes, then evaluating them with users and continuing the inquiry, which engaged both product design and UX research. In the 'delivery' stage the project element is prepared for launching, although not entirely, but progressively, to ensure the product is without fault and performing efficiently. 'Monitoring' is the last stage of UD's design thinking process that focuses on collecting

qualitative data in the form of user feedback that is beneficial to finding out the user's likes and the designer's review of the product. The process is iterated as many times as needed, starting at the first stage to collect new essential data to 'understand' the user needs and identify any further action required, see Figure 4.3.

UR uses a different approach (see Figure 4.4), but she does relate her design thinking to UD's process as they work together from different perspectives. Moreover, UR's background is in research while UD has a design background, where parts of the projects often cut across. UR started her design process with the 'unknown' or 'discovery' stage that entails "... a lot of mess at the beginning", (UR, 2020). After analysing the available data that depicts the current specific market situation and is subject to being able to trust the research, what can be learnt from this inquiry is established, from which the design problem can be defined.
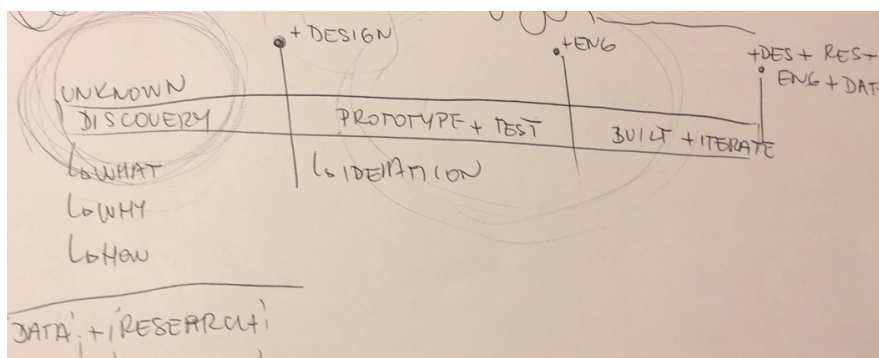


Figure 4.4 UR's design model: tailored to her processes at work

Once UR gains an understanding of what can be drawn from the data that sets the research scenario, her team would then "...go to the field speaking to the users, making sure that we are building products that are aligned with user needs" (UR, 2020). The qualitative research part of this stage in the design thinking process not only involves prototyping but also data collection on all sorts of levels, from feedback at various events, talking to the user in their own working environment as well as at the designer's workplace. The

'unknown' stage is concerned with the discovery of data suitable for all further research for the project or part of a project that can be presented in findings. With the 'prototype + test' stage the design takes effect and goes into iteration where UR's team member UD then effectively "...starts to ... design or create ... our first mocks that are then ... tested with the user... we are involving the user at this ... stage of the process where we are trying to go from one prototype to another one" (UR, 2020). Another colleague, usually someone with an engineering background would then fulfil the next stage of the process and 'build' the product that was prototyped and tested in the previous stage. UR's design thinking process would be repeated as required and individual stage outcomes would be examined in a continuous loop to ensure valuable user experience. No project would be launched in its entirety all at once but rather parts of it at a time. It begins with a selected audience in order to repeat the feedback loop, to collect more qualitative data, review the team's strategy and watch the current market.

Figure 4.5 depicts both UD's and UR's design thinking approaches. Both evaluate quantitative data with the help of their colleagues, e.g., data scientists and analysts, and use it to guide their insights, as UD identified that these roles have "...got an approach that is very user-centric in the sense that they are able to understand what type of data is important or how to create the model to actually collect the right data, so a score to evaluate something or the right matrix that would evaluate another thing" (UD, 2020). UR continued that they together "...try to find a representative sample..." and that "...there might be new themes that are emerging" (UR, 2020). After analysing a few interviews, there may be some new data coming through that suggests an attractive detail, beneficial for further research.
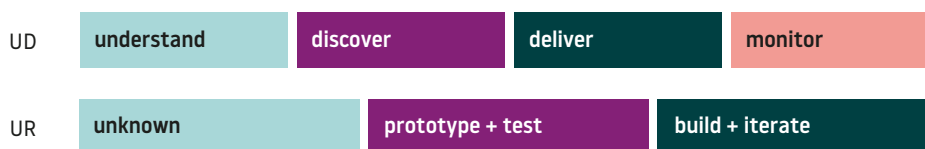


Figure 4.5 Interviews – design thinking stages

Both UD and UR think their design thinking can help each other, for example, if something is discovered and then monitored, and the person in charge realises it is taking the wrong turn, then the team can consider a new idea and change focus.

### 4.2.4 Benefits and challenges

Creating a bespoke design thinking process can improve one's performance but it can hinder the structured dialogue across the different teams. Both interviewees used design processes to improve their performance at work. However, challenges quickly arise in a large company that is trying to keep up with tight deadlines and manage things well, whilst on different tasks that sometimes cover the same area of interest but often not. Making sense of all the different data from a diverse set of perspectives needs a great deal of communication and structured dialogue within and among the diverse teams. UR suggested that discovering a sample that represents the users, and being able to tell the unfolding story backed with research, wins over collaborators.

Not having processes set by the organisation but rather formulating one's own design thinking approaches might have benefits as well as drawbacks, UD said: "It's very freeing... making us very autonomous and independent and then being able to make our own choices, but not having processes and having to create it yourself could be also something that is creating blockers" (UD, 2020). Both UD and UR perceive having a bespoke design thinking process as valuable when the various team members' confidence in one another increases with certain tasks. The comparatively horizontal culture of the organisation can be both positive and problematic. Assessing each stage of the design thinking process is therefore essential: feeding back to team members to review whether the project is still fitting with everyone's aims.

### 4.2.5 The role of visual design

UR highlighted the importance of developing ideas collaboratively in a visual form to help create new products or features and to challenge comfortable conditions to create new possibilities. UD's priority as a user experience designer was to ensure an approach to transformation through visual design that would inevitably benefit innovation culture by communicating proposed activities. She believes that visual design's part in innovation is a desirable quality: "I tend to see visual as the cherry on top" (UD, 2020). UD could explain her ideas to the team in practically one pitch, with visual design as part of the design thinking process. Her peers would identify the intended meaning and see what could develop from there. UR thought visual design can develop "...understanding across the team, as the environment again is like very complex." Also "...when you create some sort of a prototype, you, I think you bring the team together and everyone can provide their feedback... it's very critical to have some sort of visuals" (UR, 2020). UD suggested visual design would be a particularly useful expertise for communicating ideas as well as values within a team.

She also identified the use of visual design to establish partnerships from a new business perspective: "*For two almost identical products or services are considered the delights of visual design can make the difference on people being more comfortable using the one or the other*" (UD, 2020).

### 4.2.6 Interview themes

The unfolding themes that emerged from the conversation with the interviewees about their design thinking processes, see Figure 4.6, were prototyping and testing as feedback is collected in a continuous loop. The extracted data is useful to establish a representative sample. With tight deadlines, UR and UD had to present their findings within the team for the most part as they concurrently aimed to ensure the findings from these prototypes were meaningful to their peers.

Figure 4.6 Interviews – unfolding themes

Another key focus for both interviewees was the strategic approach to their day-to-day work to understand user needs. They have discussed the importance of formulating the problem in order to find a desirable solution for the users. This is one of the reasons the interview participants launched their projects gradually to obtain real-time user feedback data that allowed them to direct their corresponding research. The interviewees identified that their close partnership involving diverse roles across various departments that is built on trust positively impacts their work directly.

The data obtained through their design thinking approaches influenced their individual stages and decision making, connecting design elements that are pivotal to the user. The iterative process encouraged them to both build on each other's ideas and disrupt usual work patterns that created a new, improved balance.

## 4.3 Design thinking model for this research

### 4.3.1 Influences

The author presented design thinking approaches from a number of design agencies, and organisations that put design thinking at the heart of their work. This was followed by two interviews with participants from a user experience background in design and research from a large social technology company to investigate the application of design thinking process in the real world. With the help of these primary and secondary resources, the author gained advanced insight that helped create new meaning by discovering how design thinking processes are used to improve their performance at work. A platform was developed from the insight gained, from which a bespoke design thinking process was created, that is practicable and can be used as a base for all case studies for this research. The author's own experience as a design practitioner with a strong background in visual design, particularly in branding, has helped shape the design thinking model further, because ... "Branding has become such a well-known concept, that both in the public discourse and academia most people are well aware of the business dynamic of a good brand..." (Schroeder and Salzer-Mörling, 2006: 145).

With the non-linearity that design processes entail, the proposed design thinking model is a process of becoming, something nascent, a plan with ambition to help the organisations involved, a dialogue of theory informing practice and practice informing theory again. To create and to analyse are both types of thinking that are needed to advance the process. The contrasting perspectives allow readers to choose the way they perceive (De Bono, 2000: 52, 76).

The bespoke visual design thinking model for this research is an experience-based approach that helps build tailored processes around each case study and hence helps develop suitable insights to create meaningful outputs. Designers develop practicable solutions as a prospective opportunity and recommend these solutions to individuals who can fulfil the original ideas (Krippendorff, 2006: 27-29).

Design helps people find their purpose. With the ability to pace projects, the design thinking model for this research is fitting for partners in the space sector. Throughout the process, the organisation's brands were refined and in iteration made pure, anew.

An undivided sense of coherent progress determines balance. Meaning is created when an intention in a process is adequately demanding. This intention can then generate power and an ambition to reach an aspired goal that advances incremental change. The ambition to always aim for this meaning concludes in finding answers (Csikszentmihalyi, 1990: 216-217).

A visual language is also a language that builds knowledge because a conversation solely with authors that don't know the reader or that are dead… is not a conversation at all, it is them talking without the reader being heard. This design thinking model of this research allows its audience to be involved. The reader interprets; hence the reader can also be the author (Noble and Bestley, 2011: 23-76; Baldwin and Roberts, 2006: 23-38). Through design thinking, the reader is able to see a correlation between previously unfamiliar elements (Noble and Bestley, 2011: 23-76).

Design thinking is like a trajectory, a constant iteration of departure and arrival, of something that has to happen until it no longer has to. Until it is final, it is a filtered product, renewed but perhaps not forever final; a prototype; one that is workable.

### 4.3.2 Model

To advance an approach tailored to the satellite and space sector, a new design process was developed for this research as a practical approach, and employed in five projects. This process has elements of design thinking approaches with divergent and convergent activities, as well as a more complex feature in the ideation phase which was previously identified as 'magic' (Bierut, 2018: 20-21). It is divided into five stages, see Figure 4.7. However, rather than working stage by stage, the various stages of the design process are to be seen as a holistic investigation, where parts often overlap

and intertwine in a constant loop of iteration, generating a complex structure, unique to the organisation to which it is applied.



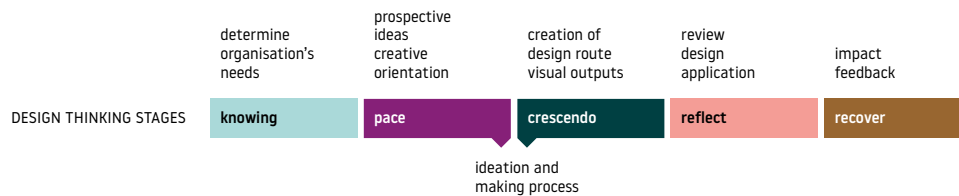| | determine organisation's needs | prospective ideas creative orientation | creation of design route visual outputs | review design application | impact feedback |
|---|---|---|---|---|---|
| DESIGN THINKING STAGES | knowing | pace | crescendo | reflect | recover |

ideation and making process

Figure 4.7 Visual design thinking model – stages

To develop a visual language suitable for the partner organisations' field of expertise, the author compared their products and services with other products and therefore established the partners' role in the market as well as their specific aim for communicating to a chosen audience. Thus, the first stage KNOWING is to learn to understand and determine each distinctive organisation's needs, to listen to its values and gain insight of its current innovative projects. To a great extent, this stage involves gathering significant data that is beneficial for further research and for finding a representative sample for each case study. It includes both focus group discussions (FGDs) and interviews. In this first stage, the design problem will be defined thoroughly, considering all its possible angles.

The first part of the ideation and making process (the second stage of the design thinking model) is PACE that can be translated as walking steadily. By this the author means that at this stage speed is picked up without having yet to worry about an exact outcome. This is where the data collected in the first stage is analysed and rendered for initial ideas, where theory becomes practice. By converging the ideas that take shape through the research, a creative orientation originates from here and branding activities accelerate. The creative orientation serves as a portfolio of emerging low-fidelity prototypes that include the creation of inspirational words from the first stage that then translate into the visual part of inspirational images, from which then again colours, fonts, shapes and patterns for the overall brand

language are derived, all in close exchange with the industry partner and other stakeholders.

Ideas and making culminate in the third stage CRESCENDO. This stage is concurrently the second part of the ideation and making process, where visual solutions are created, removed, kept, and improved.

The stage involves the actual creation of a design route that proposes the logotype and / or the brand language for the partner, based on findings from the previous stage, such as fonts, colours, shapes and patterns. This is the peak of the design thinking process, delivering visual outputs as prototypes that aim to communicate the partner organisation's innovation.

These prototypes are then tested with the partner and its stakeholders in the fourth stage REFLECT. This stage of the design thinking process is to review, encourage revision and to apply and advocate design elements to a publishable output. Design applications include a set of items, established previously as essential to the industry partner's brand identity, such as digital and printed media as well as brand guidelines, which are valuable for further use and brand development.

And lastly, RECOVER stands for investigation of the impact of the created low- and high- fidelity prototypes in connection to the economy with a focus on the UK government's Industrial Strategy and subsequent policies. In this stage, feedback from the partner organisation and stakeholders is articulated and substantiated. Data from this analysis and partner feedback will be used as evidence for the success or failure of the benefits claimed in the design thinking model employed for this research.

The individual stages of this design thinking model iterate as they are tailored to each project independently without restriction, which then can be compared to other case studies in order to get an overall perspective. The bespoke design thinking process differs from one industry partner to another (Tomitsch et al., 2018: 64-65). The model allows a distinct process of creating, testing, getting feedback, scoring, removing, keeping, and bettering, with additional data collection, relevant to each project that may

enter and exit the loop again. The author would analyse the data from the first iteration of her design thinking process and would use it to positively influence her way of working the next time she did a particular stage. As an experienced designer, she understands the importance of iterative processes to refine the prototypes, particularly at an advanced level where the individual stages change, and loops become more and more distinguished from those of other project partners. Although the author employs design thinking methodologically, she tries to ensure the partners get sufficient time to play and to experiment. Both can be afforded by monitoring the individual smaller outputs and getting feedback from partners early on so as to be able to frame and reframe problems on the way and filter possible improvements, thus leading to positive transformation that can create new meaning.

Linked to the aim of this research, the rationale behind developing a bespoke design thinking model was to effectively represent innovation culture in space technology organisations. Based on analysed data from primary and secondary resources, the author could verify the usefulness of creating her own design thinking process to enhance her design practice to help space tech organisations communicate their innovation.

### 4.3.3 Preference

The design thinking model encourages to advance quick prototyping without too much detail and feedback on the prototypes. Stage by stage the projects build on prior findings in a tailored loop of iteration and research of how the output stands in the marketplace. Here, the author preferred to offer only one design route in the CRESCENDO stage, referring to her experience of working with stakeholders, when offering multiple design options caused quality issues and slowed and confused the stakeholders' decision process. This is also the way practitioners such as Paul Rand (Logo Design Love, 2019) and creative agencies like Sagmeister & Walsh (Sagmeisterwalsh.com, 2019) work. In the case of Sagmeister & Walsh, only one design option is offered to clients, arguing this would be more strategically valuable, allowing time for

extensive research and design process in conversation with clients and users, concluding in "the best possible solution" (Sagmeisterwalsh.com, 2019). The project partners were therefore presented with a one option design concept as the outcome of the design process, and, therefore, focused on problem-solving strategically together with the partner through the iterative design thinking process, improving, and refining this one option rather than being presented with multiple design routes in the first place.

### 4.3.4 Theoretical framework: design thinking activity map

With the five industry partners and the help of each stage of the design thinking model (KNOWING, PACE, CRESCENDO, REFLECT and RECOVER), focus group discussions took place, low- and high-fidelity prototypes were created and interviews and feedback data were collected. Table 4.1 provides an overview of the author's activities with the partner organisations. This design thinking activity map serves as an analytical framework, summarising as well as comparing key elements of the work with partner organisations that are useful to the research. It is a model that depicts how different types of analysis were carried out, and it links directly to the research question. The distinctive design thinking stages are presented in relationship to the input, actors, activities and output of each case study.

The design thinking activity map offers a complete overview of the methods applied in collaboration with industry partners, and seeks to provide a framework with critical reflections on how to approach and interpret the exhibited input, actors, activities, and outputs respectively.

Table 4.1 Design thinking activity map

| | | knowing | pace | crescendo | reflect | recover |
|---|---|---|---|---|---|---|
| input | INTELLIGENT TRANSPORT | wants, needs<br>sensor technology<br>small intervention<br>skills | different modes of transport<br>names<br>decision matrices | interpretation<br>translation<br>amendment | assessment | semi-structured interview schedule<br>feedback form |
| | ASTEROID MINING | what it is, needs and wants<br>targeting the off-Earth commercial market | design critique | design by metaphor | scenario | corporate identity valuable to developing the business |
| | SPACE ENGINEERING | student society that is working to explore and develop space with four sub-divisions: lunar and Mars rovers, rocketry, space balloon and cansat | critique<br>co-design workshop<br>sketching<br>look and feel | translated into a visual system | understand the organisation's innovation and how it wants to set itself apart | funders encouraged to lend to higher risk organisations, that create new products |
| | REMOTE SENSING | mapping wildfire patterns via satellite earth observation data | empathic modelling<br>layout system<br>legibility and accessibility<br>perspective of satellites, radar pulses, visual translation of flames as inspiration | suitable logotype variations for organisation | story board | communication tool to customers and funders<br>professional presentation helps develop the business and takes the design forward into e.g. a geoportal service online |
| | SPACE SETTLEMENT | young people can take charge of their future skills through the scenario of life on Mars | FGDs<br>mind mapping | FGDs<br>participatory workshop model | empathic modelling mockups | |
| actors | INTELLIGENT TRANSPORT | designer, digital lead, CEO | animator | digital lead | digital lead | CEO |
| | ASTEROID MINING | CEO, engineer, astrogeologist, designer | CEO | CEO, engineer, scientist, astrogeologist, investment analyst | CEO | CEO, designer |
| | SPACE ENGINEERING | project, planner, aerospace engineers, outreach officer, treasurer | president, department heads | president | president, department heads | president |
| | REMOTE SENSING | researcher, technical lead geologist | | director | director | researcher, technical lead geologist |
| | SPACE SETTLEMENT | director | director, immersive technology developers, 3D printing prototypers | director | director | |
| activities | INTELLIGENT TRANSPORT | FGDs<br>collaboration across different fields of expertise<br>reframing | naming process<br>brain writing<br>creative orientation – ideas for colours, form, font, illustration style | creation of logotype<br>visual design elements | lo-fi prototypes of design applications | business case<br>enter new market |
| | ASTEROID MINING | FGDs<br>mapping<br>contextual observation | initial concept of prospective imagery, fonts, layout and colours | brand language contrasting to existing logotype | linking to the organisation's innovation by building confidence in its propositions | attract investors<br>promoting optimal market position<br>assist internal structure |
| | SPACE ENGINEERING | card sorting<br>group passing | inspirational words to describe values decoded into images<br>recognisable graphics | brand language elements (via colours...)<br>logo icons<br>brand applications | layered, reiterating elements | set itself apart from other branches and its parent organisation nationally and internationally |
| | REMOTE SENSING | mind mapping<br>comparative and competitor analysis<br>insight into prospective clients | open coding<br>inspiration translated into colour palette, typography, patterns etc. | room for interpretation<br>visual and functional elements of the brand | flexible structures to be adapted to a wide range of applications | reach new audiences, initiate enthusiasm for this start-up in the space industry<br>cross-industry collaboration is stimulating innovation |
| | SPACE SETTLEMENT | workshop observation<br>FGDs, interview | illustration, character inspiration, colour, form and typeface study | brand elements, dynamic logotype workshops | lo-fi prototypes; illustration and layout | |
| outputs | INTELLIGENT TRANSPORT | insight – satellite technologies for everyday traffic<br>structured online interview | brand name<br>creative orientation presentation | design route<br>brand | brand guidelines<br>business model canvas | explainer video<br>feedback<br>interview |
| | ASTEROID MINING | persona<br>seeking investors for satellite launch<br>detailed predictions in terms of visibility and curiosity in brand presentation | creative orientation | design strategy<br>professional identity<br>investment brochure and business collateral ready for publication | visual portfolio<br>mockup | practical application yet challenging the norm<br>audience accepting Space Mining concept<br>increased trust and profit |
| | SPACE ENGINEERING | thematic analysis<br>expertise, understanding its ambitions and preferences | mood board<br>integrating the organisation's interests and activities | rebrand | high-fidelity prototype brand guidelines | kit to attract more sponsors, partners and potential colleagues<br>name = identity |
| | REMOTE SENSING | profile | ideation sketching<br>creative orientation<br>rhythmic phrases | design route<br>logotype<br>fav icon | detailed brand guidelines combining found visual elements with future assignments across physical and digital spaces | raised image<br>social media to captivate viewers<br>growing business not limited to wildfires alone, expand its offer further afield |
| | SPACE SETTLEMENT | insight from interview and FGDs | creative orientation | first draft of design route | brand application (flyer) | |

# 5 Case Study 1 – Intelligent Transport

In the following study chapters, the author presents the practice-led research findings from five projects with partners in the industry and subsequent data analysis. This aims to show how innovation culture within space and satellite organisations can be represented via a bespoke design thinking model.

First the background of the organisation's specialism is presented, then the author's work with the organisation is illustrated via the different stages of the author's own design thinking process, and lastly the insights from interviews with employees and stakeholders are laid out. When going through each stage of the design thinking process, the author explains the motivation behind each stage at the time, looking to answer how this part of the process enhanced the organisation's innovation. The findings are explained, using the theoretical framework to assess whether the case study fits into the overall research aim, knowledge created while achieving the aim, and the impact of the findings, see Table 5.2 in Section 5.2.

Table 5.1 below provides an overview of the project partner's specialism and the value created through the author's work with the partner, linking it to the background of the company and back to the summary of all companies in Section 3.3.

Table 5.1 Project partner 1 – Intelligent Transport

| project | organisation type | specialism and rationale | employees and stakeholders | value created |
|---------|-------------------|--------------------------|----------------------------|---------------|
| Intelligent Transport (1) | SME | smart traffic application: GPS controlled sensors ensure green light corridors | Digital Leads Animators Developers | shift in thinking, app to enter new markets, business model development |

## 5.1 Background

Case Study 1 was conducted between March and July 2018 (Figure 3.2 in Section 3.3 refers to the timeline of all the projects), where the Design and

Technology company aimed to accelerate their innovation by creating a cohesive brand language for their Intelligent Transport app that reflects the scientific nature of the project. The company was also seeking to utilise the project as an umbrella activity to help them move forward to introduce their new product to the market.

The project partner created the app using sensors in traffic lights that are controlled through GPS to allow more intelligent movement throughout different modes of transport. Intelligent Transport is a multi-modal approach to improve productivity in freight transport for two major freight feeders in the England's North West – the Port of Liverpool and Manchester International Airport. Based on the company's earlier project that allows ambulances to move through traffic faster (GOV.UK, 2017), the smart freight project uses space data via GPS / VPS-controlled sensors managed by big data principles to ensure green light corridors for, but not limited to, trusted traders and suppliers moving through the entire urban transport network, which can cut congestion, idle and response times. Intelligent mobility is achieved by addressing current and future industrial, political, societal, and environmental challenges; discussing future capability in satellite technologies; and focusing on production of integrated mobility applications and hybrid communication systems (Catapult, 2018).

At the beginning of the work, the author had a meeting at Mann Island in Liverpool with employees of the project partner, and with representatives of Transport Systems Catapult, LEPs and Integrated Transport to discuss Intelligent Transport. This illustrated the importance of relationships and partnerships within the industry and generated insights into the viewpoints of experts in the field combined with the openness to interventions that induce innovation processes. The following paragraph contains subjective observation notes, and the names are changed.

'First Mia, the Digital Lead, and Lucas, the Project Development Manager and I rearranged the seats; what a beautiful view it was, overlooking Liverpool's docks. Slowly the stakeholders came, all very formal and sitting

down, they all talked about the view. I introduced myself and commented on ports in Europe. Mia and Lucas were reassuring the collaborators talking. Some of them expressed their worries in numbers, how much money would go to build roads and bridges, perhaps a port extension? And the environmental and societal impact, lorries passing through tiny villages and narrow roads at rush hour...'

As part of the meeting's agenda, the author's thinking was directed towards whether a small intervention, like the one proposed by the project partner, could be the answer - tiny sensors in the transport system with space data as an intelligent alternative to restructuring roads to move towards organising autonomous transport.

Through digitalisation as a tool on-demand, a multi-modal future could enable smarter cities (Intelligent Transport, 2018). Space data is precise and accurate, it is everywhere, all the time. With constellations, sensors embedded in junctions, bridges and buildings, satellite technology serves as a foundation for autonomous driving, automated parking, recharging, emergency services, air traffic etc. Through design, development and operation, satellite-based technologies implement navigation and communication while considering time and scope in economic terms (Catapult, 2018).

Each generation may have their viewpoints on technologies of the future. In Back to the Future Part III (set in 1885), Doc Brown predicts people will run for fun. Doc: "And in the future, we don't need horses. We have motorised carriages called automobiles." Saloon Old timer: "If everybody's got one of these auto-whatsits, does anybody walk or run anymore?" Doc: "Of course we run. But for recreation. For fun." Saloon Old timer: "Run for fun? What the hell kind of fun is that?" (Back to the Future III, 1990:1:17:07-1:17:33). Technology has gone beyond the traditional way of thinking, helping people go from A to B, enhancing effortless movement. The Intelligent Transport system has its focus on satellite technology and uses this technology to enable better and more efficient flow of traffic for users.

Further, faster and more affordable, as well as safer and punctual travel is made possible through satellites. By road, rail, in the air and at sea, journeys become interconnected, creating a complex transportation system. Different technologies work together in seamless connectivity, positioned via satellite. Satellite technology serves as a platform for increased transport efficiency, situational awareness, and enhanced user experience, bringing together the best of technology. Space data is instantly updated and shared, cutting response times and congestion, creating added value through integrated logistics. The logistics industry is worth £74.5 billion to the UK economy, where the aviation sector is worth £49.6 billion and rail is worth £9.3 billion. Intelligent mobility, e.g., integrated logistics, leads to increased transport efficiency, situational awareness, and primarily to enhanced user experience (Catapult, 2018). In addition to the logistics industry, a vast market is opening up in satellite technology specifically intended for 'connected cars', providing diverse possibilities for new income and profit (NSR, 2020a).

## 5.2 Milestones

The various milestones of the individual stages in the author's design thinking process, specifically tailored to the Intelligent Transport project are laid out in the following paragraphs and depicted in Figure 5.1. The design thinking activity map for the project partner serves as a list of tools used for each stage, see Table 5.2. This framework links to the methodologies for this research and derives from the design thinking activity map, applied to all projects in the design thinking chapter.

The author applied grounded theory when extracting the partner's needs and subsequent design opportunities from observational notes. Iterating stages from the design process complement design thinking via going back and forth when co-creating low-fi prototypes with experts from the partner and stakeholder organisations. The clustering of ideas also helped refine transcripts of interviews and feedback and confirmed the value of visual

design in creating a new service and gaining trust and confidence when entering new markets.

To outline the milestones and its activities, in the KNOWING stage the input was to find out about the project partners' needs and wants and to learn more about sensor technology as a small intervention and smart traffic application. Activities included collaboration across different fields of expertise. The design stage, PACE, involved brand language creation as a base for communication, with the input of drawing inspiration from the different modes of transport linked to the app, paving the way to one of the key ideas. Activities comprised of the naming process and the creative orientation at this stage. The activities in CRESCENDO entailed the creation of the logotype and visual design elements and the artwork of an animated explainer video, with its outputs of the design route of the actual brand. REFLECT included lo-fi prototypes of design application activities and brand guidelines as well as business model canvas as outputs. From the new name, the logo icon had to adopt a flexible role that still reflects the product's technical character. The RECOVER stage depicted a shift in thinking, entering new markets, and new business development, with outputs such as the explainer video, feedback, and interviews.
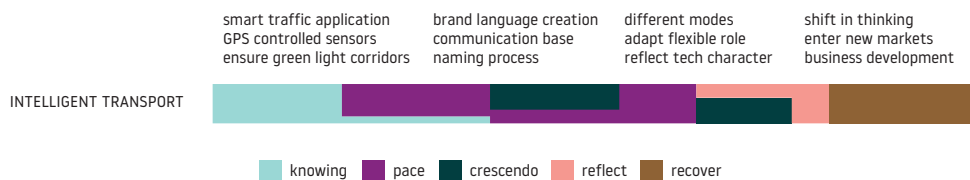


Figure 5.1 Design thinking milestones – Intelligent Transport

Table 5.2 Design thinking activity map – Intelligent Transport

| | knowing | pace | crescendo | reflect | recover |
|---|---|---|---|---|---|
| input | wants, needs<br>sensor technology<br>small intervention<br>skills | different modes of transport<br>names<br>decision matrices | interpretation<br>translation<br>amendment | assessment | semi-structured interview schedule<br>feedback form |
| actors | designer, digital lead, CEO | animator | digital lead | digital lead | CEO |
| activities | FGDs<br>collaboration across different fields of expertise<br>reframing | naming process<br>brain writing<br>creative orientation – ideas for colours,<br>form, font, illustration style | creation of logotype<br>visual design elements | lo-fi prototypes of design applications | business case<br>enter new market |
| outputs | insight – satellite technologies for everyday traffic<br>structured online interview | brand name<br>creative orientation presentation | design route<br>brand | brand guidelines<br>business model canvas | explainer video<br>feedback<br>interview |

KNOWING – During the first stage of the project, the author gained knowledge of how satellite technology is used in day-to-day traffic. The author determined the organisation's needs (see input, Table 5.2) which was to enter a new market with an intelligent traffic application using satellite technology to advance green light corridors for different modes of transport. At this stage, the company's innovation processes that have links to satellite and space technologies, and A.I. were obtained with additional focus on better post-Brexit trade; working alongside automation processes and looking into environmental issues (outputs); and bringing engineers and leaders in the North West together with creatives (activities).

After an initial briefing from the partner organisation with the designer, Digital Lead, and CEO (actors), the requirements for a brand language emerged for the smart traffic project. This involved developing a brand which could now serve as a foundation for brand communication supporting new business development opportunities.

PACE – This stage included research with prospective ideas on how brand language can be used to communicate the project partner's innovation whilst identifying a suitable font, form, colours, and illustration style for the creative orientation (activities). Key to this research, it addressed the exploration of how visual design can communicate innovation in future tech companies.

For the company's brand-new smart transport project, the initial idea was a tilted square or diamond shape with four sides or corners pointing to air or space, rail, road, and sea connecting freight etc. via these different modes of transport (input). Figure 5.2 shows a still from the explainer video (Red Ninja, 2018), created by one of the project partner's animators (actors) and art directed by the author, depicting the four modes of transport.
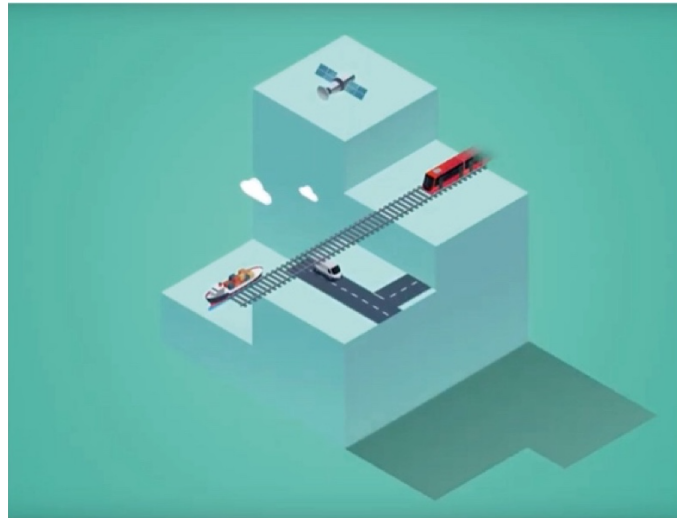
Figure 5.2 Explainer video: still – four modes

CRESCENDO – During the process of creating the logotype (activities), it became evident that the design needed to adapt a flexible role within the development of the project (input).

PACE – The naming process that started off as brain writing (activities) as part of the branding process had three parts that acted as a decision matrix (input), with relevant words to choose from, with the final name for the brand 'AI Traffic Flow' (outputs) see (Figure 5.3).
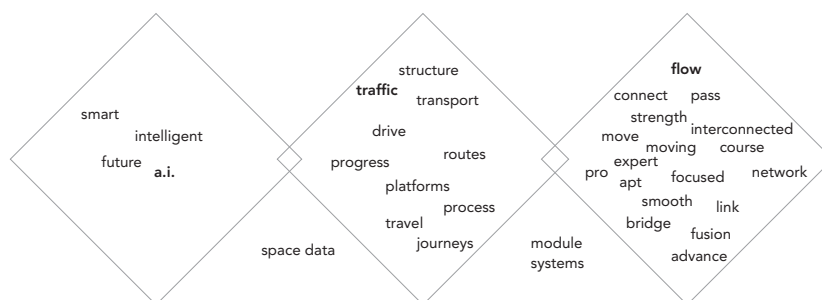


Figure 5.3 Naming

CRESCENDO and REFLECT – Visual outputs with 'flow' in the name, the idea of the tilted square had to become more flexible in shape – an

unconfined, more organic, yet interconnected shape was formed, within the parameters of the shape of a diamond with four sides. A gradient of traffic light colours with the green light prevailing has helped shape the logo (activities) for the new business case, as shown in Figure 5.4.

Figure 5.4 From tilted square to free-flowing shape: creating brand language

The logotype was key to the company's brand development, with its shape and the geometrical Avenir font and colour palette, which were adaptable to further brand applications (input). In conversation with the Digital Lead (actors), the author developed a brand language (activities) for this particular project which could then serve as a foundation for publications and brand applications, including an animated explainer video (activities; Figure 5.2; Red Ninja, 2018) that used the author's core ideas, proposed colour palette etc., as well as deriving businesses from there. The author specifically looked at how brand language impacts the innovation process whilst identifying suitable visual design tools (outputs). A whole system of brands could not be achieved within the short time period of the project. The author, however, created brand guidelines for this project to become a starting point for the design and technology company to develop further and implement it as an innovative tool that also serves as a quality asset to the company (outputs; see Figure 5.5; Appendix 1).
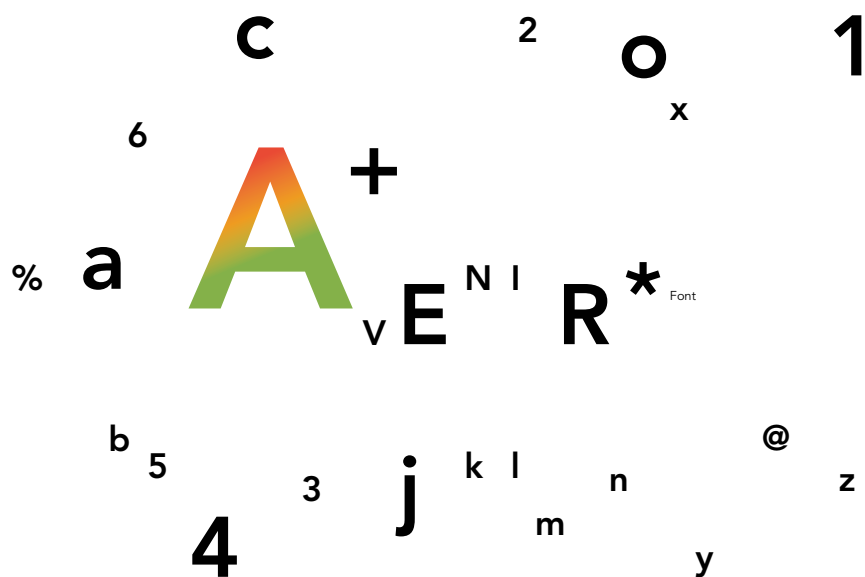
Figure 5.5 Brand guidelines – typography and colours

RECOVER – The logotype was key to the company's brand development, with its shape and colour palette being adaptable to further brand applications, e.g., the author worked closely with one of the company's animators to create an explainer video (outputs) to exploit and apply the visual design elements developed for this project. For the CEO (actors) of the company, the project was an opportunity to access talent for real-life industry collaboration that resulted in distinctive brand creation for an innovative product (outputs; see feedback Appendix 8; Intelligent Transport CEO, 2019). In response to the Industrial Strategy (BEIS, 2017), the project depicted support for a local SME, and as a result, a shift in thinking and value to the region, and it addressed issues such as the improvement of productivity by developing innovative opportunities, e.g., entering new markets (activities). During the project, in FGDs, creative thinkers sat at one table as a catalyst for collaboration, stimulating innovation with engineers and businesspeople, freight and logistics specialists, and a transport director.

The project highlighted that within activities of cross-industry collaboration, there is a need to listen to a variety of voices in order to understand and balance collective perspectives and use this to inform the project development. The role of creative thinkers included facilitation and visual communication in these collaborations, enabling cross-pollination of ideas (input) that were not previously considered. As a result, making future technology more receptive to more traditionally minded employees and partners, who may think a large investment is needed to improve roads and build bridges, whereas small interventions like sensor technology can be the answer if you view the problem in a different way.

### 5.2.1 Key learnings

The author's design thinking model created a unique process for the Intelligent Transport project with specific milestones for each stage (see Figure 5.1) that drew on the tools outlined in the design thinking activity map: input, actors involved, design activities and outputs, see Table 5.2 in Section 5.2. In brief, the milestones were based on learning about the partner's needs and the aim of its product (KNOWING); character inspiration and ideation through brand language and name creation (PACE); as well as adaptation to finalise the design route (CRESCENDO); generating brand guidelines for further application inhouse and agency (REFLECT); and evaluating the impact this project has for the company and the UK economy (RECOVER).

The design thinking activity map (Table 5.2) served as a framework for the individual design process stages, depicting how methods were also used as analytical tools in relation to input, actors, activities, and outputs in connection with the project as laid out in the previous Milestones section. For the Intelligent Transport project this meant learning about the satellite technology in use and what it is built on; what the company is trying to achieve with the product; and how a bespoke brand can communicate this to a chosen audience and its language to help develop further applications.

Lessons learned through working with the Intelligent Transport project partner include adapting to change within the ideation and making phase of the design thinking process. Good communication is essential in FGDs to prevent misunderstandings when defining the problem. Helpful examples are collating ideas in a creative orientation and presenting them as lo-fi prototypes to then discuss in FGDs to be able to amend the direction in line with suggestions discussed. Other insights were gained from appreciating and understanding collaborators' perspectives and learning from their challenges and opportunities. Key recommendations from the Intelligent Transport project include:

- Starting the design practice with research and engaging in the design process
- taking a risk in getting a new idea out and discussing it with the partner
- the ability to step back and change direction wherever necessary
- learning from cross-industry collaboration and sharing knowledge.

## 5.3 Interviews

To supplement the practical design work, interviews were a good way to gain insight into the project partner's perspective of visual design influence on their innovative products and processes.

The interviewees were all engaged in the Intelligent Transport app, and all employed in the project partner's company. The CEO (ITCEO, see Table 5.3) is also the founder of the SME and innovation is close to his heart; the Digital Lead (ITDL) was organising meetings and managing team members, e.g., through briefings for business development; and the Animator (ITA) was creating the explainer video for the Intelligent Transport app.

Table 5.3 Interview codes – Intelligent Transport

| ITCEO | ITDL | ITA |
|-------|------|-----|
| CEO | Digital Lead | Animator |

• both face-to-face and e-interview • e-interview only

The CEO (ITCEO) said that in the Design and Technology company "…we are trying to create some new value from nothing and commercialising that value" – as a large component of their innovation (ITCEO, 2019). The company's Digital Lead (ITDL) and Animator (ITA) participated in the online interview alongside the CEO to describe the role of innovation in the development of new services and the definition of innovation. The other questions were answered through a system of Likert scales (see Appendix 7 'Online Interviews Summary'), depicting the value of design and the role of innovation in various areas of the economy and technology. Both ITCEO and ITDL agreed to design being valuable to empathy, cost, and business development-related issues, however ITA does not believe design is helping in certain areas e.g., in decision-making, to generate user insight, improve financial performance, or integrating A.I. into work processes.

ITDL indicates that although innovation is crucial to developing new products, there is a lot of emphasis on innovation as a trend, neglecting the virtue of the product for a specific user (ITDL, 2019). ITA agrees that innovation plays a key role in the development of new products in the organisation: "When tackling societal problems that require technology to solve them, innovative and creative solutions are required" (ITA, 2018).

The organisation employs innovative processes such as Stanford d.school's design thinking process combined with the Lean Start-up methodology "…creating the minimum (amount of) viable products, getting feedback and incrementally building on top of that. Early products or prototyping until you got a product that you are happy with. So we like kind of start quick, build something, get feedback, iterate and just go around that loop" (ITCEO, 2019).

The ITCEO has a high regard for visual design as his preferred way of thinking and communicating, finding it hard to focus on wordy pages himself. His own presentations are image-heavy. Visual design helps the company's innovation in decision-making through creating visual content that introduces a new product idea to an audience, e.g., through branding,

animation and the visual display of quantitative data. "And I think when people see this sort of, the detail of a sort of, around some visual communication, it can help them have more faith in an innovation process and then buy into, perhaps a product or service that doesn't exist yet or they've kind of seen it. So they're saying, see it to believe it, I think there is some merit in that" (ITCEO, 2019).

The ITCEO also appreciates the effect visual design can have in releasing new ideas "…visual design can be the first prototype of a new product" (ITCEO, 2019), an idea can be presented with the help of visual design with a lot less effort than physical models. As a visual thinker design helps ITCEO with problem solving: "if I can see something, it's easier for me to understand it" (ITCEO, 2019). Whatever affected him positively at school or university or in life in general, consistently embodied visual design as a key component for that change. And one of the main factors in any decision-making process is internal or external resources, crucial to innovation. The project partner employs visual design to channel these resources and achieve the right decisions.

As to whether design improves the company's presentation, the ITCEO agrees completely: "…if you look good, people trust you more and I think that's all around the power of visual design" (ITCEO, 2019). He is always looking at creating a comprehensible and effective brand in the digital and physical context for business and project development.

"…visual design helps engage people, both internal stakeholders and employees and external stakeholders and employees. When a lot of the work which my team does is unseen for a long time, and you can kind of see it come together" (ITCEO, 2019). Often the company's products are code that is not yet visual and hence too complex to be appreciated by the audience. In the Design and Technology company there is a period of time when developments are not directly visible but rather rely on trust, however, "…if you can visually communicate some of this stuff, which you are making, it

gives the team more confidence, that this is a real thing and it's happening" (ITCEO, 2019).

Another aspect of the interview was whether or not visual design can help enter new markets. ITCEO approved of this and said: "this could be a brand, it could be some animations, it could be a website and the slicker it looks and the better it looks, the more confidence the new market has got for you" (ITCEO, 2019). Without doubt, the first impression is always visual when entering new markets, whether another country or new industry, because any potential user would look up the company online.

Differentiation from their competition has been of great advantage to the Intelligent Transport project partner as it is based in technology, and this keeps on evolving. Whilst design thinking is already firmly integrated in Silicon Valley, UK technology companies are more engineer-led, more conventional, and not really looking at visual design at all. Even though they are acclaimed companies with fantastic employees, their visual outputs are stuck in time. That is why the Intelligent Transport project partner uses more contemporary communication tools with comprehensible, straightforward and exciting techniques: "we did that through embracing visual design earlier on, even before we'd perhaps got much else besides the company. So I think it's something good to have in the DNA of your company" (ITCEO, 2019).

ITCEO neither agrees nor disagrees with the question if visual design can improve the quality of the output. "I('ve) worked on products which have had the most amazing visual design and branding, digital kind of communication assets and the product failed," (ITCEO, 2019) or at least somewhat, sometimes it is up to its creators and those around. "But it can help, …galvanise teams and act as a catalyst to bring those teams together" (ITCEO, 2019).

Even though he thinks the word is overused to an extent, he sometimes has to look it up again; nevertheless innovation means to him "creating value that doesn't already exist and implementing that value, so you kind of have a

positive result" (ITCEO, 2019). He also highlights that innovation is all about positive transformation, rather than research alone, to create and apply new value to better aspects of life – "a new way of doing something which is an improvement on the existing way" (ITCEO, 2018). The Intelligent Transport project partner's Animator (ITA) thinks innovation is to practise and generate disruptive ideas that have not been used before with the help of technology (ITA, 2018). The Design and Technology company's Digital Lead (ITDL) believes that "innovation should represent the outcome of a desire to do better, to reimagine a service or product which fails to serve its purpose fully, or one which needs updating" (ITDL, 2019). She adds that the term is frequently stigmatised for marketing purposes to advance complacency in appearing new without taking thinking processes on board that would be genuinely beneficial to the user.



Figure 5.6 Interviews – unfolding themes

The main points of the Intelligent Transport interviews (see Figure 5.6) are covered in the company's own innovation and innovative processes as:

- creating new value from nothing (ITCEO)
- a trend, neglecting the virtue of the product for a specific user (ITDL)

- a way to start quick, build something, get feedback, iterate, and just go around that loop (ITCEO),

through visual design that also serves as evaluation to the author's own design thinking model and visual outputs as a value to:

- gaining people's trust – when they see an aspect of visual communication, it can help them have more faith in an innovation process and then buy a product or service that is yet to be completed,

and in visual design as:

- the first prototype of a new product
- something tangible – if something is visible, it is easier to understand
- to advance decision making and secure funding – the project partner employs visual design to channel resources and gain the right decisions
- a professional characteristic of the company's presentation – 'if you look good, people trust you more'
- a tool for engaging people – in the time when developments are not directly visible and still rely on trust, and if some of these developments can be visually communicated, that could give the team more confidence of the reality of the product and the likelihood for this to take off
- a confidence booster to enter a new market – whether a new industry or another country, any potential user would look up the company online via their brand, animations, or their website that all draw from visual strength
- embracing the DNA of the company (ITCEO),

and the interviewees' perspective of innovation in its essence is:

- positive transformation (ITCEO)
- generate disruptive ideas (ITA)
- to reimagine a service or product to improve serve its purpose (ITDL).

# 6 Case Study 2 – Asteroid Mining

Table 6.1 Project partner 2 – Asteroid Mining

| project | organisation type | specialism and rationale | employees and stakeholders | value created |
|---|---|---|---|---|
| Asteroid Mining (2) | SME | satellite launch prior to space mining activities targeting resources on near-Earth asteroids | Engineers Scientists Astrogeologists Investment Analysts | practical application ready for publication, visual recognition, increased profit |

## 6.1 Background

The second project took place between October 2018 and April 2019. The partner aims to mine asteroids for precious metals and launch a satellite to monitor near-Earth asteroids (NEAs) prior to mining activities. Asteroid Mining is an aerospace start-up and pioneer in UK innovation, registered in Liverpool, and is the first of its kind in the UK. The collaboration with the Asteroid Mining start-up culminated with the creation of a tailored, flexible design strategy. The author developed the brand to communicate the organisation's innovation and promote it for an optimal market position. The priority of the project was to attract investors for their first satellite launch in 2025 (Asteroid Mining Corporation, 2022), currently the partner is generating data to estimate NEAs. The organisation is targeting the off-Earth commercial market using groundbreaking technologies that will enable extraction, processing and use of materials from many million NEAs. The project involved brand development, concluding with a visual portfolio that aided in promoting the start-up externally, and to assist the internal structure of the organisation.

The possibility to explore asteroids is an example of initiating enthusiasm in individuals and has innovative potential that generates inspiration. The efficacy of observing and studying space stimulates growth

and forward-thinking, beneficial to both the economy and individual achievements in the future (Giuliani-Hoffman, 2020).

"Mining the skies is no longer a subject of science fiction stories and movies". What makes space mining profitable is the staggering market value of asteroids. The space mining sector determines the probability of asteroid exploration by satellite. With a qualified asteroid in place, its features direct the mining approach (Sukumaran, 2016: 125).

Asteroids contain large amounts of precious metals (Lewis, 1992: 5), to a greater extent than earthly materials, advancing the economy by "trillions of dollars" (Jamasmie, 2017). They depict an overflow of valuable material that is conducive to space development. NEAs are likely the best starting point for mining activities, due to their reachability, diverse resources, and mining achievability. Precious commodities originating from space might soon surpass Earth resources (Sonter, 1997: 637-647). Asteroid Mining is a practicable ecological alternative for the approaching shortages on Earth (Ross, 2001: 1-4). The aspiring space mining sector with its high profitability indicates a likely shift into a new era (Lewis, 2014); it is compared to a new gold rush, that is hopeful of being beneficial to all people, acting as a driver of human space exploitation (Sterling Saletta and Orrman-Rossiter, 2018: 1-6). The commercialisation of space exploitation fosters prospective space colonisation and infrastructure (Ross, 2001: 1-4).

Asteroids that are in reach of our planet are much more suitable for mining and could serve as small-scale fuel hubs (Giuliani-Hoffman, 2020). In October 2020, the OSIRIS-REx spacecraft collected a sample from 'Bennu', a NEA. Launched in 2016, the mission is due to be completed in 2023, when the sample is expected to present valuable insight back on Earth (NASA, 2020).

Although up to now the discoveries had their main focus on NEAs and the possibility of using water for fuel, a more distant asteroid has come into the spotlight with the prospect of containing precious metals just like the Asteroid Mining project partner is looking for. On the remote asteroid

'Psyche' a spectrum was discovered identical to that of pure iron. Psyche's structure ranges from red in the sunlight to a blue surge; the quality in immersion signifies metal-oxide, which shows as extremely metal-like. Through variations due to weathering from exposure in space, a collision has taken place in the past that either removed or put on new layers or both in interdependence. In 2026, once the Psyche operation commences close to the asteroid, gathered information is expected to help identify if alterations occur because of its structure or other dimensions. Regarding the case studies of four asteroids within a comparable spectrum, ample options have yet to be uncovered by looking at asteroids using UV wavelengths. (Becker et al., 2020: 53).

Despite the asteroid's structure not being completely investigated, in theory, the probable value of iron with the proportions of Psyche would shatter all markets known on Earth, a staggering amount of $10,000 quadrillion. There are no plans to take any of its metal for human use, as technology to utilise actual samples from Psyche have not been established and the Earth's economy would very likely break under the impact. The asteroid mirrors UV rays in the same manner as the sun does with iron. With all the equipment getting prepared for a launch to Psyche in 2022, the plan is to circle the asteroid for 21 months, starting in 2026 in order to map and investigate to a more advanced extent. Recorded images are due to be available to ground staff on Earth in no more than 30 minutes. Questions arising for the mission include whether or not oxygen or other elements, e.g., sulphur or potassium, are proven to be found in the metal structure as present research suggests. Finding out the circumstances at the time of the asteroid's formation, and concluding from its structure, can then inform its origin as well as answer history of Earth-related questions (Giuliani-Hoffman, 2020). Due to the distances involved, the Asteroid Mining project partner is more interested in NEAs, with the prospect of discovering precious metals, specifically from the platinum group and working on technologies to bring them back for use on Earth (Asteroid Mining Corporation, 2022).

As part of the documentary 'Asteroids – A New El Dorado in Space?' that contains interesting facts about Jeff Bezos' Blue Moon, previously failed missions, and asteroids Bennu and Psyche, and also presented specific landing techniques on asteroids due to their uneven surfaces, e.g., through suction – the CEO and Founder of the Asteroid Mining project partner talked about how people always want things to happen and develop really quickly, but if 100 years may be doable then this is quite a milestone for asteroid mining as well (Deutsche Welle, 2021).

## 6.2 Milestones

The author's design thinking model generated a straightforward pattern with each stage bespoke to the Asteroid Mining project, detailed in this section, see Figure 6.1. Each design thinking stage provides an in-depth account of the author's input, who was involved (actors), its activities and outputs; see Table 6.2 for the design thinking activity map serving as a framework for this project.

Grounded theory was established by comparing and analysing notes and early sketches after meeting with the various professionals from the partner organisation that brought out initial ideas and then played back to develop brand language based on a feedback loop. Code excerpted emerging patterns from interviews and showed how visual design increases the ability to explain Asteroid Mining at a raised profile, improving visibility and with that accessibility to funders and new connections.

In presenting a milestone and activity overview, the KNOWING stage provided insight from activities such as contextual observations and mapping sessions during FGDs with various actors of the Asteroid Mining start-up. The input included insights into what it is about, its needs and objectives to advance the company's goal, and targeting the off-Earth commercial market. With design critique of the current brand language as the author's input, the next stage, PACE, generated an initial concept that depicts the ideas of contrast, strength, and weightlessness as activities,

concluding in the creative orientation as an output to establish the look and feel of the brand development. To help the design thinking process mature, the author employed design by metaphor as the input in the CRESCENDO stage in constant consultation with the different professionals of the partner organisation. Activities included brand language-development contrasting to the start-up's existing logotype to create power and perfection as a direct link to the coherent professional identity, as well as the investment brochure and business collateral as outputs. The input in REFLECT saw a design scenario with activities connecting to the organisation's innovation by building confidence in its propositions. Outputs were the visual portfolio of the brand development and mock-ups of design applications that were now ready for publication. In the RECOVER stage, the CEO of the Asteroid Mining project partner found the completed corporate identity valuable to the business development. The new brand elements can help attract investors, promote an optimal market position, and assist the internal structure of the start-up. The practical application serves as visual recognition for a growing audience in accepting the Space Mining concept, and as a result increased trust and profit as outputs.
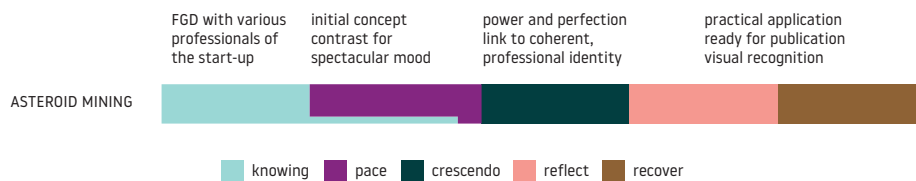


Figure 6.1 Design thinking milestones – Asteroid Mining

Table 6.2 Design thinking activity map – Asteroid Mining

| | knowing | pace | crescendo | reflect | recover |
|---|---|---|---|---|---|
| input | what it is, needs and wants targeting the off-Earth commercial market | design critique | design by metaphor | scenario | corporate identity valuable to developing the business |
| actors | CEO, engineer, astrogeologist, designer | CEO | CEO, engineer, scientist, astrogeologist, investment analyst | CEO | CEO, designer |
| activities | FGDs mapping contextual observation | initial concept of prospective imagery, fonts, layout and colours | brand language contrasting to existing logotype | linking to the organisation's innovation by building confidence in its propositions | attract investors promoting optimal market position assist internal structure |
| outputs | persona seeking investors for satellite launch detailed predictions in terms of visibility and curiosity in brand presentation | creative orientation | design strategy professional identity investment brochure and business collateral ready for publication | visual portfolio mockup | practical application yet challenging the norm audience accepting Space Mining concept increased trust and profit |

KNOWING – The author found out that the Asteroid Mining organisation is targeting the off-Earth commercial market (input; see Table 6.2) with groundbreaking technologies that will enable extraction, processing, and use of materials from many millions near-Earth asteroids (Asteroid Mining Corporation, 2022) as they can contain large amounts of precious metals (Lewis, 1992: 5), to a greater extent than earthly materials that can advance the economy (Jamasmie, 2017). What the Asteroid Mining organisation represents, its needs and wants (input) were clarified during focus group discussions (FGDs), and through mapping and contextual observation (activities) with various professionals in the company, the CEO, engineers, an astrogeologist, and a designer (actors). By developing a persona of the organisation, the need for a professional identity, including key elements such as an investment brochure, was found to be most pressing to find additional funders for the upcoming satellite launch, as well as a business collateral (outputs) for presentation externally and structure internally.
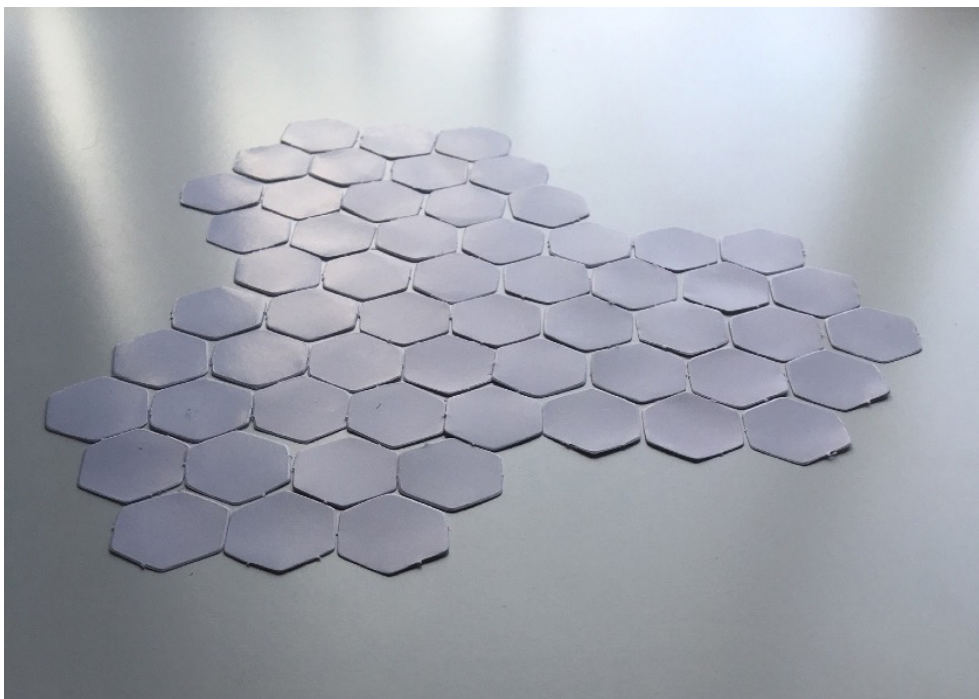


Figure 6.2 Shapes – logotype

PACE – To advance the development of the organisation's brand, the author first critiqued the design of the start-up's current logotype and brand language, (see Figure 6.2 above; input) in close consultation with the CEO (actors) in order to develop their brand to meet their funding goals and reach out to new audiences. This stage then progressed into finding inspirational terms driven by the ambitions of the project partner's proposed space activities. Prospective ideas (activities) included 'contrast' in character, colour, boldness / fineness, direction and shape; 'strength', alongside confidence, reaching above the horizon, aiming high and growing anticipation; as well as 'weightlessness', balance, and never-ending space. Based on these inspirations that translated into metaphors (CRESCENDO), the author designed a creative orientation (outputs) – an initial concept, presented with prospective imagery, fonts, layout, and colours (activities), to get an idea of how the identity is anticipated to look and feel, see Figure 6.3 for a page from the creative orientation below.



Figure 6.3 Creative orientation

CRESCENDO – Involving various members of the start-up (actors), the author used metaphors for this stage in continuous design thinking iteration (input). For the professional identity (outputs) and based on the creative orientation (PACE; see Figure 6.3), the author determined the Microgramma font for bold, extended headers that represent attention, power, and the horizon, urging slow reading to make keywords memorable. Depicting a contrast with the element of brand language and different uses of copy, the Silka font for shorter text is geometrical and contemporary, and for main text the distinctive Rotis serif font was selected that was later exchanged with the Noto Serif on the grounds of cost, which is also easy to read (see Figure 6.4 below for proposed typefaces). A thin line was formed as the brand element, complementing delicate perfection, and contrasting the logotype's hexagon shapes. The line depicts quality and weightlessness – near zero gravity that is pointing upwards in the reader's direction, diagonal, indicating floating in space and open-endedness that symbolise excitement, anticipating growth. The amber shade depicts energy and looks confident and cheerful, combined with impartial, yet sophisticated warm grey tones, it creates a spectacular mood, especially when applied to imagery, see Figure 6.3 (activities). The various brand language elements can be applied to business collateral (see Figure 6.5 for the business card), including the publication ready investment brochure (outputs; Appendix 2; Figure 6.6 for inside cover).

**FONTS**

**ABCDEFG**
**1234567**

**HEADERS**
**MICROGRAMMA B EXT**

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890
£:!%"

Copy
Rotis Serif 55

*ABCDEFGHIJKLMNOPQRSTUVWXYZ*
*abcdefghijklmnopqrstuvwxyz*
*1234567890*
*£:!%"*

*Copy highlighted*
*Rotis Serif 56*

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890
£:!%"

Copy standing out text
Silka Reg

**ABCDEFGHIJKLMNOPQRSTUVWXYZ**
**abcdefghijklmnopqrstuvwxyz**
**1234567890**
**£:!%"**

**Copy standing out text highlighted**
**Silka SemiBold**

Figure 6.4 Proposed typefaces

REFLECT – The author drew a design scenario (input) in a feedback loop with the CEO (actors) to review the visual outputs from the previous stage (CRESCENDO). This meant that, in combination with the existing logotype and characteristic hexagon shapes, the author developed the brand to create meaning directly linking to the organisation's innovation by building confidence in its propositions (activities). The typeface for copy text was exchanged to a free version due to the start-up being at a stage when their business is still looking for sponsorship and trying to keep costs low. Promoting the design route further, applications were generated by means of the mock up of the brochure and business collateral that completed the visual portfolio (see Figure 6.5 for a business card example; outputs; see Appendix 2 for the brochure).
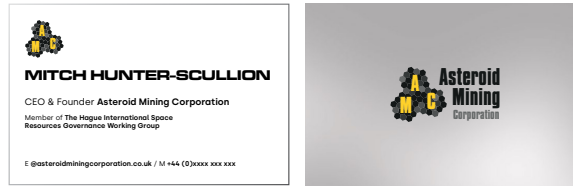
Figure 6.5 Business card layout

RECOVER – Brand development was the main focus for the collaboration with the Asteroid Mining partner. The most pressing brand elements were the brochure and business collateral that established a coherent, professional identity (KNOWING) that can act as a conversation- starter to attract investors, promote the organisation's position in the market and enhance internal structure (activities). This identity can be adapted and further developed by the organisation (input; actors). The design-led approach was valuable in creating the corporate identity, but it was also considered as a beneficial tool to developing the business (input). For the pioneer in Space Resources, the opportunity to conduct an innovative approach to design that represents the industry is the most practical application, yet one that challenges the norm (outputs). With the investment brochure ready for publication, the organisation is moving forward to the investment stage of the business model (activities; Appendix 2 for brochure; Figure 6.6 for the inside cover sample spread), helped by the brand development to become visually recognised and the Asteroid Mining concept to be accepted by a wider audience (outputs). The professional brand contributed to the start-up's confidence (activities), a momentous development in the organisation's history with considerable impact on its business (see Feedback Appendix 8; Asteroid Mining CEO, 2019).

image credit Gareth Jones – Liverpool skyline and Francesco Ungaro – starfield

Figure 6.6 Brochure inside cover

### 6.2.1 Key learnings

The Asteroid Mining project partner provided the author with a pioneering perspective of an industry that is yet to be fully explored. The author's interpretation of the different stages saw a level approach to the progress of the design thinking model, see Figure 6.1 in Section 6.2. With the help of the milestones (Figure 6.1) and the activity map (Table 6.2, Section 6.2), the design thinking process served as an enabler to the organisation's brand development. To recap, during FGDs, insight into the Asteroid Mining project partner's aims was established (KNOWING); design critique of the current identity and the initial concept concluding in the creative orientation for the look and feel were advanced (PACE); design by metaphor progressed the brand language that complemented the start-up's existing logotype and led up to the creation of the investment brochure and business collateral (CRESCENDO); a design scenario was key to creating a visual portfolio and mock-ups of the design applications that all helped build confidence in the

organisation's objectives, internally and externally (REFLECT); and the corporate identity was found to be a valuable tool to new business development and to visually recognising the Space Mining concept (RECOVER).

The Asteroid Mining project could draw from the design thinking activity map (see Table 6.2 in Section 6.2) to build brand language elements through the design thinking process. In practice this involved creating insight from the company's goals to enter the off-Earth commercial market, and from this knowledge, to pull out inspiration that could then extend into lo-fi prototypes in the form of creative orientation and directing the hi-rise prototypes for the design route. Reflecting on the brand language elements built so far, design applications could be refined into a professional identity that helped boost the partner's audience's confidence and develop the business.

One of the lessons learned during the project was to encompass a new industry that is still widely untouched but implies that huge benefits could be offered to the economy, trusting to rely on the design thinking process to deliver a professional brand. Another lesson included the importance of research in practice and the other way around – the ability to produce quick visual prototypes that can be built upon, improving the quality of the product through the process, and all relevant to coherent thinking. Based on this, some of the key recommendations, originating from the author's collaboration with the Asteroid Mining project partner are listed here:

- Not to be afraid to approach a pioneering organisation
- to develop a brand through lo- and hi-rise prototypes
- observing, taking notes, and reflecting, as research enhances practice
- to create coherence through design thinking for a professional identity.

## 6.3 Interviews

In addition to the lo- and hi-rise prototypes produced, the interviews undertaken with the Asteroid Mining project partner's CEO and Founder (AMCEO), Astrogeologist (AMAG), Chief Science Officer (AMS) and Head of Investment (AMI) help see the value visual design has to their individual views of innovation.

Table 6.3 Interview codes – Asteroid Mining

| AMCEO CEO and Founder | AMAG Astrogeologist | AMS Chief Science Officer | AMI Head of Investment |
|---|---|---|---|

• both face-to-face and e-interview • e-interview only

The author carried out an interview with AMCEO in person, whilst he as well as AMAG, AMS and AMI participated in the interview online with the overall agreement that design adds value to different aspects of technology and the industry. In a completely new field, the pioneering Asteroid Mining project partner (AMAG, 2019) is creating technology that has never been applied before (AMS, 2019; AMI, 2019). This stands for innovation in the essence of the start-up and for trying to go further than anyone has done before, continually years ahead of present developments that all demonstrate that "design plays a critical role in explaining our processes to our audience" (AMCEO, 2019).

AMCEO says that as a pioneering start-up, innovation is the foundation to all processes: "we are the first people that try to mine an asteroid in the UK, so it has to be innovative…" (AMCEO, 2018). He added that mostly when developing new technology, things clarify as processes follow on and iterate to develop distinct thinking patterns. Innovation does not come suddenly; it turns up somewhere along these processes. The company regards design as a crucial element that enables decision making to benefit its growth and prosperity. In connection to establishing new partners, AMCEO said "We've already done the technological development for the innovative and technical side of things but we then need the design to come in and make that technical

innovation accessible to the investment community" (AMCEO, 2018). Innovation becomes accessible to prospective collaborators through dividing a large project into smaller comprehensible elements, communicating the company's needs and wants.

The combination of great design and an impressive project is heading for success: "if you have a good corporate identity, if you have a well-designed product then that makes it a lot more compelling" (AMCEO, 2018) as it demonstrates the company's potential. Visual design can help communicate the Asteroid Mining project partner's innovation by creating visibility and belief in the achievability of the project's individual stages. Design can improve the value of a product through defined creative quality to its practical work (AMCEO, 2018).

AMAG defines innovation as doing something new or in a different way and to "push the limit of what has previously been thought impossible" (AMAG, 2019). AMI thinks that it simplifies people's lives by allowing a way into new technology or knowledge. To AMS innovation means the process of problem solving. And AMCEO interprets innovation as "imagining the impossible – then finding the phone numbers of the people who can make it happen" (AMCEO, 2019).



Figure 6.7 Interviews – unfolding themes

130

The key focus of Asteroid Mining interviewees (see Figure 6.7) on the role of design, including the author's contribution to the organisation through the design thinking model, can be summarised as:

- in explaining processes to an audience (AMCEO)
- through iteration, processes become clearer when developing new technology
- to make technical innovation accessible to prospective funders
- in communicating the company's needs and wants by breaking down the project into comprehensible parts
- by its combination with great products: there is power in looking good
- to communicate innovation by creating visibility and belief in the company's goals
- and by improving product value through creative quality (AMCEO).

The Asteroid Mining project partner's definition of innovation can be outlined as the ability:

- to move the boundaries of the possible (AMAG, AMCEO)
- by allowing a way into new technology (AMI)
- and through connecting with future partners (AMCEO).

# 7 Case Study 3 – Space Engineering

Table 7.1 Project partner 3 – Space Engineering

| project | organisation type | specialism and rationale | employees and stakeholders | value created |
|---------|-------------------|--------------------------|----------------------------|---------------|
| Space Engineering (3) | student society | explores and develops space with four subdivisions: lunar and Mars rovers, rocketry, space balloon and cansat | Project Planners Aerospace Engineers Outreach Officers Treasurers | rebrand creates new interest in prospective sponsors and members, raises image |

## 7.1 Background

The third project took place between May 2019 and July 2019. The partner engages in various space engineering developments and currently has four subdivisions, including lunar and Mars rovers, self-landing rockets, space balloons, and satellites built inside a can. The student society, based at a university in England's North West, works to explore and develop space and successfully participates in worldwide competitions as well as in workshops to educate and encourage the next generation. A rebrand was welcomed by the aerospace engineering organisation in order to attract more sponsors, partners and potential colleagues and to engage individuals and teams alike.

The research into space technologies is reaching more audiences with growing interest to involve universities in developing space innovation. Once a president of the student society at Princeton (SEDS, 2016), Jeff Bezos, as one of many new commercial space entrepreneurs, has had the vision to establish an off-Earth industry since high school (CNBC, 2018); and through his company is now giving back to the students of space exploration that he previously worked with (SEDS, 2016).

The Space Engineering project partner is reaching out, employing a strategic way to fulfil their vision, allowing sponsors to display their brand,

granting easier access to graduates for prospective companies and presenting space enthusiasts in the area with a platform for exploration (Issuu, 2019).

On building a rocket that sent John Glenn into space. "…Now I'm standing beneath a spaceship that's going to carry an astronaut to the stars. I think we can say we are living the impossible…" Karl Zielinski to Mary Jackson in the film 'Hidden Figures' (Hidden Figures, 2016:14:49-14:58).

Hopes are also high for NASA's plan to return to the Moon in 2024. The human mission is set to commence with the spacecraft Orion from a space launch system. The crew aims to include the first woman to set out for the Moon (Rincon, 2020). Advancing with a pace, the UK Space Agency started in 2010 and is aiming big, growing with future potential. All things space got a UK makeover, since the space agency invested £16 million. It is collaborating with NASA succeeding the Ariel satellite programme, constructing the Lunar Gateway and looking into contributing with communications systems, manufactured by Surrey Satellite Technology Ltd. Following on from Artemis, the aim is to go back to the Moon with a human crew by 2024 and concurrently establishing a foundation for research and more exploration, serving as a stopping place for these activities, including a residential area and a warehouse. The original idea is to ignite and expand new possibilities in space (Grossman, 2020).

With their motto 'Bring Manchester Closer to Space', the Space Engineering project partner is implementing this aim with their four departments. 'Rovers' has its focus on robotics with distinct teams from diverse backgrounds for a lunar and Mars rover that will both go through a design and quality process to create a working object for a challenging environment. 'Rocketry' concentrates on robotic, hybrid rockets. The department is concerned with self-landing mechanisms and looks at a possible launch from a space balloon. The 'high altitude balloon' moves into the stratosphere, as this department is science- and practice-focussed. 'Cansat' is short for a satellite, the size of – and moreover a satellite built in – a can. A cansat is usually launched from a research rocket in order to

imitate an industry-like satellite with its duration from first design to review following a flight. A diverse team of students with interests in science, space technology and engineering, is entrusted to this department. All departments are working on individual projects or collaborating with each other and partnering with stakeholders, reaching out locally, nationally, and internationally (Issuu, 2019; Manseds, 2019).

## 7.2 Milestones

This shorter and highly intensive project immediately had an entirely different dynamic to the design thinking process, see Figure 7.1 for design thinking milestones. The loop of the KNOWING, the ideation and making stages of PACE and CRESCENDO as well as REFLECT have seen three iterations before the process was completed in the RECOVER stage. The collaboration with Space Engineering was very vibrant, with a distinctive constellation of members engaged in contrasting projects, each project with unique needs and preferences that reflected in the author's practical work with the partner. With the help of the design thinking activity map, see Table 7.2, the individual design thinking stages (Figure 7.1) of the Space Engineering project are summarised in the subsequent paragraphs.

The author used grounded theory naturally augmenting the design thinking process via turning code from material gathered during FGDs into categories and then iterating with old and new elements – driving transformation when creating first and later prototypes beneficial to branding the Space Engineering organisation. Highlighting ideas from sample data that came out of feedback and interviews with participants of varied expertise validated visual design's role in differentiating the partner's identity, positively influence stakeholders and help secure more funding for visionary projects.

KNOWING had the input of the student society working to explore and develop space with four subdivisions: lunar and Mars rovers, rocketry, space balloon and cansat. Various actors of the partner organisation e.g., project

planners, aerospace engineers, an outreach officer and a treasurer all participated in activities in this stage, at different times throughout the process, including card sorting and group passing. The varying PACE stage saw co-design workshops that involved sketching as an input to gain the look and feel of the partner's projects in collaboration with the president and department heads. Activities here involved finding inspirational words to describe the organisation's values that could then be decoded into images and recognisable graphics summarised on a mood board as outputs of this stage. In CRESCENDO the ideas from the previous stage were translated into a visual system with constant feedback from the organisation's president. Activities included the creation of the logo icons for the four departments and in the later process brand applications and the completed design route as outputs. Together with the president and department heads, the author created the partner's brand to communicate the innovation that was becoming apparent by layering and reiterating elements within the process in the stage REFLECT, with hi-fi prototypes displayed in brand guidelines as outputs. As a result of the individual stages of the design thinking process and drawing from the project partner's feedback, RECOVER found that funders are encouraged to lend to higher-risk organisations that create new products such as the student society. With the active effort of setting itself apart from its parent organisation and sister branches, the Space Engineering project partner's new identity served as a professional kit to attract more funders and potential colleagues.
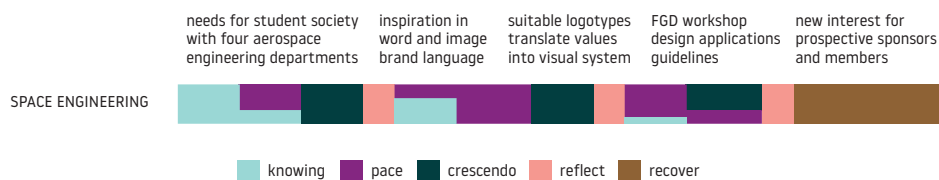
Figure 7.1 Design thinking milestones – Space Engineering

Table 7.2 Design thinking activity map – Space Engineering

| | knowing | pace | crescendo | reflect | recover |
|---|---|---|---|---|---|
| input | student society that is working to explore and develop space with four sub-divisions: lunar and Mars rovers, rocketry, space balloon and cansat | critique<br>co-design workshop<br>sketching<br>look and feel | translated into a visual system | understand the organisation's innovation and how it wants to set itself apart | funders encouraged to lend to higher risk organisations, that create new products |
| actors | project planner, aerospace engineers, outreach officer, treasurer | president, department heads | president | president, department heads | president |
| activities | card sorting<br>group passing | inspirational words to describe values<br>decoded into images<br>recognisable graphics | brand language elements (via colours...)<br>logo icons<br>brand applications | layered, reiterating elements | set itself apart from other branches and its parent organisation nationally and internationally |
| outputs | thematic analysis<br>expertise, understanding its ambitions and preferences | mood board<br>integrating the organisation's interests and activities | rebrand | high-fidelity prototype brand guidelines | kit to attract more sponsors, partners and potential colleagues<br>name = identity |

KNOWING – The author worked closely during this stage with project planners, aerospace, engineers, an outreach officer, and a treasurer (actors; see Table 7.2 for the Space Engineering design thinking activity map) from the four subdivisions to enquire about the organisation's projects (input). The author learned that the 'rovers' department emphasises on robotics for conditions on the moon and Mars that have to pass through several processes to refine the quality and the design of the products to work well. The focus of the 'rocketry' department is on a self-landing rocket with a hybrid motor, the launch of which aims to take place from a space balloon. This 'balloon' is made for a high altitude, entering the stratosphere with its department's main focus on science-based practice. The 'cansat' department is building a satellite in an actual can that aims to launch from a research rocket and is close to a satellite in the industry, being tested on from the prototyping stage to evaluation after the flight. The students are based in science, space technologies or engineering. The four departments work individually as well as collaborate on projects in partnership with the industry. The organisation successfully involves in competitions all over the world and holds workshops to equip the future generation with skills and motivation (Issuu, 2019; Manseds, 2019).

Starting the process with a unique 'vibe', this stage found that the organisation is looking for a rebrand in form of a professional identity to find more funders as well as student members. The first brief was to find a suitable logotype for the organisation as a whole, but also knowing that there are sub-departments to follow. While learning about the organisation's

values and what it wants to convey, the question arose as to how these can be translated into a visual system that works (outputs).

PACE – This stage started with design critique (input). Together with the organisation's president and department heads (actors), the author looked at the current corporate identity and what needed improving. Based on that critique, the original creative orientation involved finding the right inspirational words to describe values that then could be decoded into images in the aerospace engineering context (activities).



Figure 7.2 Primary and secondary colours

CRESCENDO – The character inspiration already started extracting a number of ideas on potential colours, typography, brand language and illustration style (input). The insight for the primary colour 'sky vs sea' came from looking back to earth from space. Supplementary colours in black, white and shades of grey as well as silver were established alongside six secondary colours to have a comprehensive choice for versatile usage, see Figure 7.2 above. The Ailerons font as the basis for the organisation's main logotype, that is entirely made up of its name's letters, is integrated into the environment of space, which has a timeless look. Another font, Bariol, was found for the tagline and text in contrast to the main logotype and to allow more of the organisation's values to come through, having a friendly and accessible appearance, see Figure 7.3 below (activities).
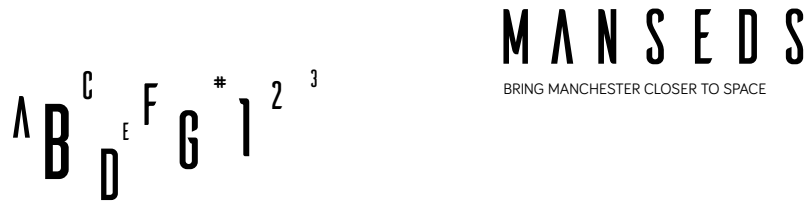
Figure 7.3 Typeface for headers and principal logotype

REFLECT – A rebrand with a clear-cut, delicate logotype in the space context was welcomed to set the organisation apart from other branches in the UK and internationally as well as serving as an umbrella to the four different departments (input; see Figure 7.3 principal logotype with tagline).

KNOWING – Rover, rocketry, balloon and cansat depict the sub-divisions of the student society with the objective of creating a coherent and accessible brand. Card sorting and group passing (activities) were set during FGDs to understand each department's ambitions and preferences (outputs) and to start the ideation and making stages of the process, see Figure 7.4 from one of the workshops with the card sorting activity.
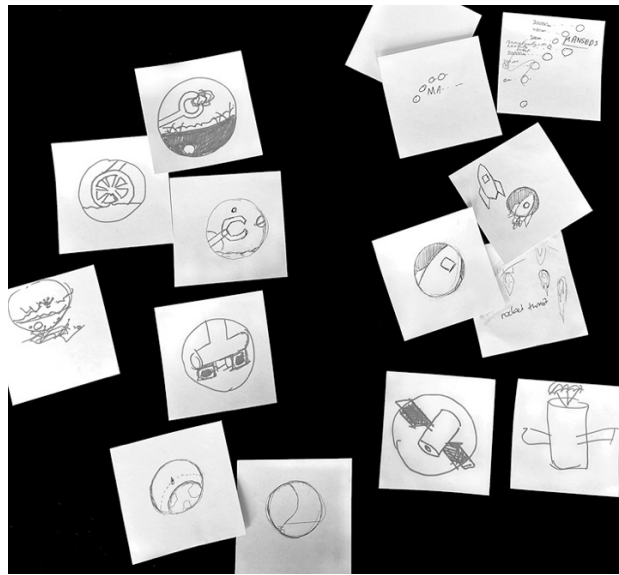
Figure 7.4 FGD workshop – card sorting

PACE – During a co-design workshop in collaboration with department heads and the organisation's president, the look and feel of the sub-logos were refined (input; actors; see Figure 7.4 for card sorting exercise). Appropriate for a replay mode, logo icons were the most suitable with recognisable graphics, characteristic of each separate department, yet together identifiable as one organisation. A mechanical robotic arm stands for rovers, a cropped rocket and thrust for rocketry, a modest balloon with payload for the balloon department, and a can spreading its wings represents cansat. The circular shape indicates movement in orbit, that is also infinite, limitless and complete. The various sketches (input) together made up a mood board (outputs) that could inform the next stage of the design thinking process.

CRESCENDO – The initial prototype logos were of great detail within the parameters of a circle and previously determined colour and imagery palette.

REFLECT and KNOWING – During a FGD workshop, co-designing with department heads and the organisation's president included mind mapping,

card sorting and sketching, a simpler design was preferred that can be scaled as needed (input; activities; actors).

PACE – This in-depth insight helped the author uncover the visual implementation of the various department characteristics allowing interesting angles, contrasting shapes and cropped elements, see Figure 7.5 (outputs).



Figure 7.5 Primary and department logotypes

CRESCENDO – With the moving yet captured logo icons (see Figure 7.5 above), the author created a rebrand including proposed brand applications for strategic design use on different types of layouts e.g., brochures, websites, on textiles, and use of illustrations in explainer videos, flyers, posters, etc., all working with the colours and principal logotype, see Figure 7.6 below (outputs).

Figure 7.6 Illustration and brand application

REFLECT – Comprising Space Engineering's completed rebrand and brand applications, the author made hi-fi prototype brand guidelines (outputs; see Appendix 3), suitable to the organisation's goals and for practical use of the brand in the future. This project has become much more layered, with reiterating elements to solve a complex task (activities) for an organisation that wants to set itself apart from other branches and its parent organisation nationally and internationally, and to bring about a varied brand that makes itself and its divisions comprehensible (input).

RECOVER – Creating a brand for a space engineering organisation has resulted in a valuable kit that translates a name into an identity to share the interest of space exploration and development and to address prospective members, partners, and sponsors (outputs). The design thinking process and subsequent successful rebranding work by the author was the result of integrating the organisation's interests and activities by understanding its ambitions and preferences. This project provided the evidence that design can help understand innovation through visual communication, which encourages funders to consider higher-risk yet innovative organisations that create new products, facilitating the growth of entrepreneurial thinking in the region, whilst differentiating itself from competitors (input; activities; see feedback Appendix 8; Space Engineering President, 2019).

### 7.2.1 Key learnings

The holistic approach to the design thinking process helped the author understand the Space Engineering project partner's unique needs and preferences, resulting in a threefold iteration of the first four stages, see Figure 7.1 in Section 7.2. The individual stages of the author's design thinking model were built on the tools and techniques presented in the design thinking activity map, see Table 7.2 in Section 7.2. The milestones can be categorised as discovering the student society as a whole and its four sub-divisions (KNOWING); taking on a co-design workshop together with department heads and the president; decoding inspirational words into images and recognisable graphics (PACE) that then translated into a visual system of the varying brand language elements (CRESCENDO), brand guidelines containing the hi-fi prototypes of the new build brand (REFLECT); and as a consequence of a name becoming an identity, generating a kit to attract prospective funders, partners and new student members (RECOVER).

The activity map (Table 7.2) together with the design thinking process (Figure 7.1, in Section 7.2) offered a platform for translating how the organisations wants to look like in a visual system. A kit that allows complementary colours, typefaces, and logotypes, relevant to brand applications at later stages and as a foundation for new brand elements in the organisation's future to speak for the various departments' values and to help them stand out against parent and sister organisations around the world, whilst conveying the society's openness and accessibility as well as its boldness and achievements.

Some of the lessons the author learned during the project were that through getting together with members of the organisation in FGDs, critiquing past visual branding and competitor identities was constructive and a good base from which to start the creative orientation. Co-design workshops with initial sketches of the four departments' logos (see Figure 7.4) were helpful in getting instant feedback and gaining better insight into

what the final logo icons were going to look like. Iterations of individual design thinking stages were suitable for the project to break down tasks and create a refined brand identity with a lot of useful lo-fi prototypes on the way. The author concludes the insights from the work with Space Engineering project partner as recommendations that can be summarised as:

- Co-design stands for impact in the design thinking process
- to get lo-fi prototypes out, refine them, and repeat (a lot)
- with design tools a huge project can be broken down into smaller ones
- through brand creation, a name becomes an identity, distinguishing an organisation from its competitors.

## 7.3 Interviews

The combination of findings from prototypes and interviews equipped the author with insight into the overall evaluation addressing the research question directly. The interviewees widely agreed about visual design's ability to add value to innovation, while a few questions received neither agreement nor disagreement, and SECO (see interview codes, Table 7.3 below) had a negative view and disagreed with all the interview questions (see Appendix 7 for online interviews summary).

The project partner comprises of different professionals, including project planners, due to the nature of the four sub-departments, outreach officers, treasurers, and aerospace engineers (see Table 7.1 and Table 7.3 for interviewees), with the majority studying subjects in science or engineering. The interviewees are engaged in the student society's different projects (SER, SEB, SERK, SELB, SEPUB) or in the organisation as whole (SEP, SET, SECO, SESC, SEOO, SEOOC and SED). Most of the interview participants have more than one role and tap into multiple projects.

Table 7.3 Interview codes – Space Engineering

| SEP President | SER Head of Robotics | SEB Project Leader: high altitude experiments | SERK Rocketry Project Leader | SET Treasurer | SELB High Altitude Balloon Project Leader |
|---|---|---|---|---|---|
| SEPUB Publicist, Rover Project Leader, Balloonian Chief Engineer | SECO Contacts Officer | SESC Sponsorship Coordinator | SEOO Outreach Officer | SEOOC Co-Outreach Officer | SED Designer |

• in person interview • both face-to-face and e-interview • e-interview only

Five participants engaged in an interview in person with the author, two of them also filled in the interview form online, and seven participated in the e-interview exclusively, see Table 7.3. On the online form, interviewees were first asked what the organisation is doing and how important innovation is for its projects.

The organisation "encourage(s) students to pursue the exploration and development of space." The Space Engineering project partner uses innovative processes to develop technologies that enable the "launch of rockets and reach the edge of space" (SET, 2019b). SEPUB says it "provide(s) a recreational platform for students to pursue their academic interests in space" (SEPUB, 2019). It is compelled to innovate in order to differentiate itself from competitors and to be at the forefront. Innovation involves a thinking process that encourages the organisation to be first, faster, and more divergent, allowing new perspectives (SECO, 2019).

The author started with a face-to-face interview with the student society's president who is also an aerospace engineer, who believes that for the organisation innovation is "crucial. It's one of the most important things. Without innovation – I don't think, we would be able to do anything" (SEP, 2019). In light of that, innovation is woven into the organisation's day-to-day activities, 'newness' is in all the projects, in the products, in idea finding, in experiences. Not many organisations work in the space industry, therefore whenever a product is being built, it is usually an entirely new one that cannot be built without innovation. Innovation has to come from the root to create positive change (SEP, 2019).

The project partner uses the engineering project cycle to boost their innovation, with the first focus on laying out the assignment, and the second on what is needed to make this happen from a design point of view. Following this, the ideation phase begins and then the process iterates, whilst the partner also investigates whether early prototypes work as they are predicted to. When subsequently everything comes together, there will be some anxiety involved, whilst one part of the prototype might work well, the other might require more attention. The process continually alternates between stages, particularly when building an entirely new product (SEP, 2019).

As the Head of Robotics and General Secretary, SER depicts that innovation is necessary in managing a budget. A product is required to be innovative to enter new markets. Innovation is a fluid process; at the beginning there may not be a lot that is visible but as the process goes on, the work becomes more innovative, and innovation can be encouraged but not planned as such (SER, 2019). The balloon department aims to create ambitious new products with a launch happening gradually due to custom-made elements that require government permission. Expanded tasks involve creating prototypes from low-cost material, "like cracking a GPS unit, so it does work at a certain altitude, which they're usually fixed to not work at and stuff like that" making the department highly innovative (SEB, 2019a). "Most of the projects (to my knowledge) use a very Macgyver approach to problem solving, so small scale innovation is vital" (SEPUB, 2019). Alongside his team, as an aerospace engineer, SEB develops high altitude experiments and launches them. He is generally supportive of the statement of visual design advancing the organisation's innovation (SEB, 2019b). SELB accepts the perspective of visual design aiding the organisation's innovation, highlighting that it improves issues around sustainability, monetary value, testing prototypes and activities in space (SELB, 2019). SECO thinks negatively about the link of visual design to innovation, disagreeing almost entirely with all the author's points (SECO, 2019). SESC is wholly positive when answering interview questions. Innovation is visible in supporting

students' decision making and ideation processes, which are greatly valuable to the organisation (SESC, 2019). The Outreach Officer "increase(s) awareness about space-related activities". Innovation is essential to develop tools and techniques for the various prototypes of the departments (SEOO, 2019).

SED studies aerospace engineering and specialises in visual design. She thinks innovation is progression that constantly transforms, building from current elements, creating new constellations (SED, 2019). Visual design can help in decision making, it helps guide people through and reduce the complexity of the process, making it more efficient and economical (SER, 2019). When trying to solve engineering-based problems, sketching is one of the creative methods in the ideation phase before working out 3D prototypes, most innovation is founded in those initial graphic designs (SER, 2019). SEB thinks that branding supports the organisation's innovation, "I need to see things to work with them, so if we all are going on imagining and not writing it down, that makes lots of work go wrong" (SEB, 2019a).

A clear advantage of visual design is to engage stakeholders that might contribute to the process. Design can simplify the organisation's aim, it helps make sense of things, something that is also crucial in an engineering discipline. Visual design helps the organisation say, "This is who we are, this is our brand, this is our organisation, those are our goals" (SEP, 2019). SET is the treasurer of the Space Engineering organisation and an aerospace engineer (SET, 2019a), and also thinks visual design is a driver for innovation (SET, 2019b). It can hugely impact and act as an influencer to the Space Engineering project partner as it seeks to include current and future members and keep up with new technologies (SET, 2019a). To individuals with no technical expertise, visual design is also beneficial in terms of explaining the organisation's products and processes, "a picture tells more than a thousand words" (SEP, 2019). To a person accustomed to creative processes, problem-solving comes naturally. "Just because they have this, I don't know…, synopsis connections in their brain" (SEP, 2019), these people

are also effective in engaging in engineering processes with creativity being key to producing positive innovation (SEP, 2019).

SED says if data is communicated visually, it enters a relationship with the user, it helps reduce tension and makes the message adaptable, creating this connection. "I guess everything is about visual aid... You make all the decisions around how you see, how you perceive it first" (SED, 2019). Visual design can help communicate ideas through simple elements such as colour combination, the use of graphics and typefaces. Design can enhance the organisation's presentation. SEP emphasised, "I do think that creative design will definitely help with brand recognition which is very important in a world where we... strive to get as many sponsorships as possible and companies want to... get something in return and if we have that recognisable brand, then they will be more likely to support us, because ok, those are those people, you know, this is oh... I've heard about that; I saw the logo. It's definitely something, I think, that will help contribute to our sponsorship partnerships of any kind" (SEP, 2019). In terms of articulating new ideas, visual design has a knock-on effect professionally that attracts companies who want to connect. Visual design is about presentation that manifests the form of websites, logotype and the overall brand image (SED, 2019). Visual design can make the organisation look friendly and accessible, which helps retain students with or without technical background by engaging and guiding them according to their interests throughout their time at university, making it easier to understand the organisation's processes. A brand can elevate the organisation by augmenting the professionalism of individual projects and workshops. One of the Space Engineering project partner's sister branches has an individual brand identity for its organisation as a whole and its sub-departments – this is concurrently the strongest competitor in the UK, its system of logotypes creating a bespoke brand image and clearly setting the organisation apart, making it highly successful in everything it does and attractive to prospective stakeholders. SEP observed, "we always like to think, we judge things on quality, but that's not always the

truth. We judge things on actual quality and how it looks like, like people who enjoy something – just because it looks nicer – much more, even if it is something purely technical. And that's the truth, like, no matter how good you are, if you can't say how good you are, then you're not that good" (SEP, 2019). The way the brand image portrays the organisation helps engage prospective funders and new members and differentiate it from comparable organisations. Branding can boost the quality of a product or activity on a professional level. To improve a product or an activity whether making it stronger, lighter, or making a discovery valuable to the market and a product practical to the user, all is innovation. It is building something new or incorporating an element that makes it original (SET, 2019a). Branding can help differentiate the organisation from its competitors and simultaneously interconnect with other branches and departments. Visual design can help create excitement and encourage collaboration (SED, 2019). It can help in taking decisions by simplifying an overwhelming amount of information and extracting the important parts. It helps find solutions when meeting in a suitable environment that encourages sharing ideas, "visual design is extremely important for that, because like having a universal brand, like looking is one thing" (SEB, 2019a). Frequently, when SEB introduces his department to an audience, they are unaware what it is all about and what it is part of, as there is no individual logotype or all-over brand for the organisation. "So, having one, making it clear that's our own, is the one thing that's very useful" (SEB, 2019a). Visual design supports engagement with student members, "because once you're inside, it's like a lot of projects, you still have to know what's going on with that project" (SEB, 2019a). To address prospective funders, a professional brand can help improve the look of the organisation's website e.g., that is important in relation to competitions as all the UK student societies apply for the same pot of funding, "obviously we compete with other teams, it's got to be the intimidation tactic... if you look better, you probably get a bit more funding" (SEB, 2019a). A professional identity contributes to the organisation's

quality as it sets a standard for the audience to see and aim for, to "be willing to dedicate more to it" (SER, 2019). It allows unity to be established and helps the organisation become positioned in its own identity, "the only thing that sets us apart from other related societies is our image" (SER, 2019). In terms of improving the quality of the output, SEB supports the view that a branded product looks more attractive and makes it the organisation's own as a form of belonging, e.g., when filming the labelled balloon with the Earth backdrop in the stratosphere (SEB, 2019a).

For SET, innovation means finding "new ideas and methods for doing and making things" (SET, 2019b). As one of the Outreach Officers, SEOOC looks into various organisations and promotes the Space Engineering partner's projects. To SEOOC, innovation "leads to new research and ideas" (SEOOC, 2019). SERK leads the project partner's Rocketry department, organises its activities throughout the year, and widely agrees that design adds value to innovation. The team frequently has to solve difficult issues it encounters. Innovation means creating new products (SERK, 2019). Innovation is "integrating unusual or new design into existing/understood products/constructions" (SEPUB, 2019). Innovation is continuously prioritising until a project's aim is fulfilled, using creative methods (SER, 2019). Innovation is all about relationships, linking things together that haven't been linked before, not for the sake of relationship alone but rather linking things that create meaning together. This combination can create a new product, whether it is linking basic elements or more sophisticated ones. "But it always has to be for a specific purpose" (SEP, 2019). Iteration and quick prototyping are welcome in this process to advance a product (SEP, 2019). For SED, innovation means change, solving a problem, finding a new purpose, "It's like taking what we have now and making it better, making it more advanced..." (SED, 2019). An idea that is novel or an inspirational solution useful for building a product or process is innovation (SESC, 2019). "Identifying a problem and solving it (SEB, 2019b) and then applying that solution. I think that's innovation" (SEB, 2019a).

Figure 7.7 Interviews – unfolding themes

The key themes emerging from the interviews with the Space Engineering project partner (see Figure 7.7) can be summarised as innovation which:

- must come from the root in order to generate positive change (SEP)
- creates prototypes from low-cost material (SEB) and "use(s) a very Macgyver approach to problem solving" (SEPUB)
- uses a process to refine prototypes (SEP) and continuously creates new constellations from current elements (SED)
- "leads to new research and ideas" (SEOOC) and helps solve difficult issues (SERK)
- fuses new or not yet understood elements with existing products (SEPUB)
- supports iteration and quick prototyping to advance a product (SEP), continuously prioritising until a project's aim is fulfilled (SER)
- links things to create meaning (SEP), explores inspirational ideas and solutions useful for building (SESC).

Through visual design, including the author's outputs using the design thinking model, being crucial to:

- reduce the complexity of the process (SER)
- create impact, acting as an influencer (SET)
- individuals with no technical expertise, in terms of explaining the organisation's products and processes, "a picture tells more than a thousand words" (SEP)
- reduce tension in the user and make the message adaptable; create connection helpful to decision making (SED)
- engage new student members and prospective partners by becoming more approachable (SEB)
- simplify large amounts of data, inspire a suitable environment that encourages sharing ideas (SEB).

And in brand identity helping:

- recognition that increases sponsorships (SEP, SEB)
- the presentation become professional to attract new partners (SED)
- the project partner differentiate itself from other departments, sister societies and competitors and unity as well as opportunities to collaborate at the same time (SED, SEB, SER)
- to look better, which equals more funding (SEB)
- the organisation's quality by strengthening the mindset to be more dedicated (SER)
- to take ownership as a state of belonging (SEB).

# 8 Case Study 4 – Remote Sensing

Table 8.1 Project partner 4 – Remote Sensing

| project | organisation type | specialism and rationale | employees and stakeholders | value created |
|---------|-------------------|--------------------------|----------------------------|---------------|
| Remote Sensing (4) | start-up (SME) | by interpreting radar data, satellite technology is used to prevent wildfires | Researchers Technical Leads Geologists | audience receptive to geoportal service through design, enhanced presentation, increased trust |

## 8.1 Background

Case Study 4 took place between September 2019 and February 2020, where the Remote Sensing start-up's new brand was created to enhance its presentation. Resulting in a professional identity that communicates the partner project to new audiences, inviting enthusiasm about the space concept whilst carefully placing the brand in a distinctive environment, fitting to the nature of the company's work.

The Remote Sensing project partner uses satellite radar technology to help prevent wildfires and preserve wildlife. The award-winning company maps wildfire patterns via satellite Earth Observation (EO) data. Preventing fires can preserve natural habitats and reduce clean-up costs worth millions (Copernicus Masters, 2016). The company is interpreting radar data with a flexible approach to expanding the organisation's offer beyond monitoring wildfires.

Science Minister Amanda Solloway stated, "The UK's space sector is playing a critical role in tackling some of the world's greatest challenges – from monitoring climate change to providing vital relief for countries affected by natural disasters" (GOV.UK, 2020b). Space data is used for virus protection and flood control. EO data has been concerned with the subordinate impact of individuals' day-to-day activities in the past and at

present, including cultivating crops and livestock, strengthening the protection of urban networks and looking after energy needs at home (Maclenan, 2019).

Space data is crucial in understanding the planet's assets, an intelligence that is valuable to monitor and protect essential areas with worthwhile insight, bringing together a variety of professions in order to create a bespoke solution to a problem (CGI-Group, 2020). Earth observation as a service that is coming from space to the planet and not the other way around and providing the perspective from a satellite may suggest the Earth as a little spot in the distance, something that needs to be protected. Astronomer Carl Sagan remarked: "When you look down at the Earth from orbital altitudes, you see a lovely, fragile world embedded in black vacuum" (Sagan, 1994: 173). Astronaut Kalpana Chawla said: "The part that is really close to my heart is the fact that we are exploring. We are going beyond our planet... Earth is like a campground... Yet so many of us are fighting over some very minor things, because we don't have this big picture in front of us – that this planet is really small. It takes just 90 minutes to go round, and this is our only campsite with air and water. If we don't take good care of it, we don't really have another place to go to" (Chawla, 2003).

Satellite images are already beneficial for mapping natural resources, catastrophe response, urban links and structures and the impact of changes in the global climate with regards to drinking water, air quality and food poverty just to name a few. Satellite technologies can also provide evidence useful to criminal investigation and crime prevention. Whether these smarter and faster satellites are to be opened up to the market and made available to everyone like GPS and technologies that can predict the weather, may be seen in the near future. Nano-satellites can be carried on smaller rockets that can be launched from a great variety of locations including in the UK. Everyone can get to know their surroundings and what consequences each individual thing can have, with the opportunity to make informed decisions in the interest of the future for all (Maclenan, 2019).

For example, Iris is a solar observation satellite that can detect methane (CH4), which is a leading cause of global warming. Canadian GHGSat launched Iris in 2020 and monitored an area in Turkmenistan with high activity of CH4 emissions due to oil and gas exploration. As a team made up of unlikely partners, GHGSat was joined by the European Space Agency with its Sentinel-5P satellite not long ago for further inquiry of methane (Amos, 2020).

As a pioneering operation to grant open access to Copernicus data, Earth Observation is an extensive collection, a contribution of seven Sentinel satellites. Constant algorithms filter information with sensor technology in place and, together with accumulated data, it can predict the weather as well as provide practical help to farmers optimise harvesting their crops (Maclenan, 2019).

Open-source satellite data makes it possible, even invaluable to uncover patterns in the context of landscape and its protection, imagery from space can be a tool comprising of different remote sensing techniques (Discover Magazine, 2015). "…To have a perspective from above, it opens up a whole new world." (Welch, 2019)

The £55 million spent on firefighting in moorland and heathland can be cut significantly if not completely avoided by mapping and monitoring wildfire patterns using remote sensing techniques via satellite technology that helps restore the affected area by reseeding (Copernicus Masters, 2016). Variations of moss can hold water like a sponge and help the area to be more resilient and slow down fire. Wildfire management can also help minimise water discolouration from ash and other fire remnants brought into streams through rain (The University of Manchester, 2018). Through Earth Observation data obtained via satellites, carbon can be detected, and models created to help restore peat and improve wildfire response mechanisms (EnviroSAR, 2020).

Experts from a variety of sectors are using EO intelligence to add value to their work (Satellite Applications Catapult, 2018). EO is supporting

objectives laid out in the Industrial Strategy, it creates opportunities in the future and opens up new markets for products and services using satellite technology innovatively. Different remote sensing techniques can map landscapes and chemicals in the air, radar pulses can read through clouds (GOV.UK, 2018). The Remote Sensing project partner's sales and marketing lead said that maps generated from "satellite data that could penetrate through the clouds… was something that was missing in the field of monitoring fires and wildfires in the UK" as it is "covered fully with cloud most of the time and therefore to get clear images, cloud-free images is almost impossible" (RSSM, 2019).

## 8.2 Milestones

The stages of the design thinking model were tailored to the Remote Sensing project as shown in Figure 8.1 for milestones, with the design thinking activity map indicating the tools and techniques from input, actors, activities, and outputs employed in each of the design stages, see Table 8.2.

Grounded theory was applied, progressing concepts from interchanging findings valuable for comparison. Lo- and hi-fi prototypes assisted the process of removing and refining, resulting in a flexible brand. The analysis of data sets from observational notes and transcripts also validated a professional visual identity's ability to explain complex activities while developing ideas with the partner and addressing future users together.

In brief, in the KNOWING stage the author discussed the company's characteristics together with the actors, researcher and technical lead, with the input of learning what makes the project special. Activities included mind mapping, competitor analysis and insight into prospective clients. The input in the PACE stage was finding initial ideas through empathic modelling by depicting words that describe the company's character which was then translated into a suitable layout system. Together with KNOWING, in-depth research followed the question of how the company uses satellite technologies to prevent wildfires and concluded with the output of a creative

orientation. Through branding activities, the author created visual and functional elements that leave room for interpretation in the CRESCENDO stage. The outputs comprised of the first draft of the design route that included the first version of the logotype and fav icon. With an element of KNOWING combined again with PACE, the input was discussing the accessibility of the company's brand image, and outputs included ideas of expanding the business offer online that took shape through design techniques such as developing profiles of prospective user groups and ideation sketching. Furthermore, CRESCENDO saw amendments and clarification with logotype variations as input that developed through activities in the REFLECT stage into brand guidelines as output. Succinctly, PACE involved additional translation activities considering the technology identity of the brand using open coding techniques. In the REFLECT stage, short and detailed brand guidelines were developed as outputs and in RECOVER, the director's feedback was acquired, generating diverse activities and outputs. The following paragraphs investigate each design stage in full depth, as depicted in Figure 8.1 and Table 8.2 below.
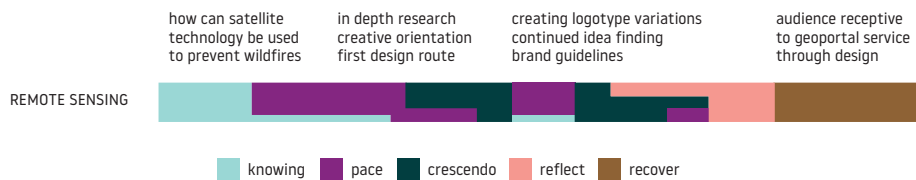


Figure 8.1 Design thinking milestones – Remote Sensing

Table 8.2 Design thinking activity map – Remote Sensing

| | knowing | pace | crescendo | reflect | recover |
|---|---|---|---|---|---|
| input | mapping wildfire patterns via satellite earth observation data | empathic modelling<br>layout system<br>legibility and accessibility<br>perspective of satellites, radar pulses,<br>visual translation of flames as inspiration | suitable logotype variations<br>for organisation | story board | communication tool to customers and funders<br>professional presentation helps develop the business and takes the design forward into e.g. a geoportal service online |
| actors | researcher, technical lead geologist | director | director | director | researcher, technical lead geologist |
| activities | mind mapping<br>comparative and competitor analysis<br>insight into prospective clients | open coding<br>inspiration translated into colour palette,<br>typography, patterns etc. | room for interpretation<br>visual and functional elements of the brand | flexible structures to be adapted to a wide range of applications | reach new audiences, initiate enthusiasm for this start-up in the space industry<br>cross-industry collaboration is stimulating innovation |
| outputs | profile | ideation sketching<br>creative orientation<br>rhythmic phrases | design route<br>logotype<br>fav icon | detailed brand guidelines combining found visual elements with future assignments across physical and digital spaces | raised image<br>social media to captivate viewers<br>growing business not limited to wildfires alone, expand its offer further afield |

KNOWING – The first stage of the design thinking process allowed the author to gain insight into what the project partner is all about. The Remote Sensing start-up is "…mapping products from satellite data for wildfire management and to assess moorland and heathland recovery in the UK." (RSD, 2019; input; see Table 8.2 for design thinking activity map). The company materialised as the director developed her PhD thesis into a working product, and with two colleagues combined their expertise innovatively by merging their multidisciplinary PhDs (RSSM, 2019). Their idea won the Copernicus Masters Sustainable Living Award over seven other competitors – to their surprise as they were a small, women-only team. Via further programmes, pitches and training with an initial provision of presentation slides, promotional flyers, a first client and subsequent funding were secured.

The start-up helped with their wildfire management expertise with two disasters in moorland in the North West of England in 2018 alone. The company is now looking to expand their offer (outputs) and research to find a strategy (activities) to deal with the changing of the climate, longer and drier summers, and patterns observed via open-source satellite data; the resilience that nature can help regenerate itself; and good governance of uninterrupted data and collaboration between communities as well as different stakeholders (The University of Manchester, 2018). A network established through one of the team members' social science-focused PhD helped benefit from relationships within communities and stakeholders in the region, from which the company could tailor their offer to what the customer requires (RSSM, 2019). "A customer would come to us with a problem, we would come up with a solution, from a satellite perspective…" (RSRD, 2019; outputs). With the media interest in the 2018 wildfires came the breakthrough.

The team (actors) was able to employ a new member for the R&D department. With land map experience and experience in geomatic benches, the start-up wants to present itself in doing justice to nature and also to

emerging technologies with an underlying sophisticated tone. The author and the director undertook several FGDs to seek co-innovative opportunities (activities), using design tools e.g., mind mapping and competitor analysis. Imagery that can speak for itself and an inclusive, straightforward system of graphics were preferred, see Figure 8.2 for character inspiration.
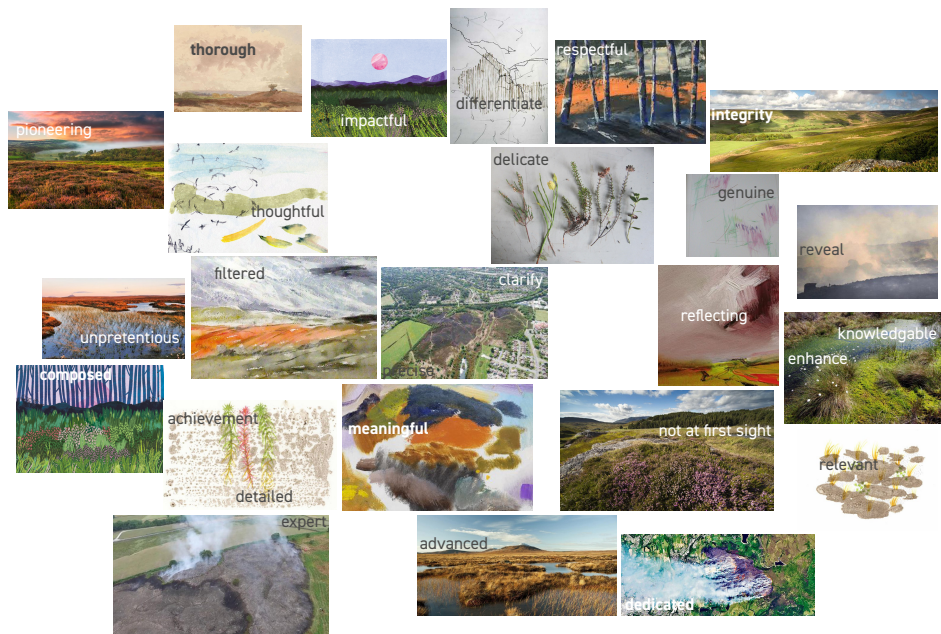


Figure 8.2 Creative orientation – character inspiration

PACE and KNOWING – Complementing the company's characteristic of nature as well as of emerging technologies with its underlying sophisticated tone (input), the PACE and KNOWING stages commenced with initial ideas and in-depth research (activities) on how satellite technology is used to prevent wildfires and concluded with a creative orientation (outputs). As part of the design thinking process and to establish the brand language, this creative orientation consisted of the initial finding of inspirational words that arose from researching the company and its immediate surroundings. Mind mapping generated early ideas that involved expressing the company's

characteristics (activities), prompted by how the company may think, how it speaks, that means how it would openly and evidently suggest its objectives and how it looks to the outside world (input; actors). The author made up the character of the company by combining together the several layers, see Figure 8.2 for character inspiration. Through rhythmic phrases (outputs), elements that portray the company were highlighted, words were then translated into images, which helped to define colours and patterns (activities), see Figure 8.3 below.
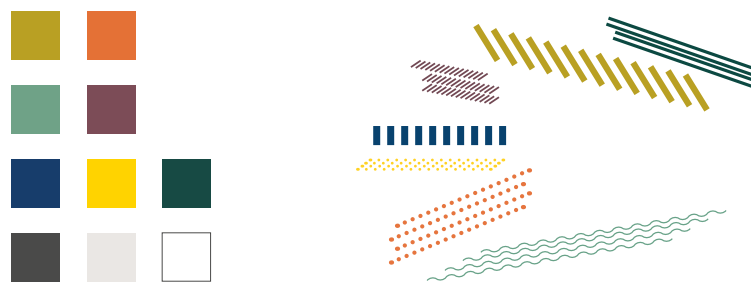


Figure 8.3 Creative orientation – colours and patterns

In order to develop the brand language, the author obtained knowledge of how satellite technology is used for conserving landscape and depicting discolouration water, how fire destroys vegetation and kills animals as their habitat is lost. Digging deeper, the company wants to expand its offer further afield and is flexible towards a growing business with departments not only limited to wildfires (input).

PACE – The character inspiration involved the finding of inspirational words that then informed imagery, on which the colour study and patterns (Figure 8.3) were based. With research insight into comparable companies and prospective clients, the colour palette may remind of but does not need to be immediately connected to nature, or specifically nature found in moorlands and heathlands in the UK. A comparative analysis (activities) has shown that organisations concerned with environmental conservation don't necessarily use colours immediately connected to nature for their main

brand (National Trust, 2020; National Geographic, 2020; Royal Geographic Society, 2020). For the Remote Sensing project partner, the author developed the primary colours suitable to the organisation (activities). *Ancient moss* and *flame* complement each other and are not immediately contrasting, which might otherwise upset the eye, so these may be principally applied to the logotype. *Ancient moss* is more confident and energetic than a subtler green tone, yet depicting nature, whilst *flame* is invigorating, representing fire and radar technologies. The secondary colours *moor grass* and *heather* can be used in addition to the primary colours, e.g., on business cards and for layout ideas (see Figures 8.4 and 8.5; Appendix 4 for short brand guidelines), where a variety of brand colours are required within a balanced group, with *moor grass* standing for a more balanced green tone and a complementing *heather* for authority and ambition. Tertiary colours *tardis*, *tormentil* and *forest* are also all found in the UK's natural environment throughout the seasons with a nod to colours used in the technology sector. In copy and on backgrounds, the supplementary colours *charcoal*, *smoke* and *bog cotton* are applied. The colours combined to create a tactical counterbalance to benefit the company's personality (see Figure 8.3).

PACE and CRESCENDO – The idea for the patterns emerged when studying landscapes from a satellite's perspective, e.g., seeing water or fields etc. and reflecting on how sensor technologies could be visualised, but leaving room for interpretation (activities). Different patterns combined to create a complex, layered structure with a variety of rounded shapes and shapes with corners that would then initiate a rhythm, a driving element that refine the company's brand, making it its own (Figures 8.3 and 8.4).

Beneficial to a layout system for all kinds of text, the author arranged typography based on the character inspiration (activities) as part of the creative orientation (outputs), including a serif font for the main text and a sans-serif font for headers that would also serve as a foundation for the logotype (input), see Figure 8.4. Typography was established, depicting a

hierarchy with the DIN, a realist font that is characterised by its legibility and for being uncomplicated, technical, unadorned, and straightforward, as well as for its ability to depict quiet authority and for being neutral, impartial, and objective. The robust serif Caslon was chosen for the main text as a stark contrast to the DIN font and in order to create a rhythm to captivate the reader. Serif fonts are suitable for reading longer chunks of text as it becomes less of a chore (Tufte, 1990: 38-65) due to the reader being able to recognise words as a whole more easily (input), because serifs create a tension in their varying stroke thickness. The Caslon is as an original English font that is at the same time robust, sophisticated, and timeless. With visual elements (activities) embracing colours and patterns, the fonts are helping to create a basis for a layout that can then be specified for website applications, brochures etc. and a first draft of the design route (outputs), see Figure 8.4.

Another visual element is the background in layouts such as the website, that may primarily be white *(bog cotton)* or with lighter colours, patterns, or imagery as this can be associated with Earth Observation (EO; input), a service that is coming from space to Earth and not the other way around with the planet viewed from a satellite in need of protection (Sagan, 1994: 173). With the perspective from space, allows us to think differently about issues on Earth as humanity's home (Chawla, 2003). A light background yearns for a shielded environment, it may reflect the desire to do better for the climate, a reminder for an uncontaminated world. In addition to a white or light background, charcoal grey was selected for book covers (see Figure 8.4), and for text rather than black for legibility, reliability, and accessibility, as grey is easier on the eye and less heavy in weight (input), moreover it reminds us of ashes, leftover from a fire.

Figure 8.4 Design route – logotype variations with brand language elements

CRESCENDO – Based on the creative orientation (PACE; outputs), the direction of the design identity was first established with a low-fidelity draft of the design route (outputs) set out with logotypes based on the sans-serif DIN font and a flexibility of surrounding patterns inspired by satellite imagery, that can adapt to different applications (activities). For the desired accessible branding, a professional look of the bespoke service needs to be followed through all platforms, including social media, in order to captivate viewers (outputs). Co-branding is an important aspect of the partner company's requirements, so the logotype needed to work in its simplest form in small sizes as well as together with brand language. Due to variable options of pattern and colour combinations, the logotype can become flexible in its essence – a dynamic logotype that can adapt to its surroundings (input), see Figures 8.3 and 8.4 for colours, patterns, fonts, and layout. Additional colours were selected and tailored to an expanding market of the project partner in order to reach its new audiences. The logotype was applied to working templates for business cards and a website (activities), see Figures 8.4 and 8.5. The organisation's sales and marketing lead believes that a professional design identity is crucial with brand elements on the website being specifically important to win an audience's interest, "If it is an

attractive design, if it's interactive design that can be playful, people will be more inclined to engage with you and your product…" (RSSM, 2019).

KNOWING and PACE – With an organic approach to design thinking process, an element of the KNOWING together with the PACE stage emerged again with the desire to have a brand image that helps the company's products and services develop further, e.g., an idea that involves making the geoportal accessible online (input). The CEO favoured a flame that was part of the old logo and through mind mapping in FGDs (activities), by combining ideas of patterns inspired by the perspective of satellites, radar pulses and the visual translation of flames (input), a solution was found for the logotype and fav icon that leaves room for interpretation by the viewer, see Figure 8.4 and Appendix 4 (outputs). With the project partner's approach to dynamic mapping allowing more detailed predictions in terms of fuel and fire risk, visibility, safety, and curiosity in brand presentation weren't compromised with aesthetics and preference in mind (input).

CRESCENDO and REFLECT – With a recurring loop of design stages, emerging patterns were refined and ideas were communicated (input) and evaluated against design criteria (activities), highlighting visual and functional elements of the brand that can speak for the company and build flexible structures that can be adapted to a wide range of applications (outputs). Furthermore, as co-branding with national and international organisations and project partners became an important aspect to include in the brand identity, brand guidelines were developed combining found visual elements with future assignments across physical and digital spaces, including logotypes and their variations, clear space, fonts, and layout including book cover and pages and business cards, see Figures 8.4 and 8.5 and Appendix 4 (outputs).

Figure 8.5 Design route – business card application

PACE – came back briefly into the design thinking loop as a combination of technological and natural aspects of the project partner (input) that required additional translation (activities), creating more rhythmic phrases and meaningful adaptation of the brand (outputs).

REFLECT – Short and detailed brand guidelines that serve as a portfolio of all design elements (activities) were created for both in-house use and external suppliers (outputs). See Appendix 4 for short brand guidelines.

RECOVER – Feedback from the project partner comprised the value of design expertise and the role of design as a communication tool to customers and funders (input) by visually conveying the organisation's meaning. By understanding and exploiting the power of visual design, the company is able to reach new audiences, initiate enthusiasm for this start-up in the space industry and the nature of its work, and to enhance the receptiveness to its ideas (activities). A professional presentation helps develop the business and takes the design forward into e.g., a geoportal service online (input). With competitive advantages in applying elements of effective visual design combined with EO technologies, cross-industry collaboration is stimulating innovation (activities). A brand identity offers an enhanced image, that expands throughout social media, and as a result captivates viewers. The identity enables the offer of the growing business to grow in a strategic and impactful way (outputs; Remote Sensing Director, 2020; Appendix 8 Remote Sensing Feedback).

### 8.2.1 Key learnings

Using design thinking, the author tailored the individual stages in collaboration with the Remote Sensing project partner that created distinctive iterations (see Figure 8.1) when choosing brand elements such as colours, patterns and typefaces as well as combining the first proposed logotype with variation to create a dynamic brand, whilst employing tools and techniques from the design thinking activity map (Table 8.2). The milestones can be summarised as research insight into the type of satellite technology used to prevent wildfire (KNOWING); the translation of character inspiration as colours, patterns and typefaces with focus on legibility and accessibility (PACE); brand elements presented as a design route, including variants of the logotype (CRESCENDO); the flexible brand accommodated in guidelines for future assignments across physical and digital spaces (REFLECT); and by understanding and exploiting the power of visual design, the Remote Sensing company is able to reach new audiences (RECOVER).

With input, actors, activities, and outputs extracted from the design thinking activity map (Table 8.2), the individual design thinking process stages could be realised and repeated as fitting to the needs of the project partner, with the important foundation of the initial FGDs with the director bringing through important analyses and insights on which the creative orientation and the design route could be built.

Some of the lessons the author could take away were FGDs – talking to the project partner about the best possible solution for the brand applications in a professional way, even if it was not the partner's original choice; you would be surprised where a good discussion can lead to. At the same time, an openness to the nature of the partner's business with thorough research into comparatives provided the ability to steer the design process into a productive direction, with visual lo-fi prototypes proving useful on the way. A selection of recommendations extracted from the design thinking process

the author tailored through the collaboration with the Remote Sensing project partner:

- Mind mapping, comparative and competitor analyses for insight
- to allow inspiration from unexpected resources
- in continuous conversation, backed up with strategy, win the partner over to opt for more suitable brand elements
- trusting in the ability of a flexible brand that encourages audience dialogue and leaves room for interpretation.

## 8.3 Interviews

In addition to the practical work of the Remote Sensing brand identity and to verify the use of the author's design thinking model, interviews were a valuable method to hear the project partner's point of view of the impact of visual design and to learn more about the company's innovation.

All three interviewees participated in person, and both the Director and the Research and Development Lead also filled in the form online, see Table 8.3. The Director and Technical Lead (RSD) is specialised in remote sensing techniques; the Sales and Marketing Lead (RSSM) built up the initial client network and was also involved right from the beginning; with another former colleague making up the original team that won the Copernicus Masters competition. The Research and Development Lead has EO experience and is the newest addition to the team.

Table 8.3 Interview codes – Remote Sensing

| RSD Director and Technology Lead | RSSM Sales and Marketing Lead | RSRD Research and Development Lead |
|---|---|---|

• in person interview • both face-to-face and e-interview

RSD, RSSM and RSRD agreed overall to visual design as a value creator in innovation. The face-to-face interview with the Remote Sensing Director (RSD) highlighted issues around improving strategy in day-to-day work, bespoke products, communication with prospective customers, and

accessibility (RSD, 2019). Online, RSD clarified the key role of innovation in the organisation, "our company focuses on extracting useful wildfire information from a range of satellite images pre, during and post wildfire events. Therefore, using new methodologies and approaches for obtaining that information and providing to our customers is central to the company" (RSD, 2020). The final product is different each time, tailored to each customer where communication is key to get the right insight into what the customer needs to gain from the satellite data that then offers improved handling of wildfires (RSD, 2020). As the Sales and Marketing Lead, RSSM noted that the start-up had its origins in the "fusion of our PhDs" (RSSM, 2019). The remote sensing technique can cut through clouds, which proved useful in the UK climate and was identified as a gap in the monitoring of wildfires. RSSM could add value through her connections with stakeholders in the Peak District. Winning the competition that was supported by ESA was proof of their original collaboration and knowledge exchange of super innovative products tailored to the individual customer, "sometimes that can lead to further innovation because they might want to use a product in a different way that we have not envisaged" (RSSM, 2019). RSRD is the Research and Development Lead of the organisation that analyses and processes satellite images. "I think products/services are inherently innovative if they are 'new'" (RSRD, 2020). Innovation is a problem-solving activity, bringing about new remote sensing techniques. It is not only 'recycling', "a customer would come to us with a problem, we'd look at potential solutions from a satellite perspective" (RSRD, 2019).

Most of the concepts are theoretical, ready to be turned into prospective products. Visual design is useful for explaining these concepts to customers, bringing them on the journey and easing the learning process with some very technical language that comes with remote sensing (RSRD, 2019). The ability to see things in a tangible way, to illustrate complex processes, explain the product and engage with prospective partners is all because of visual design (RSSM, 2019). Concerning decision making, "visual design helps in terms of

potentially when someone is looking for a service for a particular product and then deciding who to choose" (RSD, 2019).

Visuals and innovative thinking helped to get the business model rolling and secure new customers, "we found that having to map everything out … allows you to paint a picture much more clearly, rather than see bullet points on a piece of paper" (RSSM, 2019). Visual design is a tool that articulates the organisation's ideas and adapts itself to meet new customers and stakeholders with different needs with the ability to expand the organisation's offer (RSD, 2019).

With regards to establishing new partnerships, RSD is in two minds about visual design, "It can help but it could also potentially hinder us," pointing out that "if your design doesn't come across as appealing, then it could in a way stop people from maybe approaching you" (RSD, 2019). Accessibility played a large role when it comes to engaging with people, e.g., a website needs to be designed in a structured way, with a clear layout and complementing colours in order to receive responses. Often decisions can happen intuitively that have the ability to create excitement in a company or a product or, on the contrary, to disconnect, "because that company looks more professional or they're communicating the right things to me or presenting the content in a more accessible way to me" (RSD, 2019). RSSM also thinks that visual design "can help attract or push away customers" (RSSM, 2019). It is not only about substandard design but also design that is not accessible, if a design is complicated in terms of language or technicality, it can put off prospective customers. However, "if it is an attractive design, if it's interactive design that can be playful, people will be more inclined to engage with you and your product" (RSSM, 2019). Visual design is crucial to engaging with prospective partners as a tool of communication between academia and the space industry as "everyone can relate to a visual rather than (you know) text" (RSRD, 2019).

Visual design has the ability to help a product enter new markets through suitable brand applications for different technologies, outlining

societal and cultural awareness, communicating the brand to prospective customers by developing understanding; all of which supports expanding the business to other countries and into new directions that makes a good brand an indicator for success (RSD, 2019).

Branding helps an organisation be seen and make an impact (RSRD, 2019). The Remote Sensing project partner aims to show its approachability in its visual identity, "We want to look like a service where… we can provide something more bespoke and where we can develop with the client, not like ok this is the service and that's it, there's no discussion or any bit of the development, so I suppose of kind of having that open approach, getting that across in terms of with the branding and… that we're there as well and… communicate with our clients" (RSD, 2019). The organisation's identity can be raised through visual design, it can "give a lasting impression, obviously it's coming through graphic design" (RSRD, 2019). The project partner felt it was highly beneficial to collaborate with the author as a professional designer to represent the company at its best (RSD, 2019).

Visual design enables a product to be recognised for its quality (RSRD, 2019). A brand is a holistic pursuit, directly affecting the quality of the company via creating an identity, this golden thread pulling through diverse physical and digital media (RSD 2019). RSSM does not think a great visual identity can change anything about the quality of the end product as both need to be in sync (RSSM, 2019).

If a company's website looks professional, representing an image that creates excitement, then RSRD would "maybe wrongfully" (RSRD, 2019) assume that this company's services would reflect that standard. "I sort of form an image of them based on their website and the graphics they use" (RSRD, 2019). Visual design is central in preparing an approaching customer during the process of an unfinished product by catching a glimpse of the organisation's identity through collateral, such as a business card or website, "it's the window … it's the first impression you give. So, if it's professional and inviting … it can definitely capture people's attention" (RSSM, 2019).

Innovation means to solve problems. "It's that simple" (RSRD, 2019). RSDR points out that innovation is the ability to create or improve a useful product, that should be the principle in any organisation, rather than innovate for a gain in an overstatement (RSRD, 2020). RSD defined innovation as something that generates valuable data and new knowledge for the organisation's customers (RSD 2020). "I think innovation is about pushing boundaries, not following what other people have done and it's about being fearless and thinking outside the box – thinking in a blue-sky way... there are very few limits in how much you can innovate for example. So it just takes will, determination, vision and obviously then you have to find a good funder that can fund your idea to make it happen" (RSSM, 2019).



Figure 8.6 Interviews – unfolding themes

The main points drawn from the interviews (See Figure 8.6 above) can be summarised in terms of visual design impact on the organisation's innovation that can also be seen as a criterion to verify the author's prototypes and design thinking process as follows:

- accessibility and legibility (RSD)

- communication as key to gain insight into customer needs; develop with the client; helping to grow understanding (RSD); design as a communication tool between academia and the space industry (RSRD)
- useful for explaining concepts to customers (RSRD); illustrate complex processes (RSSM); playful, interactive design to engage with complex, tech products (RSSM)
- deciding who to choose, when looking for a service for a particular product (RSD)
- visuals and innovative thinking = the business model rolling = new customers (RSSM)
- brand identity creates impact (RSRD); collaboration with the author as a professional designer to represent the company (RSD); a product is recognised for its quality (RSRD, RSD); product quality and visual identity need to be in sync (RSSM)
- professional look reflects organisation's standard, can create excitement (RSRD); a window and first impression of an organisation can capture attention (RSSM).

And innovation tailored to the nature of the organisation is defined as:
- using new methodologies and approaches for obtaining information and providing to our customers (RSD); remote sensing technique can cut through clouds (RSSM)
- final product is different each time, tailored to each customer (RSD); unexpected product adaptation (RSSM)
- collaboration and knowledge exchange (RSSM); generating valuable data (RSD)
- problem solver; creating or improving a useful product (RSRD)
- being fearless; blue-sky thinking; takes will, determination, vision, and 'funding' (RSSM).

# 9 Case Study 5 – Space Settlement

Table 9.1 Project partner 5 – Space Settlement

| Project | organisation type | specialism and rationale | employees and stakeholders | value created |
|---|---|---|---|---|
| Space Settlement *(unfinished)* (5) | charity | young people can take charge of their future skills through the scenario of life on Mars | Immersive Technology Developers 3D Printing Prototypers Sensor Design Engineers Space Lawyers | the creative orientation can be used for further development and collaboration, brand application to secure new participants |

## 9.1 Background

Case Study 5 took place between September 2019 and March 2020 (see Figure 3.2 in Chapter 3 for the timeline of the projects), when the collaboration with the Space Settlement project partner was cut off early. The project was halted due to the restrictions of the COVID-19 pandemic, which resulted in physical workshops being suspended. Focus group discussions had already taken place in February 2019 but the start of the project was pushed back to September 2019 that started in parallel with Case Study 4 and allowed the more time-intense Case Study 3 to be finalised in the summer. Most of the lo-fi prototypes were completed by December 2019 with hi-fi prototypes planned for the first half of 2020. The author developed the partner's brand and created a brand application. As an example of how a non-space industry integrates into space, the partner organisation is set up in the field of education in space settlement and provides workshops aimed at high school children. This last project partner is working with a variety of technology and space-related professionals that together create a Mars scenario to boost young people's plans for their future careers.

The following paragraphs touch on human settlement on Mars, developments and opportunities related to space habitat, and outline some

of the background involving the exploration of space for humanity in general, including space travel.

Mars is the reason for numerous space missions. It is the most explored and approachable planet in the universe. Robotic spacecraft have been used for many decades, serving as both orbiters and rovers (IntechOpen, 2020).

SpaceX, Virgin Galactic, and Blue Origin among others are now competitors with entire countries in an expanding economy that entails human space travel (NSR, 2020b). With the USA and the former USSR having delivered the original space race, more recently Europe, Japan and India have used robotics to further explore Mars. China and the UAE have plans to do the same, which indicate economic and political benefit for any country. Human missions are on upcoming agendas. There has always been fascination around missions to Mars that inspire the older and future generations and everyone in the middle (IntechOpen, 2020). Space opens up doors for new disciplines in science and technology. Originality helps collaboration on the grounds of imagination, thinking through the development of possibilities of human space travel and settlement by developing plans that are brought together as a team and that address challenges of humans in space (UKSDC, 2020). By 2028, suborbital space travel anticipates to be worth $2.8 billion and bring in a revenue of $10.4 billion. Meanwhile, orbital tourism is predicted to be worth a $610 million market share and $3.6 billion equivalent in revenue, according to the space industry consultancy Northern Sky Research (NSR, 2020b).

Mars is close to Venus in their proximity to Earth, and both are very much alike with similarities in structures that range from elevations to deep creeks and atmosphere. There is evidence of water, volcanoes and deserts on Mars, so, with the possibility of settlement for human beings, Mars could serve as an alternative planet. The prevalence of Martian research can also be of advantage to discover more about the history of life itself as well as the expected future on Earth that faces constant and ongoing environmental

challenges and conflict, with the aim to make life better and worth living (IntechOpen, 2020).

Collaborative tasks in Constructing a Life on Mars workshops, aimed at high school-aged children, include role play of a range of professions and activities. Different team challenges arise in a space environment and are of tangible, intellectual and societal character. Participants are given the confidence to take charge of a career in a constantly reshaping world that functions in a digital form (Waters, 2019).

## 9.2 Milestones

The milestones of the bespoke design thinking stages (see Figure 9.1), implemented during the collaboration with the Space Settlement project partner are summarised, using the design thinking activity map (see Table 9.2) as a tool during each stage. This framework together with the author's design thinking process enabled the work with the organisation.

The author employed grounded theory through emerging patterns beneficial for testing and then communicated the lo-fi prototype to the project partner, repeating again to draw out an improved version that complemented the design thinking process. Sample data from observation and interviewing the project partner established visual design's potential to improve the service's credibility, encouraging increased interest and participation.

In brief, the milestones and activities during the process of the unfinished fifth project involved finding out more about how young people can take charge of their future skills through the scenario of life on Mars as input, through activities and outputs such as workshop observation, and insight from FGDs and the interview with the SSD in the stage KNOWING. During the PACE stage, activities included illustration style, character inspiration and colour, form and typeface study, through which the author generated the creative orientation in an iteration of the stage as an output with actors including the Director, Immersive Technology Developers and

3D Printing Prototypers in this part of the process. CRESCENDO saw the development of the participatory workshop model as input and the first draft of the design route as output when iterating. Lastly, since there was no RECOVER stage for Case Study 5, the REFLECT stage included empathic modelling and mockups as inputs to further the brand application output by employing lo-fi prototyping activities.
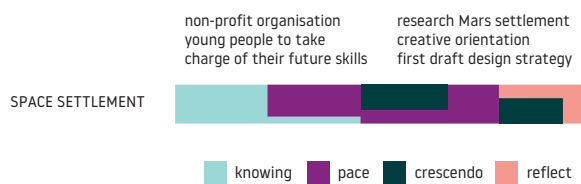


Figure 9.1 Design thinking milestones – Space Settlement

Table 9.2 Design thinking activity map – Space Settlement

|  | knowing | pace | crescendo | reflect | recover |
|---|---|---|---|---|---|
| input | young people can take charge of their future skills through the scenario of life on Mars | FGDs mind mapping | FGDs participatory workshop model | empathic modelling mockups |  |
| actors | director | director, immersive technology developers, 3D printing prototypers | director | director |  |
| activities | workshop observation FGDs, interview | illustration, character inspiration, colour, form and typeface study | brand elements, dynamic logotype workshops | lo-fi prototypes: illustration and layout |  |
| outputs | insight from interview and FGDs | creative orientation | first draft of design route | brand application (flyer) |  |

KNOWING – The author learnt about the non-profit organisation at this stage and what the Director and Programme Delivery Lead aimed to achieve from the collaboration (actors; see Table 9.2).

As an accessible planet (IntechOpen, 2020) Mars receives the greatest attention in terms of space settlement (Waters, 2019). Through hands-on activities in the Constructing a Life on Mars workshops, young people in education can take charge of their future skills through the scenario of life on Mars implementing a number of professions that address physical and digital issues (input). Through trying and testing construction, communication and societal scenarios on Mars, the high-school aged children can be better equipped for their future careers as well as their ambitions. What technologies do we take to Mars? What would we want to

create there? How could we communicate? And what would the ethics be like when we land there? Using tools that embrace virtual reality, data security, 3D printed buildings, sensors and the Internet of Things, the workshops simulate settlement on Mars.

Through workshop observation, FGDs and an interview (activities) with the Director, the author gained insight (outputs) and worked towards brand development, brand application and guidelines.
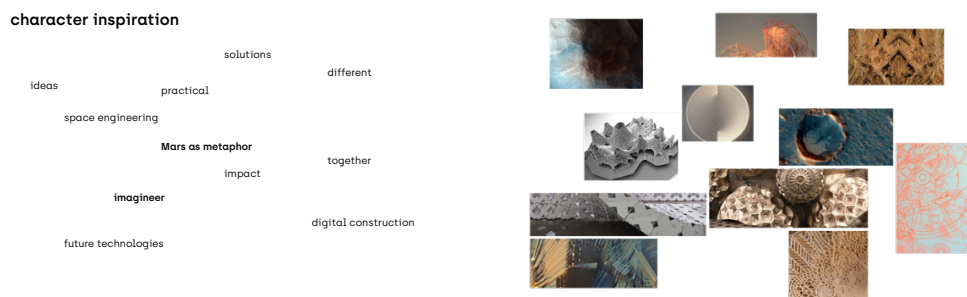


Figure 9.2 Character inspiration

PACE and KNOWING – After thorough research into Mars settlement scenarios and technologies useful in workshops, the author developed the character inspiration based on words that depict the partner's voice and conveyed a sense that was then translated into images from which shapes, patterns and colours could derive for further use in the ideation and making phase of the design process (see Figure 9.2; activities).

CRESCENDO and PACE – During conversation and mind mapping sessions in FGDs (input) with the Director, Immersive Technology Developers and 3D Printing Prototypers (actors), colour and form studies were advanced (activities). The colours for the principal brand, a deep cadmium orange with enhancing and subsequent colours, including gradients for backdrops, look energetic, determined, encouraging, bold and open, see Appendix 5 for colour studies (activities).

On the character inspiration, the author selected the Archia font for copy and headers for its geometric and compelling look, fitting the organisation's workshop objectives (activities).

The logotype is based on the typeface for flexible and dynamic application with the chosen font creating an engineered and intelligible feel, reflecting the project partner's values. Figure 9.3 displays a backdrop with the Martian sunset gradient that resembles energy and determination (activities).



Figure 9.3 Dynamic logotype – backdrop

PACE – Through continuous iteration during this stage the author generated the creative orientation (Appendix 5; outputs) that presents the character inspiration, colour studies and typeface. By establishing the creative orientation, the author developed the hand-drawn illustration style further, enhancing the project partner's people-centred formula for use on brand applications contrasting with previously found brand elements as well as brand language (see Figure 9.4; activities).

The brand language continued the strategic use of brand elements with bold frames or brackets and dashes, complementing the logotype and application of colours and gradients, see Figure 9.4 (activities). The brackets and dashes add to the inclusive community vibe, creating breaks in viewing and reading, whilst encouraging a willingness to grasp opportunities and manifest innovation.

Figure 9.4 Brand application – flyer

REFLECT and CRESCENDO – were concerned with the development of the participatory workshop model through empathic modelling in FGDs (input), highlighting the specific needs and goals of all stakeholders involved in the workshops. This also accelerated the application (outputs) of brand elements useful for workshops (activities).

The first draft of the design route was created (output) and presented to the project partner (actors). Based on the creative orientation built during the earlier design process stages, the brand elements in the first draft of the design route were duly refined and matured into a strategy through iterating (activities).

REFLECT – The last stage of the author's tailored design thinking process included mockups (input) that engaged lo-fi prototyping (activities) in order to further the brand application. In the form of a flyer, the brand application serves as a postcard (see Figure 9.4; outputs) with layout on the front and back, comprising of hand-drawn elements that promote the illustration style, in contrast to the typeface and brand language (activities). The flyer is beneficial in portraying the organisation's identity before, during and after the Constructing a Life on Mars workshops.

The brand creation for the Space Settlement project partner was interrupted through the pandemic, cutting short the design thinking process loop with a number of lo-fi prototypes created that serve as a practicable platform, useful to the organisation's future brand strategy, see Appendix 5

for creative orientation that was working towards the design route and eventually brand guidelines.

### 9.2.1 Key learnings

The design thinking model enabled a selection of individual stages repeated and fitted to the Space Settlement project, producing distinctive milestones, see Figure 9.1 at the beginning of Section 9.2, using the design thinking activity map as framework through input, actors, activities, and outputs (see Table 9.2). To summarise, the milestones generated are grounded in insight gained through FGDs, the interview with the Director and observation (KNOWING). These led to character inspiration including colour, form and typeface study and illustration style culminating in the creative orientation (PACE), from which the author developed the first draft of the design route based on brand elements and the dynamic logotype. This then helped promote the participatory workshop model (CRESCENDO), drawing from empathic modelling and advancing the brand application through lo-fi prototyping activities (REFLECT).

Linking to the Space Settlement project, the design thinking model and activity map highlighted particular challenges but also opportunities around the strategic use of design elements that creatively combine digital and analogue ideas.

Lessons learned involved gaining insight into space settlement scenarios suitable for high school-aged children through workshop observation, FGDs and interviewing and later mind mapping and empathetic modelling. The charity that helps people get into employment, can build its main brand on this project's brand language. Innovative use of visual design can activate awareness of digital skills needed in the future of work. Some of the author's recommendations obtained from the design thinking model in collaboration with the Space Settlement project partner can be summarised as:
- Empathy towards the user group secures valuable insight
- iteration refines brand elements and improves outputs in a loop

- contrasting brand language increases impact
- lo-fi prototypes work for future brand application and development.

## 9.3 Interview

The face-to-face interview with the Director and Programme Delivery Lead (SSD) complemented the practical work done in collaboration with the project partner and some of the interviewee's answers helped verify the author's design thinking process. SSD leads the Constructing a Life on Mars workshops and is also the charity's CEO, the author also met some of SSD's colleagues and stakeholders involved in the project, but the Space Settlement Director was the only interviewee as the project was cut short due to the pandemic.

Innovation is important to the Space Settlement project partner as it is the very foundation of what the Constructing a Life on Mars workshops aim to teach the high school-aged children, "the future of young people, their life, their personal lives, their working life is gonna be affected by the digital technology industry for all the different changes that are taking place. The one common thing that's gonna be important is them as people, their creativity, their ideas, their innovative ideas, thinking differently" (SSD, 2019). To SSD, innovation means reflection, ideation, defining problems and finding solutions, some of which involves working together, some of it meeting up, inquiry into a given problem, attending to different views of the problem, thinking critically and freely, "thinking differently … not staying with the same old ways" (SSD, 2019). When it comes to the workshops, innovative approaches are key to the young people, the Mars scenario offers a "context or a metaphor that they can understand and relate to" (SSD, 2019). It is about imagining what materials are available on Mars and what technologies can be used to build things, e.g., 3D printing with sand, creating structures that can be reused. The Space Settlement project can also be applied to a more sustainable life on Earth. SSD said that innovation processes as such are not yet formalised but rather "intuitive and made up"

(SSD, 2019). There are co-workers in the organisation that bring in a lot more structure that is important with regards to finance and managing stakeholders, whereas SSD is comparatively "pure ideas and connections" (SSD, 2019).

Visual design can help communicate proposals, share ideas, and convey excitement; it helps ask questions, address burning issues, and become organised. In relation to decision making, visual design is a vital tool for mapping ideas and brainstorming, "just draw ideas out and collaborate and discuss" (SSD, 2019). As a problem solver, design "helps you visualise the information and the ideas and the problems you are facing" (SSD, 2019). It helps declutter the complexity and get to the core of certain activities and make sense of the connections in the brain that constantly evolve, "you can then communicate and share that with other people, who can then contribute to it" (SSD, 2019).

SSD thinks visual design can improve the organisation's presentation to an extent that it can trigger emotions if the standard is high. A professional presentation can establish partnerships and engage new people, as they want to become part of Space Settlement project, thinking of it as trustworthy and worth investing their time or money in. Another benefit of brand applications across different media is that they are easy to share with prospective stakeholders.

A brand identity allows the organisation to differentiate itself from its competitors, when "you see the people, see the emotions, you see the atmosphere" (SSD, 2019) that make the organisation unique and get people excited about participating. The quality of the project also benefits from visual design as "it creates a framework… you use to share what you've done has got a much more professional… edge…, just straight away takes you in… And then you got this story" (SSD, 2019).

Altogether, SSD felt that innovation concerns a variety of issues, e.g., "taking what you already know and it's in front you, and reinterpreting it and reconstructing it and putting it back together to give you new ideas or new

suggestions or new ways of working or thinking. And it's also about completing new ideas, which always has to be based on something but you might not know it. You might be faced with a problem that people are trying to address but you are coming in from a different way" (SSD, 2019).



Figure 9.5 Interview – unfolding themes

The key issues that were addressed during the interview, supporting the collaborative design work with the Space Settlement project partner, can be summarised as innovation connected to:

- young people thinking differently
- relatable workshops through a scenario that makes it easier to understand
- new technology developments on Mars e.g., 3D printed buildings from materials available from its surface
- reinterpreting, reconstructing, and putting back together; new ways of working or thinking and also completing new ideas, based on something but not yet known as such.

Visual design helps to:

- stimulate an interest to ask questions and look what is happening around
- draw ideas and discuss together, communicate, and share with other people, who can then contribute to it
- link and relate how things work together, visually map on paper, help to get organised
- professional presentation that invites people to share, get involved; it gives credibility and value, willingness to invest
- differentiate – emotions can be seen that create an atmosphere, a story
- create a framework, a professional edge (SSD).

# 10 Discussion and conclusion

The insights gained through the case studies are valuable independently as well as collectively as they fostered a deeper understanding of the application of a bespoke design thinking process to a specialised industry, tailoring individual stages of that process to the projects, and connecting design practice and design theory. These findings were evaluated through feedback and interviews with participants of each individual project partner making up the case studies.

## 10.1 Key findings

The key findings illustrate the relationship of the various research objectives (O): contextual review (O1), design thinking model (O2), projects with partners (O3) and design framework (O4) to the methods (M) that were employed to achieve the overarching research aim including focus group discussions (M1), interviews and feedback (M2) and prototypes (M3); see research structure Figure 3.1 in Section 3.2. The investigation into the research aim to show how innovation culture within space and satellite organisations can be represented via a bespoke design thinking model validates the insights from the milestones of the design thinking process (O2), and the interviews (M2) combined that point to the contribution of visual design.

The found data explains how the design thinking model (O2; Section 4.3.2; Figure 4.7) using design tools from the design thinking activity map (O4; Section 4.3.4; Table 4.1) analysed, evaluated and influenced each project partner's (O3) brand for positive long-term changes, while at the same time generating bespoke patterns, see Figure 10.1. Although it was obvious according to the partners' views traced from interview data (M2), the author's visual design practice, through creating and developing brands for each project, affected the organisations by seeing the lo- and hi-fi prototypes

(M3) presented to them (M1). The organisations became aware of the effective difference in their brand image that gave visual evidence, supporting their innovation. Additionally, the impact of visual design as a problem-solving enquiry allowed enhanced recognition and accessibility of the project partners' identity, gaining trust by connecting to audiences that encouraged them to collaborate and share their knowledge, see Section 10.1.2. For this reason, using the design thinking process (O2) and activity map (O4), visual design helped organisations achieve their goal of improved presentation, communication with stakeholders and business cases that advocate reaching out to new markets, see feedback (M2), Appendix 8.

The following paragraphs give an overview of the work with the project partners individually. The abbreviations refer to each of the five case studies: 1 Intelligent Transport (IT), 2 Asteroid Mining (AM), 3 Space Engineering (SE), 4 Remote Sensing (RS) and 5 Space Settlement (SS).

The first case study, the Intelligent Transport (IT) project, offered the opportunity to create a brand, and through this development, the author was able to identify and communicate the organisation's underlying innovation values providing the potential to enable the organisation to enter new markets.

The second case study (AM) involved brand development in the context of the exploration and exploitation of asteroids to support securing funding by generating a professional identity that improves the organisation's image, hence, helping to establish new partnerships. The promotion for an optimal market position was crucial at a stage where funding was still needed for a satellite launch prior to asteroid mining activities.

The third case study, Space Engineering (SE), focused on an organisation that supports projects involving lunar and Mars rovers, self-landing rockets, space balloons and can-sized satellites. The creation of a brand helped to define the organisation's identity and set it apart from parent and sister organisations. A significant element of the rebrand was to enhance

organisational image and set a platform for more effective communication to sponsors, partners and potential new members.

With the fourth case study (RS), which uses satellites to help prevent wildfires and maintain natural resources, a professional presentation enabled the organisation to develop further and to reach new audiences. Creating a brand for a company that uses satellite data has become a tool for cross-industry collaboration that is stimulating innovation.

The evolving fifth case study uses a space settlement (SS) scenario to engage young people in workshops highlighting digital skills needed in the future of work. A creative orientation and first design route provided the industry partner with brand elements useful for application of the organisation's Mars project as well as its main brand.

The author analysed the data obtained from prototyping, FGDs and interviews and feedback (M1-3) to enhance the project partners' performance in their distinct settings. The data studied supports the research inquiry by finding alignments from evidence that visual design increases the impact of economic factors, optimising space tech innovation. Using the design thinking process, fitting to each project partner, visual design can improve performance at work through research insight that supports the building of brand elements and further translate into lo- and hi-fi prototypes, valuable to brand identity creation with its ability to adjust variance in current brand identities and during product launch.

## 10.2 Milestones

When comparing the milestones from the five case studies that supported brand creation and development, individual stages of the design thinking process varied considerably depending on each project, see Figure 10.1. Case Studies One (IT) and Two (AM) started in a similar way but then saw differences in the ideation and making phase of the process. Intelligent Transport (IT) had to adapt the different modes idea to a more flexible one after the naming process, while Asteroid Mining (AM) was more

straightforward going from creative orientation through to identity creation with iteration in each stage. The design thinking process in Case Study Three (SE) immediately had a completely different 'vibe'; because of the organisation's four sub-divisions, the structure was affected by the iterative approach due to the larger variety of design elements addressed. However, within iterations, similar patterns emerged. In the fourth case study (RS), a unique rhythm became clearly visible as the stages of the process were aligned to distinctive design features depicting the initial concept, the design direction with the creation of logotype variations, and brand language and guidelines essential for communicating the partner's value that were made appropriate for the company and its stakeholders. The evolving fifth case study (SS) drew its inspiration from in-depth research and conversations with the partner, the creative orientation and first design route that can be useful work in progress for the charity's umbrella brand.
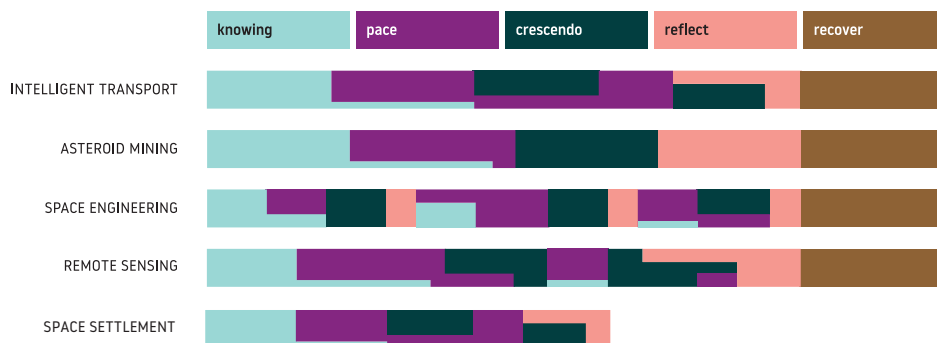


Figure 10.1 Visual design thinking model – all case studies

The differentiation within individual design thinking processes (Figure 10.1) was a consequence of the uniqueness of each organisation's needs and the subsequent identification of solutions, using the design thinking activity map. Design thinking is found to be a valuable approach for the space tech sector due to its adaptability and ability to accommodate a range of contexts.

### 10.2.1 Interpretation

The findings from brand creation and development use the design thinking model with the stages KNOWING, PACE, CRESCENDO, REFLECT and RECOVER (Figure 10.1) with tools from the design thinking activity map (Table 4.1, Section 4.3.4) that make sense using the individual milestones valuable to each case study project.

Throughout the first case study (IT), the milestones from the various stages of the design thinking process started by gaining understanding about the project and the purpose of the Intelligent Transport app (KNOWING). Character inspiration, brand language conceptualisation and naming followed (PACE), and subsequent modification of brand elements to drive the design route (CRESCENDO). The creation of brand guidelines for internal and external use (REFLECT) was proceeded by assessing the effect of the project in relation to the UK Government's Industrial Strategy (RECOVER).

For the Asteroid Mining (AM) project partner, employing the design thinking model meant that the goals from the collaboration were identified through FGDs (KNOWING). Through design critique, ideation for the creative orientation commenced (PACE) and making pursued the brand language through design by metaphor, complementing the organisation's logotype that served as a platform for the investment brochure and business collateral (CRESCENDO). A design scenario was the focus for design application mock-ups and portfolio creation to increase in-house and stakeholder's confidence in the start-up's activities (REFLECT). The visual identity enhanced the business to develop and increased brand recognition, beneficial to the Space Mining concept (RECOVER).

The third case study (SE) started with insight into the needs and wants of the student society and its four departments (KNOWING). A co-design workshop followed in collaboration with leaders from each department and the organisation's president that helped produce character inspiration for the look and feel (PACE), that was rendered into a visual system comprising

the discovered brand language elements (CRESCENDO). Brand guidelines were created, accommodating hi-fi prototypes of the new brand elements (REFLECT). The name became an identity with the ability to engage prospective funders, partners and new student members (RECOVER).

The author assimilated how satellites work to prevent wildfires in the region through the Remote Sensing project (RE, KNOWING). The initial character inspiration translated into legible and accessible colours, patterns and typefaces (PACE) that was the foundation for developing the design route, comprising of brand language elements and logotype variants (CRESCENDO), resulting in a dynamic brand application. For physical and digital use in the future, short and detailed brand guidelines were created (REFLECT). Deriving value from visual design helped the organisation extend to new audiences (RECOVER).

The fifth case study (SS) commenced with FGDs, an interview and observation to understand the project (KNOWING). Character inspiration enabled the extraction of the colour palette and form, typeface and illustration studies, resulting in the creative orientation (PACE). The first draft of the design route included brand language elements and a flexible logotype that stimulated the participatory workshop model launch (CRESCENDO). Empathic modelling helped further lo-fi prototypes for brand application (REFLECT).

## 10.2.2 Implication

The findings from case study research provided evidence for the overarching research aim by drawing from design thinking milestones, depicting each partner's needs (KNOWING), translating ideas into a creative orientation (PACE), drafting a design route and producing brand elements (CRESCENDO), reviewing the project and creating brand applications (REFLECT), and evaluating the impact, using feedback (RECOVER; Case Studies 1-4) in a constant loop of iteration (see Figure 4.7; Section 4.3.2), creating a unique pattern fitting to each project (Figure 10.1).

The ability to adapt to changes during ideation and making and to translate them into practical brand elements was a key focus in the case study findings. Preventing misinterpretation when defining problems suggests professional communication is essential during FGDs. Findings indicate collecting lo-fi prototypes in the form of creative orientation as a base for further brand development. They also imply that acknowledging the stakeholders' propositions guides the insight from their challenges and opportunities (IT).

Findings established that reaching out to a pioneering industry with the ability to create a professional brand identity and expect a positive impact on the economy. Data found during work with the project partner also indicated value in adding research to design practice and practical elements into research as well such as generating quick visual prototypes, driving coherence in identity (AM).

Co-design was one of the key findings: during FGD workshops card sorting was a useful design tool to receive instant feedback contributing to the foresight in brand creation. Another indication from meeting together with various members of the partner organisation is drawing valuable data from design critique and competitor analyses as a platform for the creative orientation. Iteration is a main focus throughout findings that has the ability to break down different assignments during the individual design thinking stages, adopting lo-fi prototyping, beneficial for brand creation (SE).

A huge take away from case study findings was through FGDs where the design problem could be addressed and possible solutions discussed together with the project partner. Important insights were gained, and design-related choices persuaded, if necessary. The investigation led further to the advantage of visual lo-fi prototypes communicating design thinking milestones, adding direction from unrestrictive study about the partner organisation and researching into comparatives and competitors (RS).

Learning from different space settlement scenarios that can be adapted to workshops for teenagers to inform their future career options has brought

insight using various design tools: workshop observation, FGDs, interview, mind mapping and empathetic modelling. The innovative use of visual design has the ability to promote digital skills set out in workshops, useful for the future of work (SS).

Together, the findings from all five case studies build on the evidence from the work with the project partners, producing lo- and hi-fi prototypes (SE, RS), using the design thinking model (Figure 4.7, Section 4.3.2) and tools from the activity map (Table 4.1, Section 4.3.4). The findings from employing the design thinking process imply:

- understanding, insight and purpose (IT, AM, SE, RS, SS)
- ideation, translation and modification (IT, RS)
- application across physical and digital platforms (IT, SE, RS)
- economic impact (IT, AM)
- making and complementing (AM, SS)
- increased confidence, brand recognition (AM, SE, RS)
- co-design (SE, SS)
- a feel, a visual system (SE, RS, SS)
- lo- and hi-fi prototyping (SE, RS)
- name becomes an identity (IT, AM, SE, RS, SS)
- variants, flexibility (RS, SS)
- extending into something new (IT, AM, SE, RS).

## 10.3 Interviews

In light of both primary and secondary research (O1, O3, M1-3), through the emerging themes in design, economy, innovation and technology (see Figure 2.1, Section 2.1), the word map in Figure 10.2 points to the number of key areas that account for the aim of this research and any overlaps that occurred. The keyword metadata was traced from a combination of all the interviews, with a hierarchy of words representing the varying importance in font size. Through this approach, extensive interviews with diverse professionals from all five partner organisations helped evaluate visual

design's ability to represent innovation culture in the space tech industry. The interviews produced a keyword metadata word cloud that highlights important words coming through from the various themes of design, economy, innovation, and technology, linking to the literature reviewed (see Figures 10.2 and 2.1). Immediately visible are issues around design, innovation, think, know, visual, new, like; with people, product etc. also considered to be important.



Figure 10.2. Interview keyword metadata

Through the combination of research methods, including interviews, feedback and FGDs (M1-3), it is verified that visual design using the author's accessible and flexible design thinking process (O2) with various tools and techniques of the design thinking activity map (O4) created an environment that cultivates long-term growth in businesses and demonstrates that an applied design thinking model can help organisations become more resilient. The data from interviews deliver evidence from a range of data based on the interviewees' professional interests. Figure 10.3 depicts the unfolding themes coming from interviews with participants from each project partner.

pink Post-its = design     green = economy     yellow = innovation     blue = technology
Intelligent Transport (IT)     Asteroid Mining (AM)     Space Engineering (SE)
Remote Sensing (RS)     Space Settlement (SS)
Figure 10.3. Interviews – unfolding themes

The following subsections present the discussion of key findings from interviews with all five case study project partners. A list of actors involved can be found in the analytical framework, the design thinking activity map Table 4.1, Section 4.3.4, and in project partners Table 3.1, Section 3.3; and the interview codes are located in Table 3.2, Section 3.5.2.

### 10.3.1 Innovation

One of the key areas that became apparent through the interviews was each project partner's perspective of innovation, see Figure 10.2 keyword metadata and Figure 10.3 in Section 10.3.2 (yellow Post-its).

Innovation is understood as a way of creating value from nothing (ITCEO) and as an iterative prototyping tool (ITCEO, SEP, SEB). It reimagines a service or product and improves it to serve its purpose (ITDL, RSRD) and is a constant fusion of something new or not yet understood from

elements that are already there (SED, SEPUB). Through reinterpreting, reconstructing, and putting elements back together, innovation entices new ways of working or thinking (SSD). As a problem solver (RSRD), innovation is continuously prioritising until a project's aim is fulfilled (SER).

It has to come from the root of the organisation and individuals (SEP) in order to foster disruptive ideas (ITA) and positive transformation (SEP, ITCEO). Innovation is a risk-taker and an unconstrained, creative thinker (RSSM), a bond for contrasting elements to create meaning (SEP). Using determination, vision, and 'funding' (RSSM), it connects with future partners (AMCEO, RSSM), encouraging knowledge exchange (RSSM) that generates valuable data (RSD).

Innovation shifts the boundaries of the possible (AMAG, AMCEO) by unexpected product adaptation (RSSM), simply thinking differently (SSD) and by facilitating a way into new technology (AMI). The final product varies each time, tailored to the user (RSD), a product becomes relatable through a scenario that makes it easier to understand (SSD).

## 10.3.2 Visual design

The role of visual design using design thinking was another key area coming through in interviews.. Visual design could be proved to benefit innovation culture in each organisation, covering the areas of design, economy, innovation and technology as discussed in Sections 5.3, 6.3, 7.3, 8.3 and 9.3. as well as in Figures 10.2 and 10.3 (pink Post-its). Each interviewee possesses skills in a specialised area related to the satellite and space technology sector, valuable to the breadth of the data collected

Interviews with participants focused on their specific interest and business aim as visual outputs from a bespoke design thinking model provide a number of possibilities to choose from. Interviewees agreed on the ability of visual design to make processes clearer by simplifying complex data and visualising them (AMCEO, ITCEO, SER, SEB, RSSM, RSRD). RSSM says that visual design encourages interactive play and engagement in technology

products, and SEB thinks that it inspires an environment for sharing ideas. SSD found a professional presentation to be inviting to share as well as get involved, and as a platform portraying credibility, motivating investment. These findings mean that design is capable to **clarify difficult issues through**:

- simplifying complex data (AMCEO, ITCEO, SER, SEB, RSSM, RSRD)
- communicating the organisation's needs (AMCEO)
- visualisation (AMCEO, ITCEO, SER, SEB, RSSM, RSRD)
- engaging interactivity (RSSM).

They indicate that a professional presentation **provides an environment to**:

- share ideas (SEB, SSD)
- get involved and motivate funders (SSD).

In terms of decision making, ITCEO indicates that visual design is an enabler for channelling resources to secure funding, and SED adds this is through reducing tension, making the message more adaptable and hence eases decision making. RSD also thinks this is the case when comparing products and choosing between competitors. This means that visual design is able to **assist decision making by**:

- channelling resources (ITCEO)
- explaining the core message in an accessible way (SED)
- comparing and choosing from competitors (RSD).

ITCEO notes that trust is another important issue visual design addresses. By communicating the process of a product development, stakeholders are more likely to buy the unfinished product. SSD says that it entices to ask questions and RSDS also thinks it makes up for a great communication tool. RSD adds that visual design is crucial for insight and understanding the user, using lo-fi prototypes. **As a communication tool, visual design helps**:

- gaining stakeholders' trust to buy an unfinished product (ITCEO)
- getting people interested and asking questions (SSD, RSDS)
- obtaining user insight (RSD).

Accessibility and legibility in visual communication are significant to RSD. ITCEO sees it as a tool for giving in-house teams confidence in a product, especially when progress is not yet directly visible. Through the way it relates to things, SSD thinks it helps the structure. Visual design is the first prototype of a product according to ITCEO. This means that visual design **engages people through**:

- accessibility and legibility (RSD)
- giving confidence in the not yet visible progress of a product; being the first prototype (ITCEO)
- linking up, creating structure (SSD).

ITCEO notes that visual design can help an organisation to push itself into new markets. Most people look up a product or business online, which is built on visual design. RSSM thinks that it is the basis for securing new customers by helping set up the business model. For visual design, the interview findings mean that it **helps succeed in**:

- entering new markets as people google up companies (ITCEO)
- pitching a business model and concurrently securing new customers (RSSM)

AMCEO says that looking good is powerful and ITCEO agrees that if an organisation looks good stakeholders trust it more. Visual design adopts the DNA of an organisation. SEB and SEP note that a professional identity increases funding. RSRD and SET say it creates impact. And RSRD and RSD understand that it can enhance a product's quality, however RSSM thinks that the quality and the visual identity need to be aligned. This means that a **good looking and professional identity demonstrate**:

- power (AMCEO); trust; the company's DNA (ITCEO); monetary value (SEB, SEP); impact (RSRD, SET) and quality (RSRD, RSD, RSSM).

AMCEO credits branding for communicating innovation by creating visibility of an organisation and SET believes it acts as an influencer. SER pays attention to visual design's ability to help people work better, with more

dedication, and SEB adds that it can create a state of belonging and help take ownership. A professional brand reflects the quality of an organisation and generates enthusiasm as stated by RSRD. SSD says it can tell a story by creating a feel and voice of the organisation. RSSM considers it as a first impression, a window into an organisation and SED adds that a brand is able to attract new partners. SED, SEB and SER point to a brand's ability to convince in competition as a differentiator and collaborator simultaneously. The findings drawing from the various interviewees emphasise **the value of brand which can be summarised as**:

- communicating innovation (AMCEO)
- creating visibility (AMCEO)
- act as an influencer (SET)
- improve work and dedication (SER)
- take ownership and a state of belonging (SEB)
- reflecting quality and generating enthusiasm (RSRD)
- tell a story, creating emotions and atmosphere (SSD)
- being a window into the organisation, as a first impression (RSSM)
- attract new partners (SED)
- differentiate and collaborate (SED, SEB, SER).

The key findings from interviews with project partners encapsulate the argument that visual design is valuable to space tech innovation. They addressed the emerging themes of design and innovation and also touched on economy and technology.

## 10.4 Limitations

The research was set out to be difficult to analyse value from visual design in numbers. However, methods like prototypes from the design thinking process, project partner feedback and interviews, co-design tools and techniques led to insight and recommendations that were good indicators for design contribution.

The limited number of space tech organisations in the North West of England constrained choice from the originally anticipated mixed sizes of organisations. The author collaborated predominantly with SMEs and start-ups, and depended on the available data from case study findings that cannot confirm the same results for larger organisations. This limitation, however, led to interesting choices in the nature of the organisations and enabled closer relationships with project partners, which was valuable for working in FGDs, and contributing to the breadth of the research findings.

Furthermore, due to the COVID-19 pandemic, the last case study was not finalised and was cut short at the last stage of the design thinking process. The project partner took more time than anticipated to reorient the business model to a digital and later hybrid mode, which could not accommodate the cutting off dates of the author's research schedule. However, the project allowed for more variety in the overall findings to the advantage of the research aim as it also implemented the design thinking model and framework, employing all the research methods as the other case studies.

## 10.5 Recommendations

This section provides an overview of the recommendations filtered through from case studies findings through data from milestones and interviews.

Practical recommendations for design practice include approaching a pioneering organisation with confidence (AM).

The author proposes starting the design practice with research and engaging in the design process (IT) by observing, taking notes, and reflecting, as research also enhances practice (AM) that augments the design thinking process by mind mapping, comparative and competitor analyses for further insight (RS) and empathy towards the user group (SS; RSD).

The found data implies that research has the capacity to establish inspiration from unexpected resources (RS). As the first prototype (ITCEO), visual design helps in decision taking through engaging interactivity (RSSM) and channelling resources (ITCEO). Findings suggest creating lo-fi

prototypes, laying them out to discuss with the partner, repeating (a lot) and refining them, improving outputs through the design thinking loop (IT, SE, SS), all contributing to developing a brand (AM). With visual design tools, data can be simplified, and a large project can be broken down into smaller parts (SE; AMCEO, ITCEO, SER, SEB, RSSM, RSRD).

Further study could improve the ability to step back and change direction wherever necessary (IT) and in continuous conversation, backed up with strategy, the partner can be persuaded to decide on more suitable brand elements (RS).

Based on case study findings, the author recommends co-design to get people involved (SSD), for its positive impact during processes (SE), and encouraging inquiry (SSD, RSDS), sharing ideas (SEB, SSD) and knowledge in cross-industry collaboration (IT). Findings suggest that organisations or products can extend into new markets through visual branding (ITCEO) that helps attract new partners (SED), secure stakeholders and enables new business model development (RSSM).

And drawing from the found data through prototyping and interviews, suggestions encompass contrasting brand language for increased impact (SS), legible brand language allowing an accessible environment (RSD) because an accessible brand message (SED) means easier choices (RSD). Findings point to creating coherence through design thinking for a professional identity (AM) and trusting in the ability of a flexible brand that encourages audience dialogue and leaves room for interpretation (RS). Through brand creation, a name becomes an identity (SE), it becomes the DNA (ITCEO) that differentiates an organisation from its competitors (SE) and concurrently invites collaboration (SED, SEB, SER). Lo-fi prototypes work for future brand application and development (SS).

Findings from interviews imply that, as a window and first impression (RSSM), visual design reflects an organisation's quality (RSRD, RSD, RSSM), has the ability to tell its story, creating an atmosphere and bringing out emotions (SSD). They confirm that looking good is powerful (AMCEO),

it creates impact (RSRD, SET), equals money (SEB, SEP) and user confidence and trust that validate investment (ITCEO). Therefore, being capable of communicating innovation creates visibility and hence brand value (AMCEO). Brand language can act as an influencer (SET), it increases work dedication (SER) and encourages enthusiasm (RSRD), ownership and a sense of belonging (SEB).

## 10.6 Conclusion

Using a bespoke design thinking model and employing tools and techniques from a design thinking activity map, the author created and developed brands for five project partners in the satellite and space industry in the North West of England, that communicate the organisations' innovation to boost economic value. The partners' brand images have been transformed as a result of applied design thinking. The enhanced brand value indicates the contribution that visual design has in communicating space tech organisations' innovation, promoting sustainable impact in the region. Therefore, this research demonstrates how innovation culture within space and satellite organisations is represented through a visually rich design thinking model.

With practice-based research, the author contributes to knowledge exchange in the overlapping areas of design, economy, innovation, and technology, linking these four by creating value from brand identities for partner organisations in space tech.

Design: The author's contribution to design is the brand creation or development via a bespoke visual design thinking model that contain ideation and making stages to represent space tech innovation. The author's model also supplements well known approaches such as Cross' 'designerly thinking' (Cross, 2011: 69-75) and Lupton's design process (Lupton, 2011: 6-11) by augmenting the problem definition, ideation and making with the author's reflect and recover stages to encourage revision of the process and investigate the impact of low- and high-fidelity prototypes created. The

author's design model applies design thinking to an industry specialised in satellite and space technologies. It advocates the personalisation of design elements within the iterative process corresponding to other models including the 'Double Diamond' (Design Council, 2019) and Stanford's design thinking (Stanford d.school, 2019) that a number of design agencies' adapt (see section 4.1), as well as to UX practitioners at a large social technology organisation the author interviewed who also tailor their design approaches to build products for specific user groups (see section 4.2.3). Individuals and organisations, from a design background or interested in visual design can benefit from design thinking that will help them understand users better and make something that fits their needs. According to project partners, the author has worked with, design has the ability to create visibility of their products or services. It is a window to organisations by reflecting their brand and visualising their goals. Design can increase work commitment by establishing an environment of belonging. Visual design manages complex data and increases legibility. By explaining key messages in accessible ways, it provides a platform to share ideas, gets people interested in a product or service and ask questions.

Economy: The key contribution to economy is the impact of professional brand identities that the author built using an own iterative design thinking process and measured that impact via interviews and feedback with partners in space tech organisations. Beneficiaries include organisations that aim to increase their productivity, using design thinking approaches to help them grow their business. Always tailored to a specific industry, the author's design thinking model allows organisations to determine user needs, visualise prospective ideas that are presented back to them, build prototypes and then review them in continuous consultancy and finally analyse their economic impact. Interviews and feedback from partner organisations provide evidence that having an attractive brand reflects product quality that can trigger economic success. It attracts new partners and helps enter new markets. Visual design can build confidence in what is not yet seen and helps

pitching new business models. Increased brand recognition can motivate funders to get involved with organisations' products and services as it demonstrates quality and monetary value.

Innovation: The author contributed to this area of knowledge by brand creation and development using a tailored design thinking model that communicates an organisation's innovation and engages a wider audience with space technology. According to partners from the organisations the author worked with: Intelligent Transport, Asteroid Mining, Space Engineering, Remote Sensing and Space Settlement, the author works closely with them and applies the partner's ideas, their goals and vison using her design thinking model. The organisations' innovative projects are communicated through top-quality brands, the author develops or creates, using the design thinking model. Interviewees agree that brand value comes from the ability to communicate innovation. Visual design can positively influence users, create, improve and link structure. Applying new ways of working and thinking, iterative design thinking continually takes apart and connects (contrasting) elements. In order to reimagine a product or a service, design takes risks to innovate. People who want to create something tangible that inspires organisations, and their stakeholders can gain from this knowledge and learn to apply new ideas through design thinking that augment and communicate their innovation. Visual design can shape an image of organisations and their language that helps users to access and explore their brand.

Technology: This research offers a bespoke design thinking model to technology through which visual brand language is built that then tells the space tech partners' business narrative. In accordance with the space tech organisations the author worked with, visual design is capable of decluttering and making their complicated processes easier to understand, creating value for users and funders alike. As stated by partners, with professional and research expertise, the author contributes through her design approach to the development of space technology and concurrently to the organisations'

self-confidence. An interactive approach, design thinking helps users to compare and choose from competitors. It equips organisations with user insight and helps gain stakeholders' trust. Engaging and co-designing with teams made up of professionals from different fields and levels of technical expertise, the author tailors the design thinking model to suit each space tech partner's needs and accurately tell the partner's story. Consulting back with low-fidelity prototypes, the author then develops further via design thinking iteration to arrive in high-fidelity brands (see section 10.1-10.5 for summary in discussion). Beneficiaries of this knowledge include organisations that aim to use visual design to declutter technical vocabulary and create a story that best mirrors their goals and achievements and can gain from knowledge exchange with their desired audience.

Primary data correlates with secondary research and aligns with the overarching aim of the research that informed a final design thinking model and is valuable to space tech organisations.

The research structure is built on four objectives: contextual review, the design thinking model, projects with partners and the design activity thinking map that serves as framework, informing the research aim. The research synthesises theory and practice, working through the combination of case study and grounded theory methodologies, using focus group discussions, interviews and feedback and prototypes methods essential for developing the study.

Five contrasting projects: Intelligent Transport, Asteroid Mining, Space Engineering, Remote Sensing and Space Settlement apply the same design thinking model, tailored to each partner's needs, resulting in a complex yet accommodating structure. This process is divided into the stages: 'Knowing, Pace, Crescendo, Reflect and Recover' that inform, generate, and provide novel approaches to solve problems strategically, creating opportunities conducive to innovation, and help ensure the longer-term sustainability of organisations.

Enhancing the evidence from findings through the design thinking model, various professionals from the five project partners were interviewed that produced key indicators for further insight into visual design's ability to communicate their organisations' innovation addressing different aspects of their day-to-day activities.

Using the overlaps of the design, economy, innovation and technology themes, the societal and monetary value from visual design, and co-creating opportunities with the space tech community, pointed to the knowledge contribution. The literature review identified the influence design practice has on future tech organisations, and that people- and community-focused design activities help economic growth and prosperity. According to the data investigated, design augments innovation and its processes using strategic approaches. By creating conditions beneficial to space tech innovation, visual design has the ability to captivate people. Inquiry into comparatives and competitors using various design thinking processes, tools and techniques verified the author's own design thinking model and framework.

Gathered data from findings regarded research as valuable in design practice and the other way around, design practice as beneficial in research. Visual design is found generally to be the first prototype and the first impression of an organisation, reflecting the quality of its products. It supports decision making and easier choices, explaining more clearly through simplifying complex data and promoting accessibility. Using the design thinking model, data from interviews and prototypes pointed to visual design's ability to tell an organisation's story, to establish a professional identity that advocates coherence and concurrently differentiation. Based on the findings, in the context of the UK Government's Industrial Strategy (BEIS, 2017), visual design helps develop and build business cases to enter new markets and advances communication with prospective funders and new audiences, attracting new partners. It engages people, provides conditions fitting for co-design and cross-industry collaboration. An efficient brand can act as an influencer, it fosters confidence and trust in a product

that leads to monetary value. According to interviewees, looking good means impact and enthusiasm, and creates a sense of belonging.

Based on the findings, design practitioners can be confident when approaching a pioneering space technology organisation, of interesting collaboration, plenty to learn from each other through co-design, focus group discussions across industries leading to unexpected findings, and insights that encourage knowledge exchange.

For further insight from the implications of the key findings, future research is recommended for personalising the author's design thinking model, applying it to different sectors and work scenarios that require problem-solving. During the iterative process, creating lo-fi prototypes from initial ideas and discussing these with stakeholders involved in the project are useful to refine brand elements before the final launch. Repeating individual stages or design activities, using tools and techniques from the design thinking activity map within each stage improves outputs through the design thinking process loop that contribute to brand development. Partially launching lo-fi prototypes can advance future brand application. The user insight generated through the stages is a crucial platform for professional brand creation.

The evidence provided from outputs through this research shows that the design thinking model has the ability to create visibility of an organisation that is meaningful for communicating innovation that contributes to brand value.

# References

Abernathy, W. and Utterback, J. (1978) 'Patterns of industrial innovation.' *Technology review*, 80(7), pp.40-47.

Adler, J., Na, J.H. and Evans, M. (2019) 'DESIGN VALUE IN FUTURE TECH ORGANISATIONS How can design communicate innovation?' *Proceedings of the 4D Designing Development, Developing Design conference. Meanings of Design in the Next Era*. Osaka: Ritsumeikan University, pp. 139-147. [Online] [Accessed on 28 February 2022] http://4d-conference.com/wp-content/uploads/2019/12/4D_Proceedings_Osaka019_04122019.pdf

Adler, J., Na, J.H. and Evans, M. (2021) 'Design thinking x space innovation.' *Postgraduate Conference on Interdisciplinary Learning. Re-imagining Postgraduate Studies in the 21st Century and Beyond*. Hong Kong: Lingnan University. [Online] [Accessed 17 March 2022] https://commons.ln.edu.hk/pg-conf-2021/day1-1/panel3/3/

Adler, J., Na, J.H. and Evans, M. (2022) 'Design communicating space tech innovation.' *Proceedings of the Design Thinking Research Symposium 13. Expanding the frontiers of design: A blessing or a curse?* Haifa: Technion, Israel Institute of Technology, pp. 447-466. [Online] [Accessed 28 March 2022] https://dtrs13.net.technion.ac.il/files/2022/03/DTRS13-Proceedings-.pdf

AHRC. (2013) 'The Value of Design.' *YouTube: ahrcpress*. [Online] [Accessed 29 September 2018] https://www.youtube.com/watch?v=nNy1wxnFq8Y

Amabile, T. (1988) 'A model of creativity and innovation in organizations.' *Research in organizational behavior,* 10(1), pp. 123-167.

AMAG (2019) *E-Interview for J. Adler*. 18 January.

AMCEO (2018) *Interview with J. Adler*. Liverpool: 12 November.

AMCEO (2019) *E-Interview for J. Adler*. 23 January.

AMI (2019) *E-Interview for J. Adler*. 18 March.

AMS (2019) *E-Interview for J. Adler*. 26 March.

Amos, J. (2020) 'Satellite Achieves Sharp-Eyed View Of Methane.' *BBC News*. [Online] [Accessed 23 September 2020] https://www.bbc.co.uk/news/science-environment-54210367

Amos, J. (2021) 'Sir Richard Branson gains licence for commercial spaceflights.' *BBC News*. [Online] [Accessed 25 June 2021] https://www.bbc.co.uk/news/science-environment-57611550

Asteroid Mining CEO (2019) *Feedback form for J. Adler*. 1 April.

Asteroid Mining Corporation (2022) 'Project El Dorado.' *Our missions*. [Online] [Accessed 29 January 2022] https://asteroidminingcorporation.co.uk/missions

*Back to the Future III.* (1990) Directed by Robert Zemeckis. [Film] USA: Amblin Entertainment and Universal Pictures, 1:17:07-1:17:33.

Bakhshi, H., Downing, J., Osborne, M. and Schneider, P. (2017) *The Future of Skills: Employment in 2030.* London: Pearson and Nesta, p. 14.

Baldwin, J. and Roberts, L. (2006) *Visual communication: from theory to practice.* Lausanne: AVA, pp. 23-38.

Baregheh, A., Rowley, J. and Sambrook, S. (2009) 'Towards a multidisciplinary definition of innovation.' *Management decision,* 47(8), pp. 1323-1339.

Bason, C. (2015) 'Why the world's leading organisations are looking to design.' *Design for Europe.* [Online] [Accessed 30 May 2018] http://www.designforeurope.eu/news-opinion/why-world-s-leading-organisations-are-looking-design.

Bazalgette, P. (2017) *Independent Review of the Creative Industries.* [Online] [Accessed 29 September 2018] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/649980/Independent_Review_of_the_Creative_Industries.pdf

Becker, S. and Whisler, T. (1967) 'The innovative organization: a selective review of current theory and research.' *The Journal of Business*, 40(4), pp. 462-469.

Becker, T., Cunningham, N., Molyneux, P., Roth, L., Feaga, L., Retherford, K., Landsman, Z., Peavler, E., Elkins-Tanton, L. and Walhund, J. (2020) 'HST UV Observations of Asteroid (16) Psyche.' *The Planetary Science Journal*, 1(3), p. 53.

BEIS. (2017) *Industrial Strategy: Building Britain for the future.* London. [Online] [Accessed 29 September 2018] https://doi.org/10.1049/ir:19930092

Benton, S., Miller, S., and Reid, S. (2018) *The Design Economy 2018.* [Online] [Accessed 29 September 2018] https://www.designcouncil.org.uk/resources/report/designeconomy-2018

Bierut, M. (2018) *Now you see it and other essays on design.* New York: Princeton Architectural Press, pp. 20-21.

Blueorigin (2021) 'Earth, in all its beauty, is just our starting place. Blue Origin is opening the promise of space to all.' *Blue Origin.* [Online] [Accessed 20 July 2021] https://www.blueorigin.com

Borja de Mozota, B. (2006) 'The four powers of design: A value model in design management.' Design Management Institute. *Design Management Review*, 17(2).

Bresciani, S. (2019) 'Visual Design Thinking: A Collaborative Dimensions Framework to Profile Visualisations.' *Design Studies*, 63, pp. 92-124.

Catapult. (2018) *Intelligent Transport Programme – Catapult.* [Online] [Accessed 10 May 2018] https://sa.catapult.org.uk/our-focus/intelligent-transport

CGI-Group. (2020) *Earth Observation.* [Online] [Accessed 24 June 2020] https://www.cgi-group.co.uk/en-gb/space/earth-observation

Chawla, K. (2003) *Astronaut Profile*. [Exhibition] 2017. Leicester: The National Space Centre.

Chun Tie, Y., Birks, M., and Francis, K. (2019) 'Grounded theory research: A design framework for novice researchers.' *SAGE open medicine, 7.*

CNBC. (2018) 'Valedictorian Jeff Bezos said he wanted to build 'space hotels and colonies' in his 1982 high school graduation speech.' *CNBC make it, Entrepreneurs.* [Online] [Accessed 5 February 2022] https://www.cnbc.com/2018/08/31/amazon-jeff-bezos-proposed-colonizing-space-high-school-graduation-speech.html

Contractor, F. and Lorange, P. (1988) *Cooperative Strategies in International Business.* Lexington, MA: Lexington Books.

Cooper, R., Hernandez, R., Murphy, E. and Tether, B. (2016) *Design Value: The Role of Design in Innovation.* Lancaster: Lancaster University.

Cooper, R. and Kleinschimdt, E. (1986) 'An investigation into new product process: steps, deficiencies, and impact.' *Journal of Product Innovation Management,* 3, pp. 71-85.

Cooper, R. and Kleinschmidt, E. (1987) 'New products: what separates winners from losers?' *Journal of Product Innovation Management: An international publication of the Product Development & Management Association,* 4(3), pp. 169-184.

Copernicus Masters (2016) 'Envirosar© – Managing Wildfire Disturbance In Moorlands And Heathlands.' *Copernicus Masters.* [Online] [Accessed 24 June 2020] https://copernicus-masters.com/winner/envirosar-managing-wildfire-disturbance-moorlands-heathlands

Cox, G. (2005) *Cox Review of Creativity in Business: Building on the UK's Strengths.* [Online] [Accessed 12 December 2018] http://webarchive.nationalarchives.gov.uk/20120704143146/http://www.hm-treasury.gov.uk/d/Cox_review-foreword-definition-terms-exec-summary.pdf

Cross, A. (2020) *New North West 'Space Hub' Promises Economic Benefit.* [Online] [Accessed 18 November 2020] https://www.thensc-uk.com/news/2020/11/18/new-north-west-space-hub-promises-economic-benefit

Cross, A. (2021) *Delivering regional growth by developing the space industry.* [Webinar] [Online] UKRI – STFC, 9 July.

Cross, N. (2011) *Design Thinking.* London: Bloomsbury, pp. 27, 51, 69-75, 135.

Crotty, M. (1998) *The foundations of social research: meaning and perspective in the research process.* London: Sage Publications, pp. 2-9.

Csikszentmihalyi, M. (1990) *Flow: The psychology of optimal experience.* New York: Harper & Row, pp. 51, 131, 216-217, 241-280.

Davids, A. (2018) 'Creativity is a process, not a discipline.' *Superunion.* [Online] [Accessed 5 July 2018] https://www.superunion.com/insights/creativity-is-a-processnot-a-discipline

Dawood, S. (2018) 'Pentagram's Natasha Jen: "Design thinking is extremely dangerous".' *Design Week*. [Online] [Accessed 14 December 2019] https://www.designweek.co.uk/issues/5-11-march-2018/pentagrams-natasha-jen-design-monster-unleash-fix-world

De Bono, E. (2000) *The De Bono Code Book*. London: Viking, pp. 52, 76.

Design Council. (2012) 'Design delivers for business: A summary of evidence from the Design Council's Design Leadership Programme.' *Design Council*, p. 2.

Design Council. (2017) 'Designing a future economy: developing design skills for productivity and innovation.' *Design Council*, pp. 6-13.

Design Council. (2019) *The Design Process: What is the Double Diamond?* [Online] [Accessed 21 June 2019] https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond

Design Council. (2020a) 'Using design as a force for change. Strategy 2020-24.' *Design Council*, pp. 7-18.

Design Council. (2020b) 'Four ways that government can make better use of design to increase R&D.' *Design Council*, p. 4.

Deutsche Welle. (2021) *Asteroids – A New El Dorado in Space?* [Online] [Accessed 13 March 2021] https://www.dw.com/en/asteroids-a-new-el-dorado-in-space/av-56840881

Discover Magazine. (2015) *How Google Earth Has Revolutionized Archaeology*. [Online] [Accessed 24 June 2020] https://www.discovermagazine.com/the-sciences/how-google-earth-has-revolutionized-archaeology

Dodgson, M. (1993) *Technological Collaboration in Industry*. London: Routledge.

Dosi, G. (1990) 'Finance, innovation and industrial change.' *Journal of Economic Behavior & Organization,* 13(3), pp. 299-319.

Dougherty, D. (1992) 'Interpretive barriers to successful product innovation in large firms.' *Organization science*, 3(2), pp. 179-202.

Drucker, P. (1985) *Innovation and entrepreneurship: Practice and principles*. London: Heinemann.

Drucker, P. (2002) 'The Discipline of Innovation.' *Harvard Business Review*. [Online] [Accessed 7 September 2018] https://hbr.org/2002/08/the-discipline-ofinnovation

EnviroSAR. (2020) *Home*. [Online] [Accessed 24 June 2020] http://www.envirosar.com

ESA. (2020) *Sentinel-6. Charting sea-level for Copernicus*. [Online] [Accessed 31 July 2020] https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-6

Fitch. (2012) *Understanding the new customer journey*. [Online] [Accessed 14 December 2019] https://thestorewpp.files.wordpress.com/2012/12/article_new_customer_journey_mindstates-3_fitch.pdf

Frayling, C. (1994) 'Research in art and design.' *Royal College of Art Research Papers*, 1(1), 1993/4.

Giuliani-Hoffman, F. (2020) 'Psyche, An Asteroid Believed To Be Worth $10,000 Quadrillion, Is Observed Through Hubble Telescope In New Study.' *CNN*. [Online] [Accessed 6 November 2020] https://edition.cnn.com/2020/10/31/us/psyche-asteroid-ultraviolet-trnd-scn/index.html

Gaia. (2022) 'GAIA.' *Earth Artwork by Luke Jerram*. [Exhibition]. Warrington Parr Hall, UK. 6-10 March 2022. Warrington: Culture Warrington.

Goldschmidt, G. and Smolkov, M. (2006) 'Variances in the Impact of Visual Stimuli on Design Problem Solving Performance.' *Design Studies*, 27(5), pp. 549-569.

Gopalakrishnan, S. and Damanpour, F. (1997) 'A review of innovation research in economics, sociology, and technology management.' *Omega*, 25(1), pp. 15-28.

Gorb, P. and Dumas, A. (1987) 'Silent Design.' *Design Studies,* 8(3), pp. 150-156.

GOV.UK. (2017) *Red Ninja's smart tech clears the road for ambulance crews*. [Online] [Accessed 3 March 2020] https://www.gov.uk/government/case-studies/red-ninjas-smart-tech-clears-the-road-for-ambulance-crews

GOV.UK. (2018) *Earth Observation (EO)*. [Online] [Accessed 24 June 2020] https://www.gov.uk/government/collections/earth-observation-eo

GOV.UK. (2020a) *Shetland Spaceport Boosts UK's Plans For Launch*. [Online] [Accessed 28 October 2020] https://www.gov.uk/government/news/shetland-spaceport-boosts-uks-plans-for-launch

GOV.UK. (2020b) *UK To Launch New International Space Collaborations*. [Online] [Accessed 7 October 2020] https://www.gov.uk/government/news/uk-to-launch-new-international-space-collaborations

GOV.UK. (2021) *Build Back Better: our plan for growth*. [Online] [Accessed 12 August 2021] https://www.gov.uk/government/publications/build-back-better-our-plan-for-growth/build-back-better-our-plan-for-growth-html

Grossman, D. (2020) 'How The UK Is Quietly Disrupting The Space Industry.' *Inverse*. [Online] [Accessed 18 December 2020] https://www.inverse.com/innovation/uk-disrupting-the-space-agency

Hagedoorn, J. (1990) 'Organizational Needs of Inter-firm Cooperation and Technology Transfer.' *Technovation*, 10(1), pp. 17-30.

Harari, Y. (2017) 'Reboot for the AI revolution.' *Nature*, 550 (7676). [Online] [Accessed 29 September 2018] http://www.nature.com/news/reboot-for-the-airevolution-1.22826

Heaton, J. (2004) 'Reworking qualitative data.' *Sage,* p. 58.

Hernandez, R., Cooper, R., Tether, B. and Murphy, E. (2017) *Design, the language of innovation,* (26), pp. 1-14.

Herr, K. and Anderson, G.L. (2005) 'The action research dissertation: A guide for students and faculty.' *Sage publications,* p. 4.

*Hidden Figures*. (2016) Directed by Theodore Melfi. [Film] USA: Fox 2000 Pictures, 14:49-14:58.

IDEO. (2020) *IDEO Design Thinking*. [Online] [Accessed 28 November 2020] https://designthinking.ideo.com

IntechOpen. (2020) *Mars Exploration – A Story Fifty Years Long*. [Online] [Accessed 22 September 2020] https://www.intechopen.com/books/mars-exploration-a-step-forward/introductory-chapter-mars-exploration-a-story-fifty-years-long

Intelligent Transport. (2018) *Intelligent Transport's top five lessons from InnoTrans 2018*. [Online] [Accessed 29 September 2018] https://www.intelligenttransport.com/transport-articles/72027/intelligent-transports-top-five-lessons-innotrans-2018

Intelligent Transport CEO (2019) *Feedback form for J. Adler*. 9 May.

Issuu. (2019) *ManSEDS Sponsorship Proposal 2018-19*. [Online] [Accessed 22 December 2019] https://issuu.com/manseds/docs/manseds_sponsorship_proposal

ITA (2018) *E-Interview for J. Adler*. 21 August.

ITCEO (2018) *E-Interview for J. Adler*. 21 August.

ITCEO (2019) *Interview with J. Adler*. Liverpool: 6 December.

ITDL (2019) *E-Interview for J. Adler*. 16 July.

Jamasmie, C. (2017) 'Luxembourg shoots for the stars with fresh space mining deal.' *MINING.COM*. [Online] [Accessed 18 June 2019] https://www.mining.com/luxembourg-shoots-stars-fresh-space-mining-deal

Jarvis, B. (2021) 'UK Launch'… have we lost our way?' *Linkedin.com*. [Online] [Accessed 12 February 2021] https://www.linkedin.com/pulse/uk-launch-have-we-lost-our-way-ben-jarvis/?trackingId=cNs1DG%2FCTWejBVUl%2FMuPLQ%3D%3D

Kalama, M. (2019) 'The Space Factory Of The Future - Innovate UK.' *Innovateuk.blog.gov.uk*. [Online] [Accessed 6 October 2020] https://innovateuk.blog.gov.uk/2019/07/25/the-space-factory-of-the-future

Kanter, R. (1983) *The change masters*. New York: Simon and Schuster.

Kress, G. and van Leeuwen, T. (2006) *Reading Images: The Grammar of Visual Design*. 2nd ed., New York: Routledge, pp. 17-19, 32-34.

Krippendorff, K. (2006) *The semantic turn: a new foundation for design*. Boca Raton: CRC/Taylor & Francis, pp. iii-iv, 27-29.

Kuang, C. (2012) 'Wolff Olins Offers Branding Lessons For Would-Be Game Changers.' *Fast Company*. [Online] [Accessed 14 December 2019] https://www.fastcompany.com/1669060/wolff-olins-offers-branding-lessons-for-would-be-game-changers

Leeuwis, C. and Aarts, N. (2011) 'Rethinking communication in innovation processes: creating space for change in complex systems.' *Journal of agricultural education and extension*, 17(1), pp. 21-36.

Leonard-Barton, D., and Swap, W. (1999) *When Sparks Fly*. Boston: Harvard Business School Press, p. 7.

Leurs, B. (2018) 'Landscape of innovation approaches.' *Nesta*. [Online] [Accessed 29 September 2018] https://www.nesta.org.uk/blog/landscape-of-innovationapproaches

Lewis, J. (1992) 'Extraction of volatiles and metals from extraterrestrial materials.' *Lunar and Planetary Laboratory*, The University of Arizona, p. 5.

Lewis, J. (2014) *Asteroid Mining 101: Wealth for the New Space Economy*.

Liedtka, J. (2018) 'Why Design Thinking Works.' *Harvard Business Review*. [Online] [Accessed 16 October 2020] https://hbr.org/2018/09/why-design-thinking-works

Liedtka, J., King, A. and Barnett, K. (2013) 'Solving Problems With Design Thinking: 10 Stories of What Works.' *Columbia Business School*, p. 4.

Liedtka, J. and Ogilvie, T. (2011) *Designing for growth: a design thinking tool kit for managers*. New York, Chichester: Columbia University Press, p.34.

Logo Design Love. (2019) *NeXT logo presentation, by Paul Rand, for Steve Jobs*. [Online] [Accessed 22 June 2019] https://www.logodesignlove.com/next-logo-paul-rand

London Economics. (2020) 'Space.' *London Economics*. [Online] [Accessed 1 December 2020] https://londoneconomics.co.uk/space

Long, M. (2021) 'New Design Council CEO Minnie Moll: "You can't retrofit design thinking".' *Design Week*. [Online] [Accessed 10 February 2021] https://www.designweek.co.uk/issues/18-24-january-2021/new-design-council-ceo-minnie-moll-you-cant-retrofit-design-thinking

Lopez, P. (2019) 'An insight-ful approach to growth – Views.' *Interbrand*. [Online] [Accessed 14 December 2019] https://www.interbrand.com/views/an-insight-ful-approach-to-growth

Lupton, E. (2011) *Graphic Design Thinking: Beyond Brainstorming*. New York: Princeton Architectural Press, pp. 6-11, 15-16, 22, 61-62, 74, 92, 96, 113, 132, 136, 174.

Maclenan, A. (2019) 'Your Eyes In The Sky: Making Satellites Work For Everyone.' *Nesta*. [Online] [Accessed 9 October 2020] https://www.nesta.org.uk/feature/tipping-point/your-eyes-sky-making-satellites-work-everyone

Manseds. (2019) *About*. [Online] [Accessed 19 December 2019] http://manseds.co.uk

McCarthy, S. (2013) *The designer as author, producer, activist, entrepreneur, curator & collaborator*. Amsterdam: BIS Publishers, p.23.

Miles, M.B. and Huberman, A.M. (1994) *Qualitative data analysis: An expanded sourcebook*. 2nd ed., Sage, pp. 27, 57, 71, 92, 96, 103, 133, 162, 211, 227, 236, 268.

Mills, A., Durepos, G. and Wiebe, E. (eds.) (2009) 'Encyclopedia of case study research: L-Z.' *Index, 1.* Sage.

Mills-Scofield, D. (2012) 'Hope Is A Strategy (Well, Sort Of).' *Harvard Business Review.* [Online] [Accessed 8 December 2020] https://hbr.org/2012/10/hope-is-a-strategy-well-sort-0

NASA. (2020) *OSIRIS-REx.* [Online] [Accessed 20 October 2020] https://www.nasa.gov/osiris-rex

NASA. (2021) *Earthrise.* [Online] [Accessed 12 January 2022] https://www.nasa.gov/multimedia/imagegallery/image_feature_1249.html

National Geographic. (2020) *National Geographic: Stories Of Animals, Nature, And Culture.* [Online] [Accessed 3 July 2020] https://www.nationalgeographic.com

National Trust. (2020) *Days Out.* [Online] [Accessed 29 June 2020] https://www.nationaltrust.org.uk/days-out

Noble, I. and Bestley, R. (2011) *Visual Research: an introduction to research methodologies in graphic design.* 2nd ed., Lausanne, Worthing: AVA Academia, pp. 23-76.

NSR. (2020a) 'Advanced Television: Study: Satellite Targets Connected Cars.' *NSR.* [Online] [Accessed 16 October 2020] https://www.nsr.com/advanced-television-study-satellite-targets-connected-cars

NSR. (2020b) 'CNBC: How Spacex, Virgin Galactic, Blue Origin And Others Compete In The Growing Space Tourism Market.' *NSR.* [Online] [Accessed 16 October 2020] https://www.nsr.com/cnbc-how-spacex-virgin-galactic-blue-origin-and-others-compete-in-the-growing-space-tourism-market

Nyrnes, A. (2006) *Lighting from the side: rhetoric and artistic research.* Bergen: Bergen National Academy of the Arts.

OECD. (2018) *Defining innovation – OECD.* [Online] [Accessed 7 September 2018] https://www.oecd.org/site/innovationstrategy/defininginnovation.htm

Oslo Manual. (2005) *Guidelines for Collecting and Interpreting Innovation Data.* [ebook] 3rd ed., Paris: OECD/European Communities, pp. 11-20. [Online] [Accessed 7 September 2018] https://www.oecd.org/sti/inno/oslo-manual-guidelines-for-collecting-and-interpreting-innovationdata.htm

Parliament.uk. (2007) *House of Commons – Science and Technology – Seventh Report: the UK Space Industry.* [Online] [Accessed 18 January 2021] https://publications.parliament.uk/pa/cm200607/cmselect/cmsctech/66/6608.htm

Parmar, R., Mackenzie, I., Cohn, D. and Gann, D. (2014) 'The new patterns of innovation.' *Harvard Business Review,* 92(1), p. 2.

Pettigrew, A. (1997) 'What is a processual analysis?' *Scandinavian journal of management,* 13(4), pp. 337-348.

Porsche. (2021) 'Porsche SE invests in rocket technology start-up Isar Aerospace.' *Porsche SE.* [Online] [Accessed 28 July 2021] https://www.porsche-se.com/en/news/press-releases/details/news/detail/News/porsche-se-investiert-in-raketentechnologie-start-up-isar-aerospace

Raswsthorn, A. and Antonelli, P. (2022) *Design Emergency*. London: Phaidon, pp. 85-103.

Red Ninja. (2018) 'LIFE - AI Traffic Flow Animation.' *YouTube: Red Ninja.* [Online] [Accessed 11 January 2022] https://www.youtube.com/watch?v=nL46FWJQkFc

Remote Sensing Director (2020) *Feedback form for J. Adler*. 10 March.

Rincon, P. (2020) 'Nasa outlines plan for first woman on moon by 2024.' *BBC News.* [Online] [Accessed 23 September 2020] https://www.bbc.co.uk/news/science-environment-54246485

Ross, S. (2001) 'Near-Earth Asteroid Mining.' *Space Industry Report,* pp. 1-4.

Rothwell, R. (1982) 'The role of technology in industrial change: Implications for regional policy.' *Regional studies,* 16(5), pp. 361-369.

Rothwell, R. (1994) 'Towards the Fifth generation Innovation Process.' *International Marketing Review,* 11(1), pp. 7-31.

Rothwell, R. and Gardiner, P. (1985) 'Invention, Innovation, Re-Innovation and the Role of the User: A Case Study of British Hovercraft Development.' *Technovation,* 3(3), pp. 167-186.

Rothwell, R. and Zegveld, W. (1985) *Reindustrialization and Technology*. Harlow: Longman.

Royal Geographical Society. (2020) *Royal Geographical Society – About Us*. [Online] [Accessed 3 July 2020] https://www.rgs.org/about

RSD (2019) *Interview with J. Adler*. Manchester: 16 October.

RSD (2020) *E-Interview for J. Adler*. 24 February.

RSRD (2019) *Interview with J. Adler*. Manchester: 19 November.

RSRD (2020) *E-Interview for J. Adler*. 28 February.

RSSM (2019) *Interview with J. Adler*. Manchester: 19 November.

Sagan, C. (1994) *Pale blue dot: A vision of the human future in space*. Random House, p. 173.

Sagar, J. (2015) 'Exclusive: the world's top agencies reveal how they develop new brands.' *Creativebloq.* [Online] [Accessed 14 December 2019] https://www.creativebloq.com/branding/exclusive-worlds-top-agencies-reveal-how-they-develop-new-brands-11513873

Sagmeister, S. (2008) *Things I have learned in my life so far*. New York: Abrams.

Sagmeisterwalsh.com. (2019) *Running the Studio*. [Online] [Accessed 22 June 2019] https://sagmeisterwalsh.com/answers

Saint-Exupéry, A. (1944) *The Little Prince*. Wordsworth Editions, p. 100.

Salinas, L. (2016) *The Production of Digital Public Spaces*. Lancaster University: Lancaster Institute for the Contemporary Arts, pp. 224-225

Salmons, J. (2011) 'Designing and Conducting.' *Research with online interviews,* pp. 3-20.

Salmons, J. (2016) 'Choosing methodologies and methods for online studies.' *Doing qualitative research online*. SAGE, pp. 17-39.

Satellite Applications Catapult. (2018) 'Research Into The Value Of Satellite-Derived Earth Observation Capabilities To UK Government.' *Satellite Applications Catapult*. [Online] [Accessed 24 June 2020] https://sa.catapult.org.uk/news/research-into-the-value-of-satellite-derived-earth-observation-capabilities-to-uk-government

Satellite Applications Catapult. (2021) 'Geospatial Intelligence.' *Satellite Applications Catapult*. [Online] [Accessed 23 July 2021] https://sa.catapult.org.uk/topic/geospatial-intelligence

Sci-Tech Daresbury. (2020) 'New North West 'Space Hub' Promises Economic Benefit.' *Sci-Tech Daresbury*. [Online] [Accessed 20 November 2020] https://www.sci-techdaresbury.com/new-north-west-space-hub-promises-economic-benefit

Scozzi, B., Garavelli, C. and Crowston, K. (2005) 'Methods for modeling and supporting innovation processes in SMEs.' *European Journal of Innovation Management*, 8(1), pp. 120-137.

Schroeder, J. E. and Salzer-Mörling, M. (2006) *Brand Culture*. Abingdon: Routledge, p. 145.

SEB (2019a) *Interview with J. Adler*. Manchester: 4 July.

SEB (2019b) *E-Interview for J. Adler*. 5 July.

SECO (2019) *E-Interview for J. Adler*. 25 June.

SED (2019) *Interview with J. Adler*. Manchester: 7 June.

SEDS. (2016) 'Jeff Bezos to donate $250K Heinlein Prize to SEDS student space leaders organization.' *SEDS USA*. [Online] [Accessed 5 February 2022] https://seds.org/2016/09/15/jeff-bezos-to-donate-250k-heinlein-prize-to-seds-student-space-leaders-organization

SELB (2019) *E-Interview for J. Adler*. 10 June.

SEOO (2019) *E-Interview for J. Adler*. 16 July.

SEOOC (2019) *E-Interview for J. Adler*. 19 July.

SEP (2019) *Interview with J. Adler*. Manchester: 9 May.

SEPUB (2019) *E-Interview for J. Adler*. 10 June.

SER (2019) *Interview with J. Adler*. Manchester: 4 July.

SERK (2019) *E-Interview for J. Adler*. 10 June.

SESC (2019) *E-Interview for J. Adler*. 26 June.

SET (2019a) *Interview with J. Adler.* Manchester: 4 July.

SET (2019b) *E-Interview for J. Adler.* 19 July.

Shanks, M. (n.d.) 'An introduction to design thinking – process guide.' *D.school.*
[Online] [Accessed 6 March 2021]
https://web.stanford.edu/~mshanks/MichaelShanks/files/509554.pdf

Sheppard, B., Sarrazin, H., Kouyoumjian, G. and Dore, F. (2018) 'The Business Value Of
Design.' *McKinsey.* [Online] [Accessed 1 December 2020]
https://www.mckinsey.com/business-functions/mckinsey-design/our-insights/the-
business-value-of-design

Silverman, D. (2007) *A very short, fairly interesting and reasonably cheap book about
qualitative research.* Sage, p. 37.

Silverman, D. (2017) *Doing qualitative research.* 5th ed., Sage, pp. 263, 283, 297, 475.

Sonter, M. (1997) 'The technical and economic feasibility of mining the near-earth
asteroids.' *Acta Astronautica*, 41(4-10), pp. 637-647.

Space Engineering President (2019) *Feedback form for J. Adler.* 14 August.

Spacegovuk. (2021) 'UK Space Agency and NASA Perseverance – discover the mission
and space careers.' *Youtube,* 11:36-12:17. [Online] [Accessed 5 March 2021]
https://www.youtube.com/watch?v=txu9srZ6lzw

Space Growth Partnership. (2018) *Prosperity from Space.* [Online] [Accessed 31 July
2020] https://www.ukspace.org/wp-content/uploads/2019/05/Prosperity-from-Space-
strategy_2May2018.pdf

Spaceportcornwall.com. (2020) 'Spaceport Cornwall.' *UK Spaceport Site Newquay
Cornwall Airport.* [Online] [Accessed 28 October 2020] https://spaceportcornwall.com

Spacex. (2021) 'SpaceX designs, manufactures and launches advanced rockets and
spacecraft.' *SpaceX.* [Online] [Accessed 22 July 2021] https://www.spacex.com

SSD (2019) *Interview with J. Adler.* Manchester: 17 September.

Stanford d.school. (2019) 'Design Thinking Bootcamp.' *Stanford d.school.* [Online]
[Accessed 14 December 2019] https://dschool.stanford.edu/executive-
education/dbootcamp

Sterling Saletta, M. and Orrman-Rossiter, K. (2018) 'Can space mining benefit all of
humanity?: The resource fund and citizen's dividend model of Alaska, the 'last frontier'.'
*Space Policy*, 43, pp. 1-6.

Stewart, I., De, D., and Cole, A. (2015) *Technology and people: The great job-creating
machine.* London: Deloitte. [Online] [Accessed 29 September 2018]
https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/finance/deloitte-uk-
technology-and-
people.pdf%0Ahttps://www2.deloitte.com/uk/en/pages/finance/articles/technology-and-
people.html

Suárez, F. and Utterback, J. (1995) 'Dominant designs and the survival of firms.' *Strategic management journal,* 16(6), pp. 415-430.

Suchman, L., Trigg, R. and Blomberg, J. (2002) 'Working artefacts: ethnomethods of the prototype.' *The British journal of sociology,* 53(2), p. 172.

Sukumaran, P. (2016) 'Mining Asteroid Resources.' *Journal of the Geological Society of India, 88*(1), p. 125.

Tan, D. (2017) 'Watch: Paula Scher reveals how the Pentagram design process works.' *Designtaxi.com.* [Online] [Accessed 14 December 2019] https://designtaxi.com/news/392532/Watch-Paula-Scher-Reveals-How-The-Pentagram-Design-Process-Works

Tech City UK. (2017) *Tech Nation 2017.* [Online] [Accessed 29 September 2018] https://technation.techcityuk.com

The European Design Leadership Board. (2012) *Design for Growth & Prosperity.* Helsinki: DG Enterprise and Industry of the European Commission, p. 46.

The Logo Creative. (2018) *Designer interview with Paula Scher.* [Online] [Accessed 14 December 2019] https://www.thelogocreative.co.uk/designer-interview-with-paula-scher

The University of Manchester. (2018) *University start-up company to expand its peat and heathland wildfire research efforts.* [Online] [Accessed 24 June 2020] https://www.manchester.ac.uk/discover/news/university-start-up-company-to-expand-its-peat-and-heathland-wildfire-research-efforts

Tomitsch, M., Wrigley, C., Borthwick, M., Ahmadpour, N., Frawley, J., Kocaballi, A.B., Núñez-Pacheco, C. and Straker, K. (2018) *Design. think. make. break. repeat. A handbook of methods.* Amsterdam: Bis Publishers, pp. 22-23, 34, 40, 64-65, 78-79, 84-85, 92.

Transformation North West Cohort – Adler, J., Blackwell, B., Costabile, I., Kallegias, A., Kowalska, P., Latham, G., Omar, L., Partha, C., Pialorsi, V., Robins, J., Street, J. and Wareing, L. (2018a) *Driving Industrial Strategy for North West Growth – the Role of the Creative Industries,* pp.22-27, 52-53.

Transformation North West Cohort – Adler, J., Blackwell, B., Costabile, I., Kallegias, A., Kowalska, P., Latham, G., Omar, L., Partha, C., Pialorsi, V., Robins, J., Street, J. and Wareing, L. (2018b) *The Transformation North West design charter.*

Tufte, E. (1990) *Envisioning information.* Cheshire, CT: Graphics press, pp. 38-65.

UD (2020) *Interview with J. Adler and B. Lee.* London: 13 February.

UKSDC. (2020) 'Video Competition.' *UKSDC.* [Online] [Accessed 2 October 2020] https://uksdc.org/compete/video

UR (2020) *Interview with J. Adler and B. Lee.* London: 13 February.

Van de Ven, A. (1986) 'Central problems in the management of innovation.' *Management Science,* 32, pp. 590-607.

Venkatesh, A., Digerfeldt-Månsson, T., Brunel, F., Chen, S. (2012) 'Design Orientation: A Grounded Theory Analysis of Design Thinking and Action.' *Marketing Theory,* 12(3), pp. 289-309.

Verganti, R. (2008) 'Design, Meanings, and Radical Innovation: A Metamodel and a Research Agenda.' *Journal of Product Innovation Management,* 25(5), pp. 436–456.

Verganti, R. (2009) *Design driven innovation: changing the rules of competition by radically innovating what things mean.* Harvard Business Press, pp. 5, 11-12, 24-29.

Virgingalactic. (2021) 'Virgin Galactic is launching a new space age, where all are invited along for the ride.' *Virgin Galactic.* [Online] [Accessed 11 July 2021] https://www.virgingalactic.com

Waters, M. (2019) 'Constructing A Life On Mars.' *Calom.space.* [Online] [Accessed 19 October 2020] https://www.calom.space

Welch, P. (2019) 'How a metal detector and Google Earth are helping one man uncover the past.' *Google.* [Online] [Accessed 24 June 2020] https://about.google/stories/weekendwanderers

Wilson, M. (2017) 'Pentagram Doesn't Just Create Brands, It Writes New Languages.' *Fast Company.* [Online] [Accessed 14 December 2019] https://www.fastcompany.com/90109560/pentagram-doesnt-just-create-brands-it-writes-new-languages?utm_source=DesignTAXI&utm_medium=DesignTAXI&utm_term=DesignTAXI&utm_content=DesignTAXI&utm_campaign=DesignTAXI

Yazan, B. (2015) 'Three approaches to case study methods in education: Yin, Merriam, and Stake.' *The Qualitative Report,* 20(2), pp. 134-152. [Online] [Accessed 14 December 2019] http://www.nova.edu/ssss/QR/QR20/2/yazan1.pdf

Yin, R. (2014) 'Case study research and applications: Design and methods.' *Sage publications,* 5th ed., p. 17.

Zachry, M. and Thralls, C. (2004) 'An interview with Edward R. Tufte.' *Technical Communication Quarterly,* 13(4), pp. 447-462.

Zalla, M. (2016) 'The five fundamentals of great package design.' *Landor: Thinking.* [Online] [Accessed 14 December 2019] https://landor.com/thinking/the-five-fundamentals-of-great-package-design

# Appendices

**Appendix 1**

**Brand guidelines for Case Study 1 – Intelligent Transport**

AI TRAFFIC FLOW

Clear Space

BRAND GUIDELINES 2018

Janett Adler : Transformation North West

AI TRAFFIC FLOW

AI TRAFFIC FLOW

c 2 1

o

6 x

A +

% a ᵥE ᴺ ' R * Font

b @

5 z

³ j k l n

4 m

y

**Tangerine tango red**
C 0
M 82
Y 80
K 0

**Saffron orange**
C 4
M 45
Y 92
K 0

**Peridot green**
C 56
M 10
Y 86
K 0

**Appendix 2**

**Investment brochure for Case Study 2 – Asteroid Mining**

# ASTEROID MINING
# THE 21ST CENTURY GOLD RUSH

*image credit* Gareth Jones – Liverpool skyline and Francesco Ungaro – starfield

# "IMAGINING THE IMPOSSIBLE – THEN FINDING THE PHONE NUMBERS OF THOSE WHO CAN MAKE IT HAPPEN...

# THERE'S MONEY UP THERE"

## MITCH HUNTER-SCULLION

CEO & Founder **Asteroid Mining Corporation**

# CONTENTS

# 1

# INTRODUCTION

**Humanity is currently entering a new golden age of exploration; with recent advances in space technology, our solar system is gradually opening up to commercial exploitation. One of the principal facets of the extraterrestrial economy is the mining of precious metals from asteroids.**

The Asteroid Mining Corporation (AMC) was founded by Mitch Hunter-Scullion in March 2016. For the past three years AMC has been developing a roadmap to the utilisation of asteroid resources. We are planning a small, low cost satellite mission to prospect near-Earth asteroids (NEAs) for potential asteroid mining candidates. Commercialisation of the data collected during this survey will fund the company's subsequent mining missions.

# 2

# STRATEGY OVERVIEW

Just like in terrestrial mining, there are two main phases to asteroid mining: exploration and extraction. The exploration phase (2019-2023) involves a two stage approach:

**1** First, AMC will prospect the near-Earth asteroids (NEAs) from Low Earth Orbit (LEO) with Asteroid Prospecting Satellite 1 (APS-1), in order to conduct a compositional survey to identify NEAs with high concentrations of platinum group and rare Earth metals (PGMs and REMs). AMC will commercialise this dataset in a space resources database. Detailed knowledge regarding the sources of these valuable materials in the NEAs will be economically disruptive, and we expect a strong interest in our dataset from industry, governments and academia around the world.

**2** AMC will use the profits from its space resource database to fund the second exploratory mission, the first commercial mission to an asteroid. Asteroid Prospecting Satellite 2 (APS-2) will visit a NEA identified in our dataset as being rich in PGMs, producing detailed topographical and compositional surface maps from a low orbit in order to identify the optimal landing site for mining craft. APS-2 will then land at the nominated site to scrutinise the surface conditions and test various attachment and drilling mechanisms prior to the first extraction mission.

A further aim of APS-2 is to establish a legal claim to the resources on and within the asteroid that it visits. This will be applied for both nationally in parliament and internationally through the UN Office of Outer Space Affairs. AMC will then enter the extraction phase; marking the transition from the first to the second five year plan.

The goal of the extraction phase is to recover 10 tonnes of material from the aforementioned asteroid by 2030. The primary resources that AMC is interested in recovering are platinum and other PGMs. Platinum is currently valued at 25 million GBP per tonne, a price which is increasing due to scarcity. An injection of 10 tonnes of platinum into the annual global supply of approximately 200 tonnes is unlikely to cause a major depreciation in the market price, given that demand has consistently outstripped supply for several years. AMC will repeat this mission until the asteroid's resources are depleted, with the revenues from each mission being reinvested into the development of extraterrestrial infrastructure to facilitate further asteroid mining missions and eventually, human habitation of space.

# 3

# THE TEAM

The core team currently consists of 7 young professionals from varied backgrounds and spans a broad skill-set encompassing the sciences, finance, arts and engineering. AMC is currently pre-capital and our members have contributed thousands of man hours on a voluntary basis – so committed are we to our collective vision. The company is now eager to take the next step by employing its workforce full time as the first ever UK space miners.



*Mitch Hunter-Scullion*
*Founder and Chief Executive Officer*
BA Hons International Relations and History from Liverpool Hope University. Member of The Hague International Space Resources Governance Working Group. Registered Political Lobbyist to the Scottish Parliament. Space Mining Broadcaster.



*Jacob Lam*
*Chief Financial Officer*
MSc Finance and Law from Queen Mary University of London. Former distressed debt broker in the City of London. Now working as a hedge fund broker in Hong Kong.



*Jeremy Soper*
*Chief Operations Officer*
MEng Aerospace and Mechanical Engineering from the University of Cambridge. 6 years' experience R&D in the Roadrail industry; now seeking to make his mark off the planet.



*Aleksandra Marinova*
*General Counsel*
*Specialist Space Lawyer*
LLB International Law from Lancaster University. Fellow of the Royal Astronomical Society. Member of European Centre for Space Law and the Space Generation Advisory Council.



*Subham Kr. Gupta*
*Chief Technical Officer*
MSc Astronautics and Space Engineering from Cranfield University. 3 years' experience in mechanical space systems: lunar mission SRMSAT-2, asteroid retrieval.



*Ben Dorset*
*Chief Scientific Officer*
MPhys Physics with Astrophysics from the University of Kent. Asteroid YORP effect researcher. Spectroscopic Analyst.



*Stewart Leech*
*Chief Design Officer*
BAHons Graphic Design from the University of Central Lancashire. National magazine designer.

# 4

# CONQUERING MALTHUSIAN THEORY

On Earth resources are limited. In the vast expanse of space they are practically unlimited.

Many of us go about our lives under the assumption that everything we consume can be replaced indefinitely at the same price. However, everything from the trace indium in our smartphones to ubiquitous copper is limited in availability on our planet. If we want to continue to innovate, produce and create then we must look further afield for resources. The metals that form the basis of modern society can be found in relative abundance on asteroids, comets and other bodies throughout the solar system. Extracting these from outer space avoids the environmental costs to our precious, life-bearing home planet.

With a successful asteroid mining and material processing infrastructure in place, there would be a new technological and innovation boom generating wealth and jobs. Precious and strategic metals could be returned to Earth and used to supplement terrestrial stocks, whilst other base metals such as iron and resources like water can be kept for use in orbit. Provision of materials beyond the Earth's gravitational well will lower the cost of innovation, accelerating humanity's expansion throughout the solar system.

The Japanese space agency's Hayabusa 2 probe successfully landed on NEA Ryugu in September 2018, demonstrating that the technology already exists to establish an asteroid mining industry. Encouraged by recent advances in reusable rocket technology, AMC believes the time is ripe to commercialise that which has historically been the preserve of state organisations: the exploration of outer space. In this we are not alone. The company has garnered support and approval from academia and the wider space industry (see partners). A handful of US companies, most notably Planetary Resources and Deep Space Industries, share similar goals. The government of Luxembourg has thrown considerable weight behind the industry by enacting its own space mining legislation in 2017. Make no mistake; moves are afoot to ignite the 'asteroid rush'. AMC has positioned itself at the forefront of this nascent sector, and with financial backing the bounty of the NEAs can be ours for the taking.

# 5

# THE BOUNTY

There are 3 main classifications of asteroid: metallic *M-type*, carbonaceous *C-type* and silicaceous *S-type*. From meteoric impact samples, we know that:

*M-types* sometimes contain large concentrations of iron, nickel, cobalt, titanium and PGMs (platinum, palladium, rhodium, ruthenium, osmium and iridium).

*C-types* contain some metals with carbon and hydrated minerals.

*S-types* can contain iron, nickel and magnesium silicates.

Water is also a highly valuable resource that can be obtained from asteroids and used for drinking, agriculture and radiation shielding. It can be split via electrolysis into hydrogen and oxygen for rocket fuel and life support.

AMC looks to generate revenue from the valuable PGMs contained in asteroids and later provide a supply of water and base metals which make up the larger fraction of asteroid composition.

## Metallic asteroids of **25 metres** diameter could be worth approximately **2.3 billion GBP**:

| | | |
|---|---|---|
| **29.0 t**onnes of platinum | £25 million per tonne | = **£725M** |
| **16.5 t** of palladium | £22.5M/t | = **£371M** |
| **14.1 t** of iridium | £23.8M/t | = **£333M** |
| **14.5 t** of osmium | £9.8M/t | = **£142M** |
| **4.0 t** of rhodium | £29.9M/t | = **£120M** |
| **21.5 t** of ruthenium | £1.5M/t | = **£33M** |
| **0.6 t** of gold | £31.3M/t | = **£19M** |

Of course AMC is not just predicated on this long term goal; on our path towards the Asteroids we will introduce new revenue streams from hardware development to data driven applications that will draw profits long before we get anywhere near an Asteroid.

# 6

# ASTEROID PROSPECTING SATELLITE 1 (APS-1)

APS-1 will conduct a spectral survey of the NEAs from LEO to gather new data for the space resources database, including estimates of size, shape, trajectory and composition, enabling an assessment of each NEA's commercial value and aiding in the planning of potential missions to extract its resources.

APS-1 will take the form of a small 6U CubeSat satellite. Thanks to the diversification of miniaturised space technology, it need be no larger than a desktop computer, keeping launch costs to a minimum (as little as £22k per kg for auxiliary payloads piggybacking on another mission). Through this mission, AMC will gain valuable experience in satellite technology and a leading position within the global space industry.

Onboard, a remote near-infrared spectroscope will analyse the light reflecting off target asteroids. Unlike a ground-based equivalent, it does not have to contend with the interference of the Earth's atmosphere. Neither is it constrained by circadian timings, so through judicious choice of orbit, observation downtime can be reduced drastically, permitting a much more cost effective observation schedule when compared to a fixed ground-based telescope.
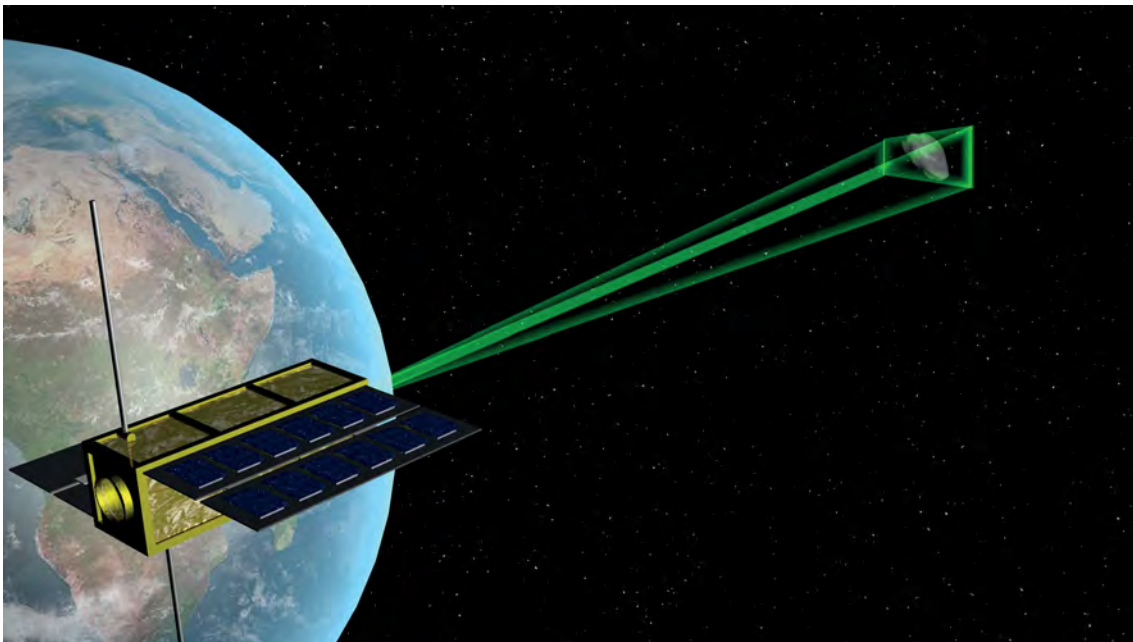


*image credit* AMC – (artistic impression) APS-1 scanning NEA

# 7

# OUR PARTNERS

Through academic alliances we gain access to experts in the fields of astronomy, spectroscopy and space engineering such as Dr Amanda Hughes, widely-cited expert on asteroid mining and a member of AMC's board of advisors, who compiled the initial feasibility study for APS-1. AMC is currently working with Liverpool John Moores University's Astrophysics Research Institute to validate our remote PGM detection technology, whilst funding applications are underway to develop a proprietary subsystem for improving the tracking accuracy of the spacecraft instrumentation with the University of Liverpool's Engineering Department. Additional promising partnerships are being fostered with the University of Glasgow, University of Edinburgh and Strathclyde University.

Further afield, we also have a bourgeoning relationship with the Space Robotics Laboratory at Tohoku University, Japan. Mickael Laine of the SRL has expressed interest in working with AMC on the Space Robotics challenges; drawing on his experience in developing the Hakuto rover for iSpace which was a major factor in their recent $92 million series A funding round.

AMC is a Member of the Satellite Finance Network; and is engaging their expertise on regulatory, licensing and financial elements of the Space Industry.

AMC has close links to the Northern Space Consortium and Space Network Scotland; the regional trade bodies for the Space Industry in the NW of England and Scotland; our areas of operation.

AMC is a Member of The National Security and Resilience Consortium which provides links into London based government networks and R&D opportunities.

Internationally; AMC is a Member Organisation of The Hague International Space Resources Governance Working Group, with our CEO Mitch sitting on the expert led Members' Council and our General Counsel Aleksandra being an Observer. The Hague WG has drafted an international legal framework for space resources activities; and is now working towards enacting it in international law. This has significant advantages to AMC and plays into our global lobbying and marketing strategy for space mining. This being key to our plans to establish legitimate property rights that are accepted by both the governments who license our operations and the wider international community through the United Nations, where AMC will proactively lobby for an International Space Resources Treaty.

Public relations will play a major role in opening up the resources of the solar system for economic exploitation; therefore AMC have prepared a relationship with the Newgate Communications who will handle AMC's communications strategy with planned stories in reputable publications such as the Financial Times. As part of the comms strategy AMC is being filmed for a documentary that will outline our vision of the future to the general public.

# 8

# OUR SPACE RESOURCES DATABASE

AMC will combine the data obtained by APS-1 with existing information about the NEAs to produce a commercially available data service much like a Bloomberg Terminal for space resources. Licenses to view the data will be available for purchase in the academic, governmental and private sectors. The data will be formatted as best suits the needs of each client. Our space resources database will be unique in including spectral and compositional data as well as price analytics to give a holistic view of the asteroid as a resource.

Our pricing point for the database is a conservative £100,000 per institution per 100-asteroid set, or £5,000 individually. This price is derived from the current cost of generating similar data using ground observations. A 2 metre diameter telescope would be required at a cost of £10,000 per night, in which time an average of 1.5 spectral classifications can reasonably be expected.

In this new gold rush, we are selling the shovels to fund our own digging exploits. Only 23 such sales are necessary to offset the cost of APS-1 (see §8), before profit can be channelled towards APS-2. AMC will use the leverage this gives the company over the global asteroid mining industry to offer our services and expertise to governments and corporations around the world.

# 9

# THE COSTS

We are seeking *£2.3M* to cover the cost of APS-1, broken down below:

6U CubeSat (ClydeSpace quote April 2018)   = *£860k*
Launch on an ISRO PSLV   = *£550k*
Payload instrumentation   = *£250k*
Labour costs over 2 year project duration   = *£420k*
Space resources database development   = *£100k*
Lobbying and Marketing   = *£120k*

We seek to offset much of these costs by utilising the generous public R&D funding mechanisms which are available through Scottish Enterprise and other partners.



*image credit* Amanda / DH-Textures – dark storm clouds

# PROPOSED TIMELINE

## 2019 – 21

**Asteroid Prospecting Satellite 1 (APS-1)**
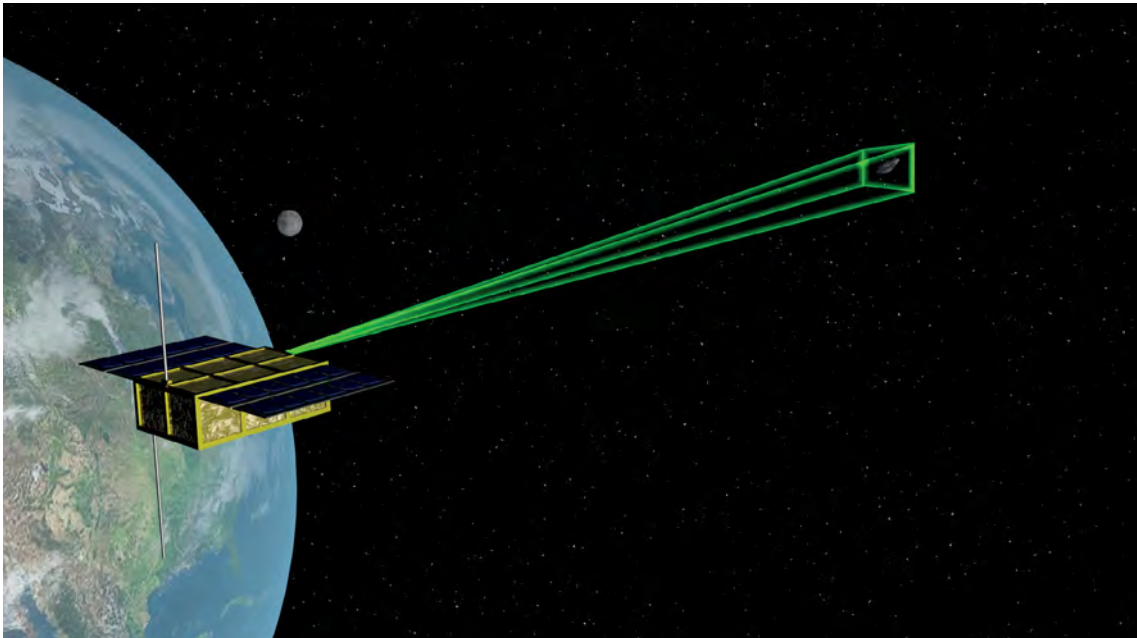Data mining the NEAs using CubeSat based remote sensing.



*image credit* AMC – APS-1 scanning NEA

## 2022 – 25

**Asteroid Exploration Probe (AEP-1)**
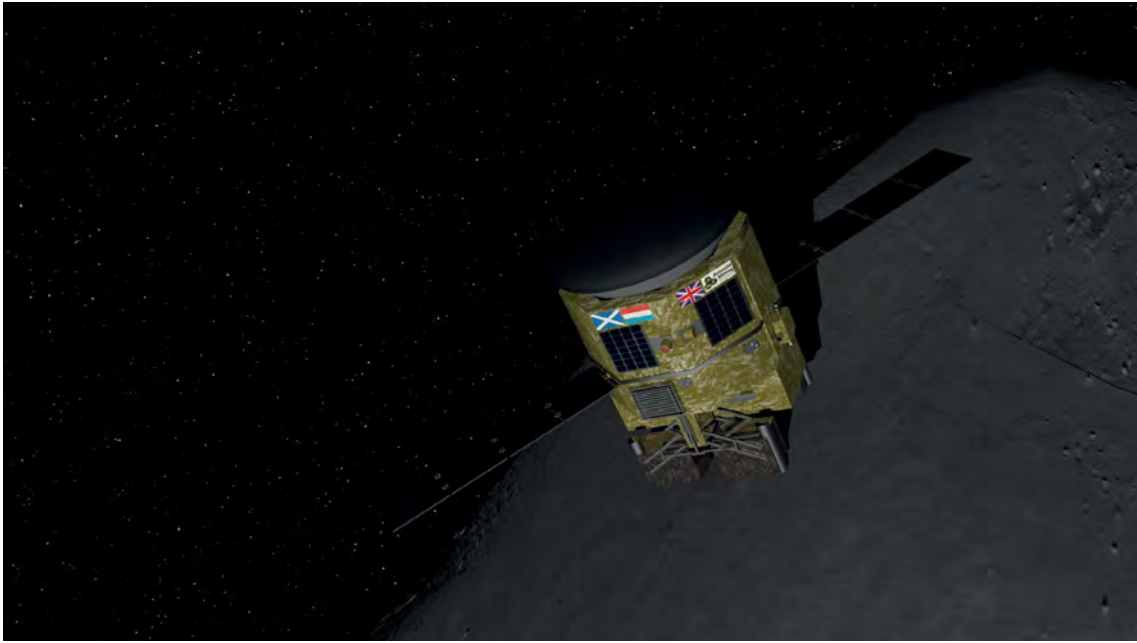Prospecting from low orbit and landing on the chosen NEA to scout potential mining site and test mining equipment.

*image credit* AMC – AEP-1 scouting mining site

## 2025 – 30

## Asteroid Mining Probe 1 (AMP-1)

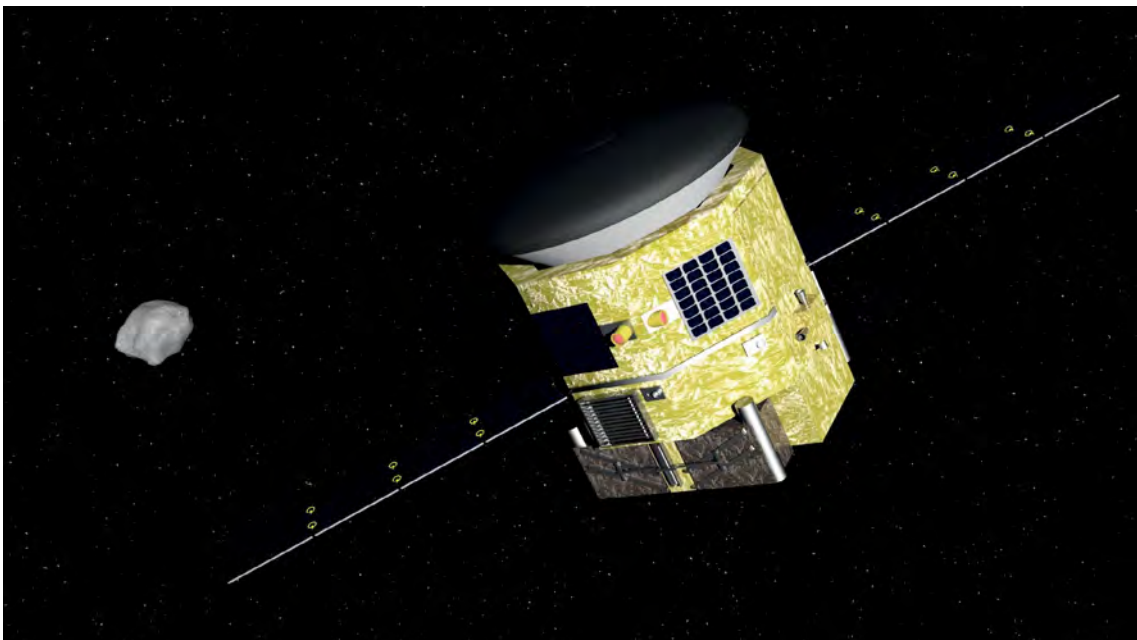Extract and return 10 tonnes of material from the NEA to Earth.



*image credit* AMC – AMP-1 approaching a NEA

# GLOBAL AMBITION

AMC has intentions to become a multinational corporation. This is driven by commercial necessity; Jacob, our CFO is a Hedge Fund Broker in Hong Kong, therefore it is in our interest to use this to our advantage to set up a presence in Asia.

While Luxembourg is the global hub for the Space Mining industry and is offering very generous incentives in order to attract businesses to relocate their Headquarters there. AMC has already been in preliminary discussions with the Government of Luxembourg about establishing AMC SarL, a Luxembourgish entity to serve as the centre for our legal and financial team.

In due course AMC expects to grow into the North American market and would continue to expand its operations globally as we progress through our development plan. With a strong global network of AMC offices coordinated for a global hub in the UK or Luxembourg; the company will be in an ideal position to dominate the Extraterrestrial Economy as we open it up during the 2020's.
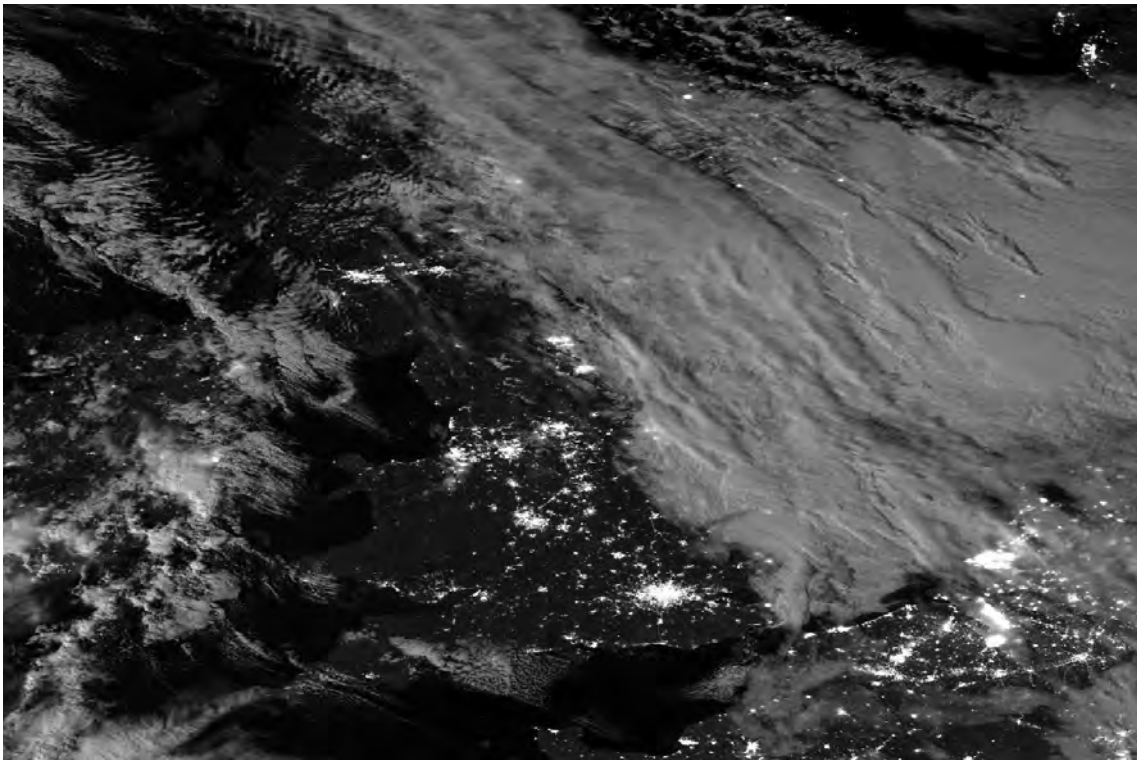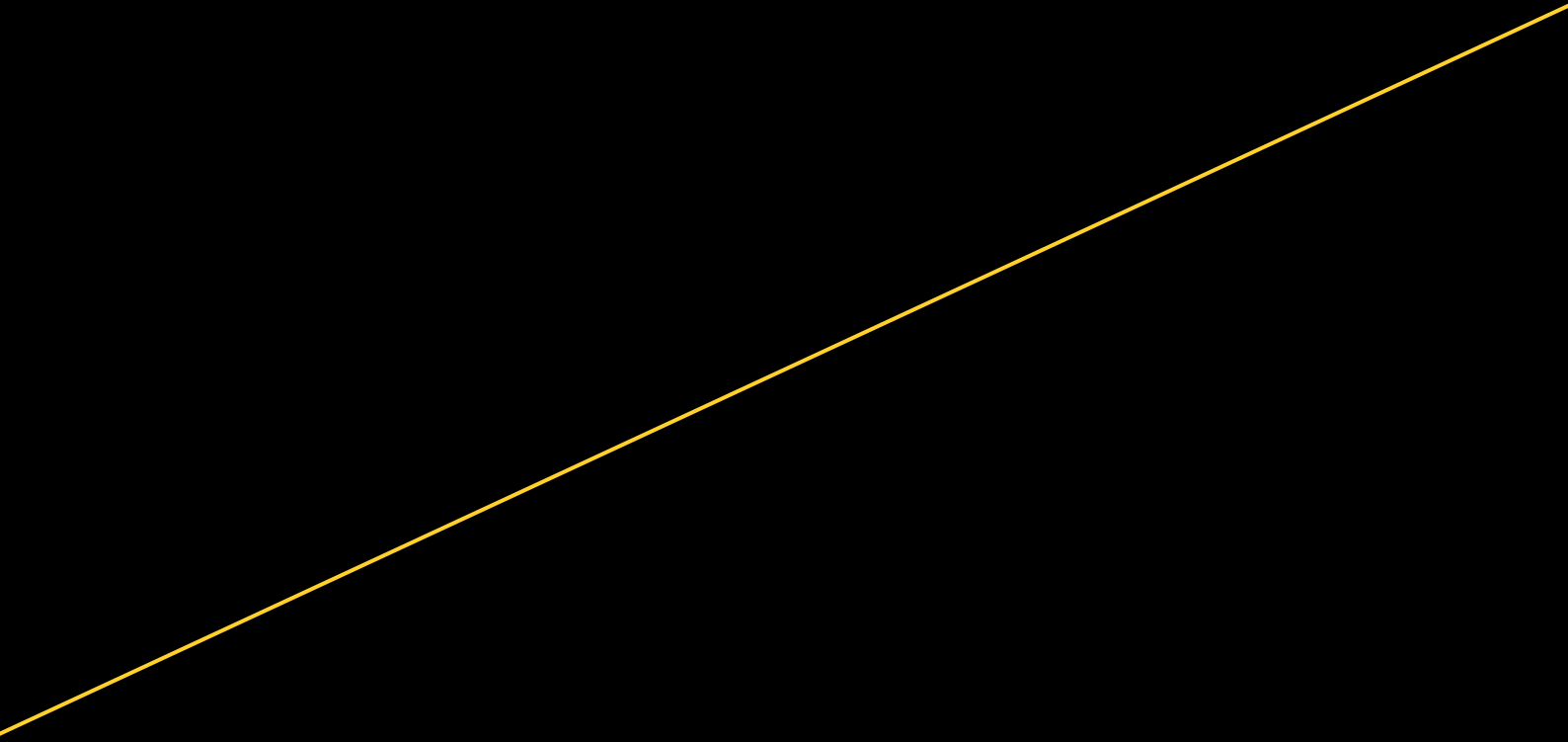


*image credit* Simon Proud – via NPP satellite – UK 'city lights and cloud patterns'

**Appendix 3**

**Brand guidelines and creative orientation for Case Study 3 –
Space Engineering**

**MANSEDS**
BRAND GUIDELINES
and CREATIVE ORIENTATION

# INSPIRATION

What does MANSEDS want to look like?
How does this translate visually?

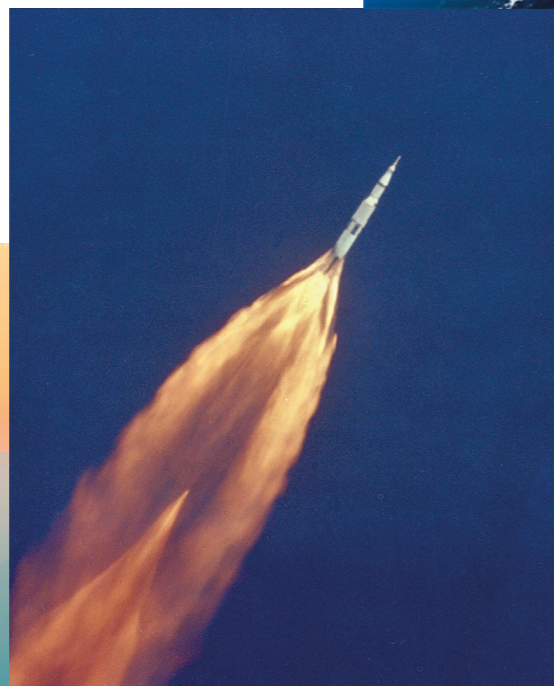engineered

aspirational

intelligent

precise

determined
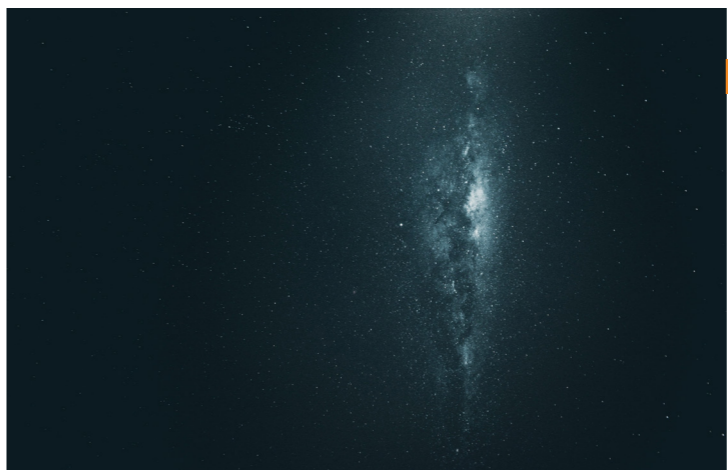
approachable

bold

ambitious

sincere

FORMA

AILERONS
TYPEFACE

Friendly

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

*T.S. Eliot*

# COLOURS

primary colour

**sky vs sea**

*C* 80  *M* 28  *Y* 15  *K* 2
*R* 2  *G* 142  *B* 186

*speaks*
trust, honesty, intelligence, peace, approachability

in addition to black, white and shades of grey, e.g.

| K 100 | K 0 | K 12 | K 43 | K 77 |
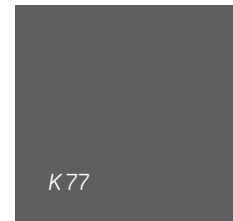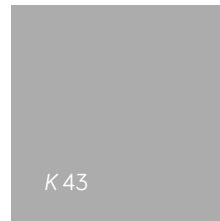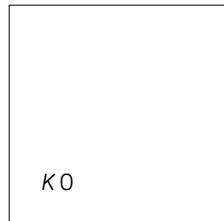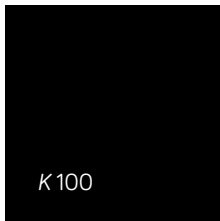
*that speak*
elegance, purity, foundation, impartiality, backbone

and silver

quantum silver

*that speaks*
technology, achievement, wisdom

## secondary colours

**deep bluebird**

C 100   M 81   Y 41   K 36
R 23   G 49   B 80

*speaks*
precision, knowledge, integrity

**space peridot**

C 54   M 9   Y 88   K 0
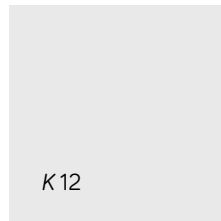R 138   G 179   B 68

*speaks*
growth, harmony, safety

**tamed peacock**

C 32   M 9   Y 18   K 0
R 186   G 210   B 211

*speaks*
serenity, collaboration, sophistication

**flame tangerine**

C 0   M 55   Y 92   K 0
R 241   G 136   B 32

*speaks*
enthusiasm, determination, spark

**bumblebee**

C 0   M 24   Y 88   K 0
R 253   G 198   B 39

*speaks*
joy, activity, excitement

**electric grape**

C 79   M 93   Y 27   K 18
R 81   G 45   B 100

*speaks*
power, ambition, creativity

# LOGOTYPE

principal MANSEDS logotype

A B C D E F G # 1 2 3

*font*
Ailerons
*looks*
cosmos, distinguished, epic, timeless

MANSEDS

# LOGOTYPE

clear space
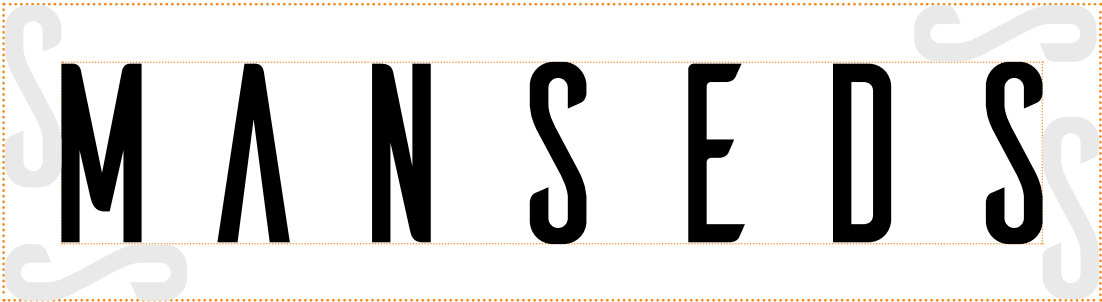
**MANSEDS**

MANSEDS

# MANSEDS

MANCHESTER STUDENTS FOR THE
EXPLORATION AND DEVELOPMENT OF SPACE

# MANSEDS

BRING MANCHESTER CLOSER TO SPACE

# LOGOTYPE

sublogos
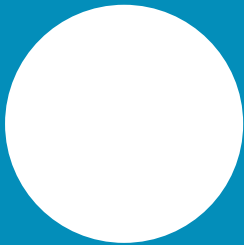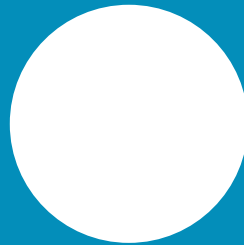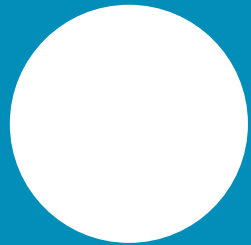
rover          rocketry          balloon          cansat

# ROVER

A mechanical robotic arm stands for rovers.

# ROCKETRY
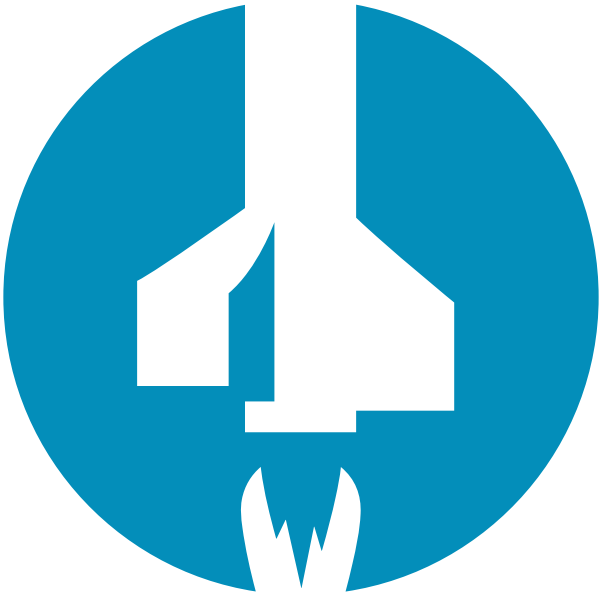


A cropped rocket and thrust for rocketry.

# BALLOON
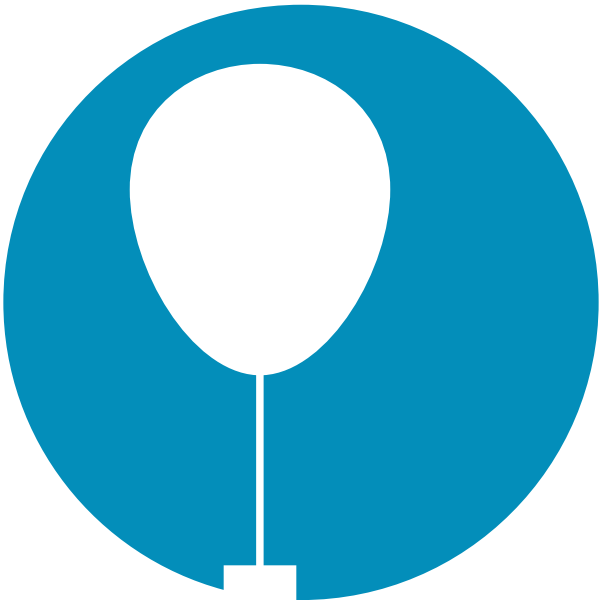


A modest balloon with payload.

# CANSAT
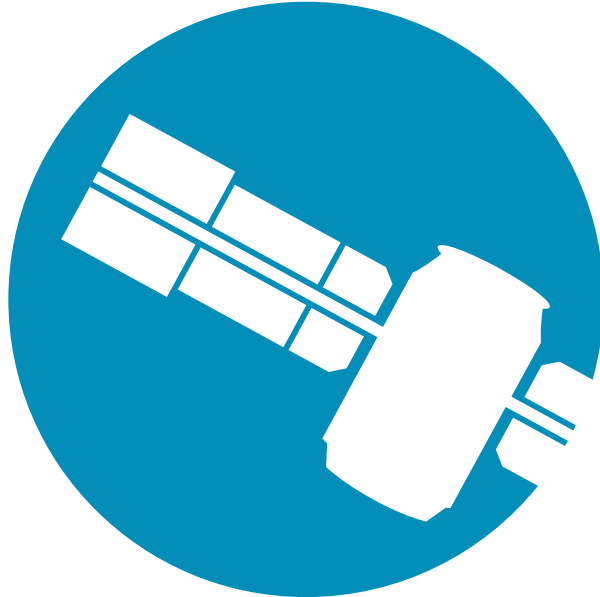


A can spreading its wings representing cansat.

# MANSEDS

SUBLOGOTYPES
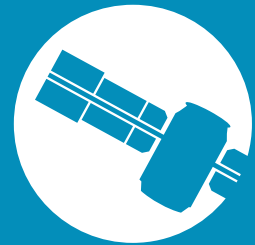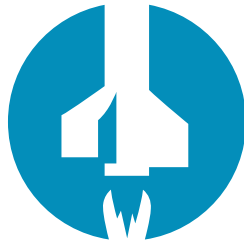
rover          rocketry          balloon          cansat

# MANSEDS

SUBLOGOTYPES

rover          rocketry          balloon          cansat

# MANSEDS

SUBLOGOTYPES



rover



rocketry



balloon



cansat

# MANSEDS

SUBLOGOTYPES
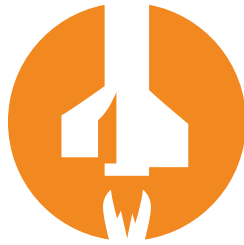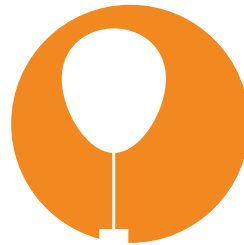
rover
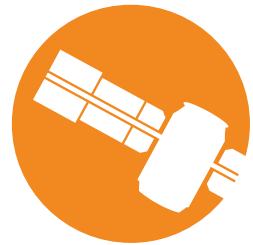
rocketry

balloon

cansat

# MANSEDS

SUBLOGOTYPES
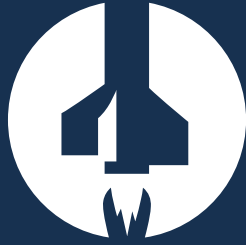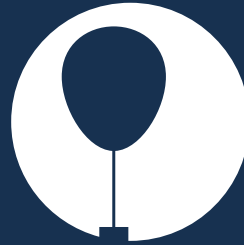
rover      rocketry      balloon      cansat
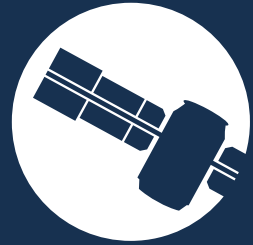
# MANSEDS

SUBLOGOTYPES
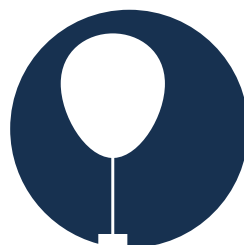
rover
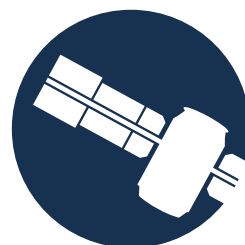
rocketry

balloon

cansat

# MANSEDS

SUBLOGOTYPES
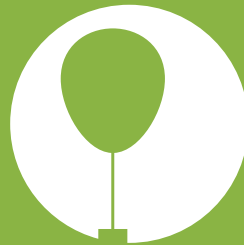
rover          rocketry          balloon          cansat
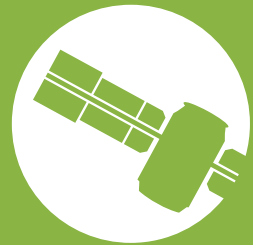
# MANSEDS

SUBLOGOTYPES

rover

rocketry

balloon

cansat

# MANSEDS

## SUBLOGOTYPES



rover     rocketry     balloon     cansat

# MANSEDS

SUBLOGOTYPES

rover      rocketry      balloon      cansat

# TYPOGRAPHY

fonts applicable to copy etc., incl. font sizes

Bariol
Regular
AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
0123456789o123456789.,;:-‘'”/(?&@£#)\

Bariol
Light
AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
0123456789o123456789.,;:-‘'”/(?&@£#)\

Bariol
Italic
*AaBbCcDdEeFfGgHhIiJjKkLlMm*
*NnOoPpQqRrSsTtUuVvWwXxYyZz*
*0123456789o123456789.,;:-‘'”/(?&@£#)\*

Bariol
Light It
*AaBbCcDdEeFfGgHhIiJjKkLlMm*
*NnOoPpQqRrSsTtUuVvWwXxYyZz*
*0123456789o123456789.,;:-‘'”/(?&@£#)\*

Bariol
Serif R
AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
0123456789o123456789.,;:-‘'”/(?&@£#)\

Bariol
Bold
**AaBbCcDdEeFfGgHhIiJjKkLlMm**
**NnOoPpQqRrSsTtUuVvWwXxYyZz**
**0123456789o123456789.,;:-‘'”/(?&@£#)\**

*font*
Bariol
*looks*
friendly, congruous, pleasant, coherent, accessible

# BRAND LANGUAGE

strategic use of design elements and layout application

I think this project sounds a like a lot of fun –
bringing together as it does a whole gamut of skills
from autonomous control to rocket science with a very
tangible goal. Independent problem solving is that we
try to teach in our degree and it's great to see students
involved in extracurricular projects that build on that
aspect of being a physicist.

*Jeff Forshaw*
*Professor of Physics*
*University of Manchester*

Manchester Students for Exploration
and Development of Space (ManSEDS)
is a fast-growing society in the University
of Manchester.

We are a group of students who are passionate about the exploration and development of space as we all see it as one of the most interesting and adventurous challenges of our lifetime. We *design* and *build* rovers / rockets / balloons / satellites, giving our members vital *hands-on experience* and familiarising them with the full life cycle of industrystandard projects from beginning to end. Students that take part in our society are encouraged to push the limits of their knowledge beyond what they learnt from academia.

We have had an outstanding track record in these competitions with our CanSat teams achieving first place in their US and UK competitions respectively. We also run various outreach activities through which we hope to inspire more bright minds to be interested with the space industry and STEM subjects in general.

# MANSEDS

BRING MANCHESTER CLOSER TO SPACE

# MANSEDS

BRING MANCHESTER CLOSER TO SPACE

*brand language*
bold line
*looks*
strength, agreement, stability

# LOGOTYPE

applications
e.g. hoodie

MANSEDS

illustrations, e.g. for explainer videos, brochures, flyers, posters etc.
*applying colours and principal logotype*

# WEBSITE

look and feel

A straightforward, structured approach that can then lead into a flexible, yet complex layout. Primary and one secondary colour combined with black and white photogtaphy.

# WEBSITE

# MANSEDS

## INNOVATION FEST

Alumni ad Manchester Explorationis et Spatium progressio (MANSEDS) est in ieiunium-crescentis societatem Universitate de Manchester.

Tendit ad festum trillion pupa spatium industria in Universitate inducere inspiret corda sequerentur clara futura per somnium. Nos autem in brevi colloquio cum hosting speakers. We et a cogitationibus suis donec magnus ostendit nobis proficere ad praetoria nave projects quatuor.

### ROVER

MANSEDS Rovers est discipulus qui continet bigas plumbum robotics XIII adipiscing et graduati de alumni ad Manchester, UK sub progressio alumni ad Explorationis et societatem.

### ROCKETRY

A Group Rocketry in secunda scaena prototyped disposito, et eruca: powered by solidum est cibus motricium, qui non ordinent UKSEDS intravit in nationalibus rocketry competition.

### BALLOON

Mancunian Balloonian est discipulus-princeps altitudo annos nata ducitur (x) project.
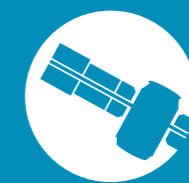
### CANSAT

Positus fabricandi consilio CanSat est terminus stat pro "possunt satellite-sized", quod est typically launched verbis sonantibus elementum convallis purus.

JANETT ADLER
TRANSFORMATION NORTH WEST
JULY 2019

**Appendix 4**

**Short brand guidelines for Case Study 4 – Remote Sensing**

**EnviroSAR**

Brand Guidelines
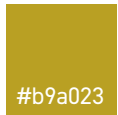
#b9a023

#e47136

#6fa287

#7c4c57
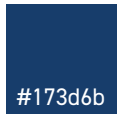
#173d6b

#ffd300
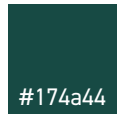
#174a44
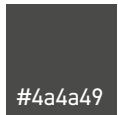
#4a4a49
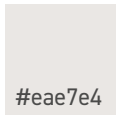
#eae7e4

#ffffff

#008c45

#002173
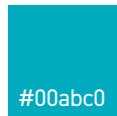
#00abc0
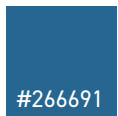
#266691
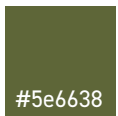
#5e6638

#b44424

| | |
|---|---|
| primary | ancient moss, flame |
| secondary | moor grass, heather |
| tertiary | tardis, tormentil, forest |
| supplementary | charcoal, smoke, bog cotton |

| | |
|---|---|
| additional | |
| BR | fern, freshwater, wetland |
| AU | deep river, bushland, roadside |

– colours –

# EnviroSAR©
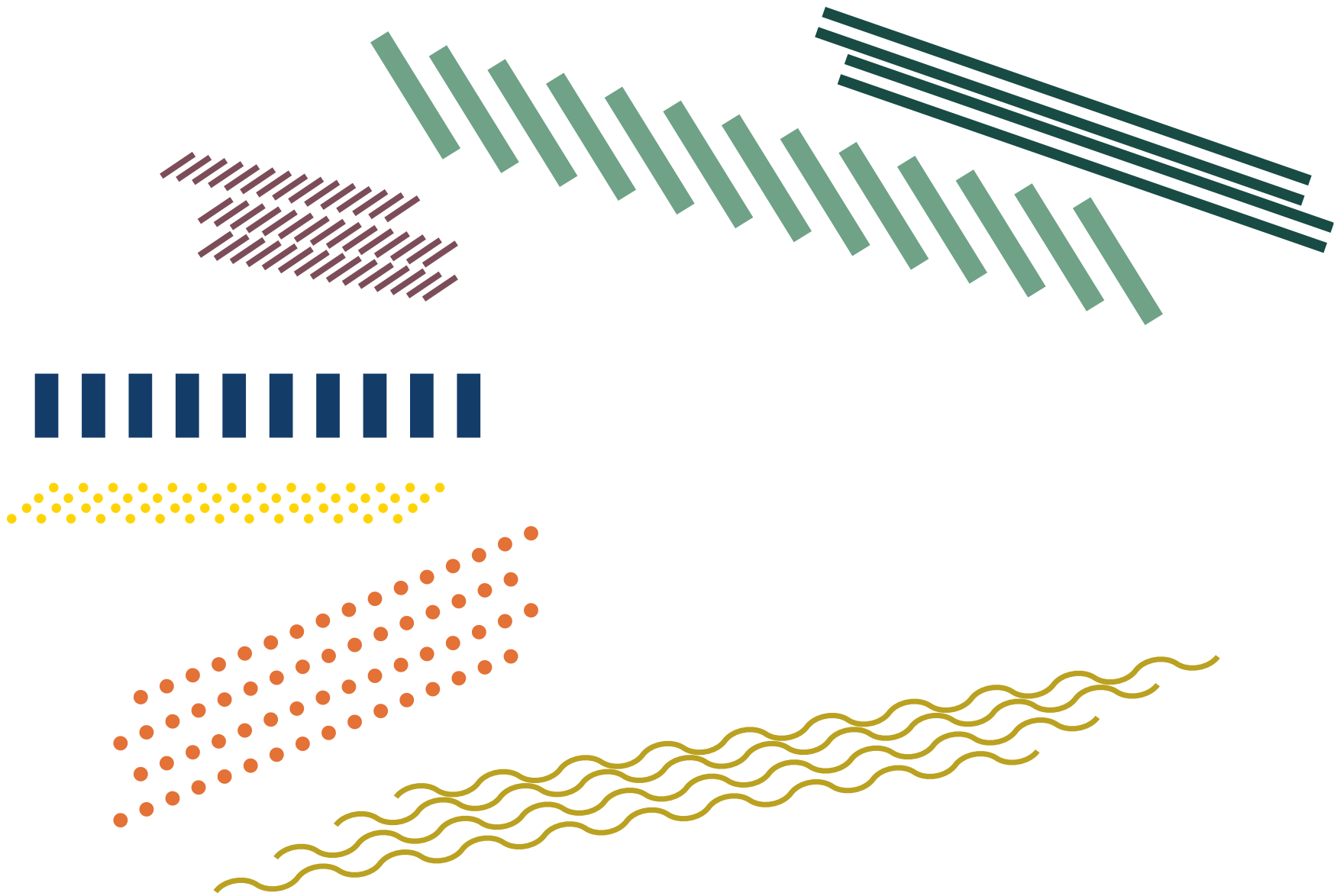
– logotype –

– use of patterns –

EnviroSAR©

– logotype variations –

– logotype variations / short version / favicon –

**EnviroSAR**©

**E**

– logotype variations –

EnviroSAR©

– clear space –

EnviroSAR©

– clear space –

– clear space –

# discover

A national monitoring and
detection tool of peat moorland
and heathland wildfires by
generating products from Earth
Observation data to help:

DIN 2014

legibility
uncomplicated
technical
straight forward

Adobe Caslon Pro

serif fonts make reading
less of a chore
timeless
sophisticated
original English font
robust texture
contrast / tension
character

– fonts –

AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:-'""/(?&@£#)\

AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:-'""/(?&@£#)\

AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:-'""/(?&@£#)\

– font for headers / large copy –

AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
0123456789o123456789.,;:–"'/(?&@£#)\

*AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
0123456789012345 6789.,;:–"'/(?&@£#)\*

**AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:–"'/(?&@£#)\**

– font for copy and others –

# EnviroSAR ©

Managing wildfire disturbance in moorlands and heathlands

## discover

A national monitoring and detection tool of peat moorland and heathland wildfires by generating products from Earth Observation data to help:

E

**EnviroSAR**©

Managing wildfire disturbance in moorlands and heathlands

– layout –

## EnviroSAR®

### Ut wisi enim ad minim

Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in.

Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulputate velit esse

molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blandit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Lorem ipsum dolor sit amet, cons ectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exerci tation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in.

## EnviroSAR – Managing wildfire disturbance in moorlands and heathlands

Wildfires are a major hazard and produce devastating environmental and economic impacts. In moorland and heathland areas, wildfires discolour drinking water supplies, release carbon dioxide and damage these unique ecosystems. Around £55 million a year is spent by the emergency services on fighting wildfires. EnviroSAR is a targeted service for peat moorland and heathland restoration and management using Copernicus Earth observation (EO) satellite data to deliver burned-area products, and will be the first national mapping and monitoring tool for UK wildfires. The EnviroSAR geoportal will understand patterns of wildlife occurrence, help mitigate the risks, target land management and reseeding, reduce water discolouration and the associated risks.

– layout / book pages –

**EnviroSAR**©

**Dr Gail Millin-Chalabi**
Director & Technical Lead

www.envirosar.com
M +44 (0)7808 894909
E gail.millin-chalabi@envirosar.com
follow us @EnviroSAR

Environmental Applications // Earth Observation Specialists // Customer Consultation // Spatial Data Delivery // Bespoke Training Services

– business card –

Janett Adler
January 2020

# TRANS FORMA TIONW

**Appendix 5**

**Creative orientation for Case Study 5 – Space Settlement**

# Constructing a Life on Mars

creative orientation / brand guidelines vol. 1

Janett Adler
07
11
19

# character inspiration

solutions

different

ideas

practical

space engineering

**Mars as metaphor**

together

impact

**imagineer**

digital construction

future technologies
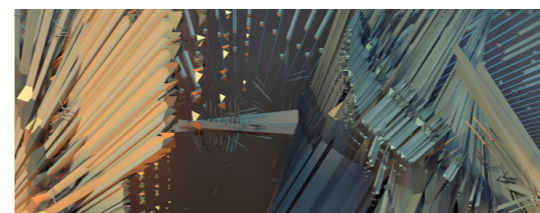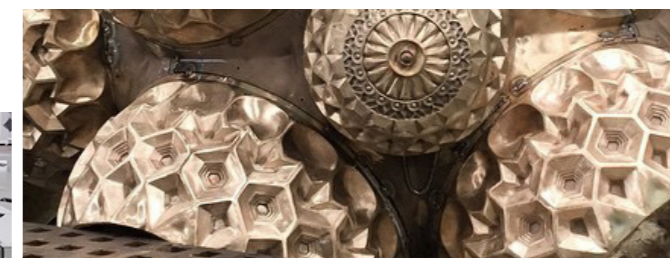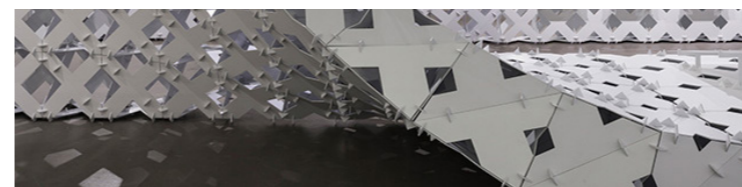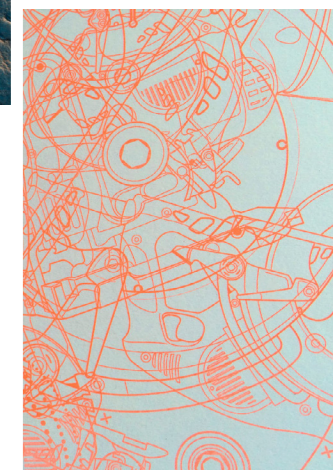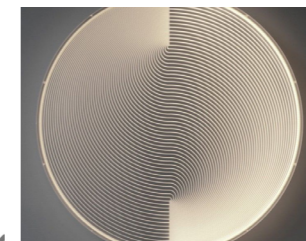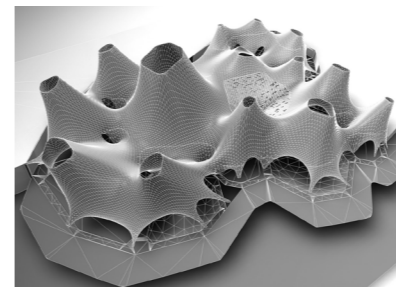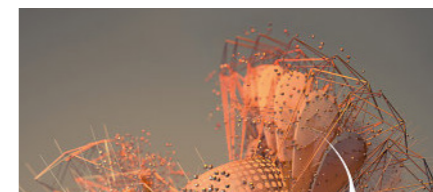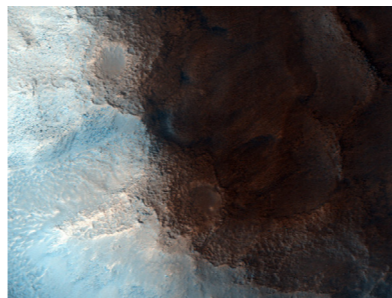
# colours

colours for main branding, enhancing and subsequent use;
including gradients for backdrops

## primary

Deep Cadmium

## primary and supplementary

Deep Cadmium

Dusk
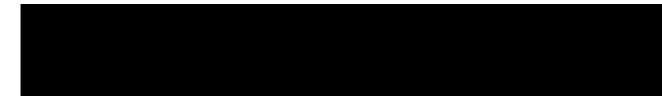
Pitch

Lightbox

**colour**
looks
**energetic, determined, encouraging, bold, open**

## secondary

| | |
|---|---|
| | Cosmos Depths |
| | Ether |
| | Reflecting Ridge |
| | Rusted Ore |

## secondary and gradients

| | |
|---|---|
| | Cosmos Depths |
| | Ether |
| | Reflecting Ridge |
| | Rusted Ore |
| | Martian Sky |
| | Martian Sunset |

# typography

fonts for copy, headers etc.

Archia
Regular
AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:–'""/[?&@£#]\

Archia
Medium
AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:–'""/[?&@£#]\

font
**Archia**
looks
engineered, intelligible, genuine, geometrical, compelling

Archia
Thin
AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:–'""/[?&@£#]\

Archia
Light
AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:–'""/[?&@£#]\

Archia
SemiBold
**AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:–'""/[?&@£#]\**

Archia
Bold
**AaBbCcDdEeFfGgHhIiJjKkLlMm
NnOoPpQqRrSsTtUuVvWwXxYyZz
01234567890123456789.,;:–'""/[?&@£#]\**

**logotype**

the logo is based on typography /
flexible and dynamic application

**Constructing a Life on Mars**

**CaLoM**

# brand language

strategic use of design elements:
bold frames / brackets and dashes
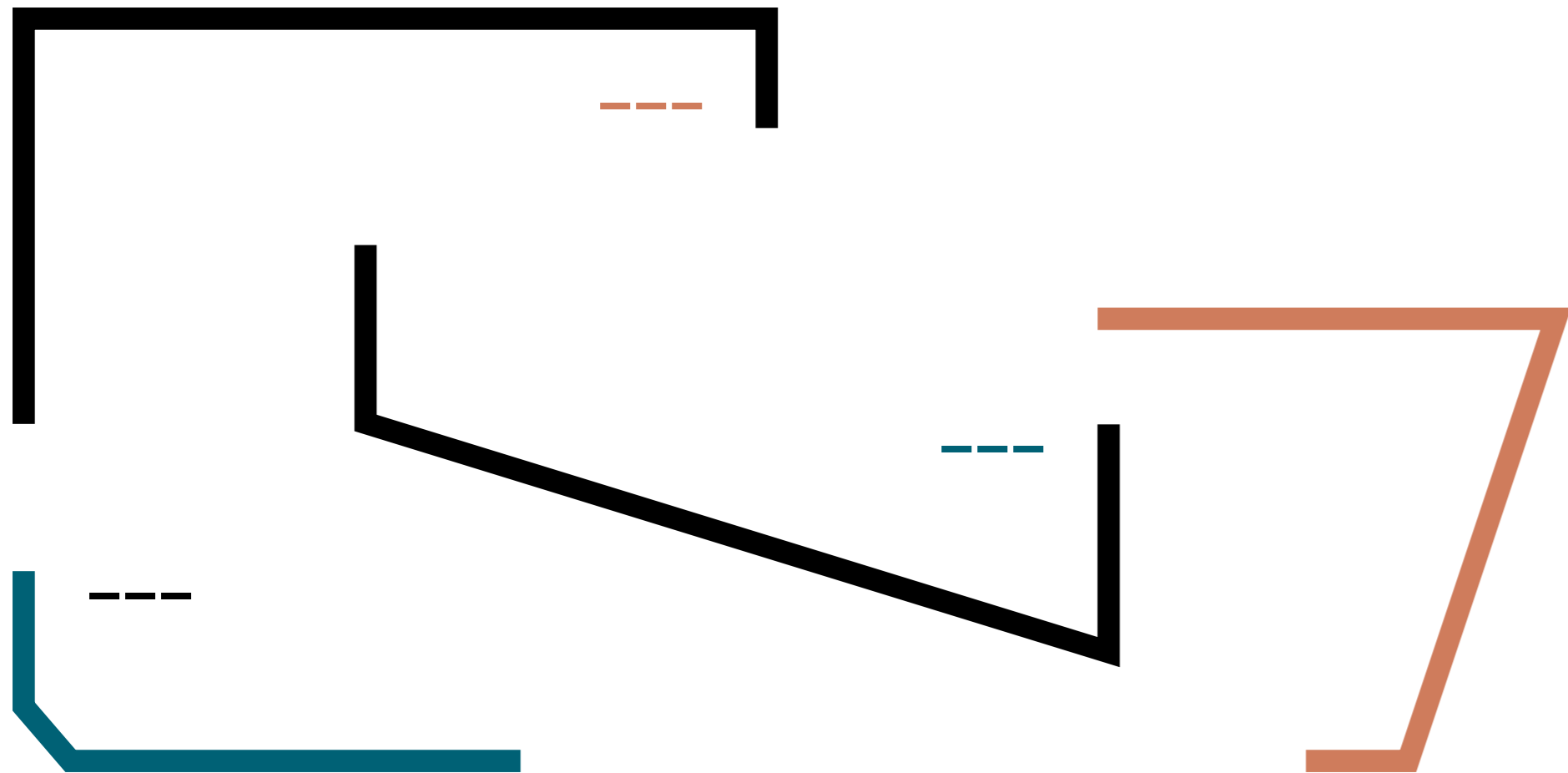
# illustration style

handdrawn elements contrasting to font
and brand language
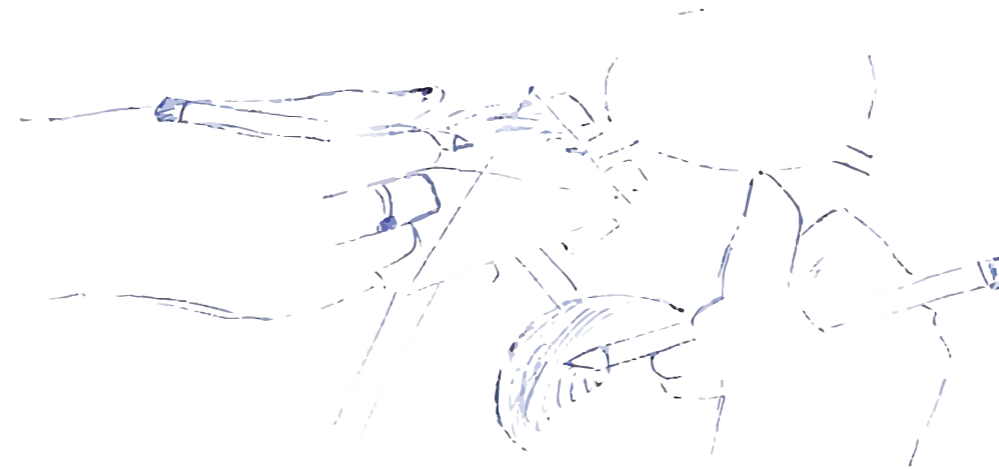
# application

example: flyer

front



CaLoM

Launching soon.
Constructing a Life on Mars ——— CaLoM
——— is a workshop that uses the scenario of
people planning to travel to and settle on
Mars to give young people the opportunity
to explore careers in the space, engineering,
technology, and digital construction sector.
——— www.calom.org

back



——— It's been amazing! All these new things
we've learned. It's crazy. I've enjoyed it.
It's actually for me a new focus to be an
astronaut just to get in on that experience...

## next steps

• complete brand guidelines for future applications
• can 4wardfutures built on the CaLoM brand?

TRANS
FORMA
TIO NW

Thank you

**Appendix 6**


**Interview transcripts**

■■■■: Would you mind reminding me what is the theme of both of your thesis so I just have it in mind?

■■■■ Yeah. I think it's different.

■■■■: So, my research is about how to develop products and services which is related to data in order to create value... in turnover and what's the role of design in there. What's the development reasons and what is the stages you go through to develop products and services, especially compared to traditional product development and processes. So my research keyword will be like processes, activities in each stages and what's the aim of each stage, what's the development reasons you have like what's the challenge you have and how designers contribute to overcome the challenges. I'm gonna ask you to illustrate the process first but you can go to explain.

■■■■: Can I ask questions? So, when you are talking about designers, like, how do you interpret designers because like we are under one design function but obviously we have...

That's a good question. Let's say... let's forget about design but how do you overcome the challenges, what's the challenge you have?

Mine is sort of like design communicating space tech innovation. So, I'm having these five case studies and they are all in the satellite and space industry. But I'm a graphic designer, so **I apply visual design to help these guys innovate their stuff**.

That's amazing.

So, **I'm applying like a design thinking process but it's not like fixed or something**, I just call it some names, but **it's sort of layered and in the end it can be different for each case study**.

That's very interesting.

**A bit like lego blocks**. It can be layers like you mentioned layers or something, **it can be intertwined**. I don't know if you're going back directly to Cambridge or where you come from. But there is an exhibition on design for living on Mars, Design Museum in London, if you have some time to spare. Ah cool, yes. Interesting yeah, ok cool. I kind of want to know more about Facebook's office, **approaches** or something like that, and **how these relate maybe to prototypes**. But my interview is not actually an interview, so what you are going to talk about is very free.

So, previously like you said, you don't really have, steps, set processes, but still do you mind to illustrate what's the key stages of your products and services? Like name them and normally how long does it take of each stage...

Mh, difficult one. Should we look over each other's shoulder? I was gonna say, I was gonna do that... [Drawing.] It's not a linear process, so I shouldn't even draw it like that. But **it's like a mess right, so it starts like a mess**, things can be frightened and then a mess **and then define** right... Should I be detailed, or...? Yeah, as much detail as possible, that'd be great. What activities you do in each stage as well. It'll be interesting to see how it comes from your perspective. We have never done this exercise.

...Ok, I think I have the highlighted ones. Oh, that is so cute. How long does it normally take in each section? It depends on the project. It depends on the project, right. It depends on the scales. It depends if you're trying to launch something from 0 to 1 or if you are trying to iterate on something or if you are trying **launching a part of the project**. Let's say you are working on, I don't know, let's say the unboarding of the project. That's an example. Well, this is not the full product, then that might affect the timeline as well. So **it can take two days**, the whole process? yes, **or it can take two years**. Makes sense, yeah. Does that answer...? Yeah, perfect. Would you mind to go through, in more detail, explain in more detail, like you checked possibilities (?), what's the aim of the things, you know all the things (?) you do have when you are going through these stages. [referring to drawing] I put at first... This is a **loop**, meaning that you for a same part of product, product in the whole of future, we **might do this loop a few times if necessary**. First would be what we call '**understand**', so we would assume, this is how what we call as part of the process, it's called 'understand'. It's very much **UX research heavy and it could include immersion**, like going **to see the users understand** the **need**. It could **include qualitative research, service, interviews**. And it could include **quantitative research**. It could be **data collection** as well. So, **understanding, the where, the when, the who** all those sort of things. What about advertisement? Let's say related to advertisement, all our spaces are slightly more complex, but yeah, or it could be related to let's say you want to work only for a specific type of user. **How do you make sure, that this product that you are building is made for this specific type of user?** You'd need to understand them fully. So, all those things could help, but you will tell more, I'm

sure. Then I have the **'discovery' process which is, from the design function perspective, more UX research and product design heavy** and can involve **engineering** as well in the process here. So in there, I include **prototyping and user (ability) testing, experimenting** and A/B testing, so 'discovery'. Then I have the '**delivery**' process, which could be like **executing on the piece and then being able to launch** it. But on the launching, I gave… So this will **apply** way more the **content strategist**. Something that is maybe good to know is that we are **not** launching **100%**, we are built to also **launch gradually**, depending on what **we want to be sure** on what we are launching is **not broken**, it will be that we make something or it's actually **working well**, so this is also collaboration with (an) engineer, deciding ok this might only be launched to 10%, so we understand for those 10% of teasers that's ok and then we gradually open. And the last phase, I've put '**monitoring**' but I could find a better word for this, but like this (put iterating), yeah **being able to gather feedback**. See, if what you actually launch is **working**, it's **useful**, **people like it**, so **it could be also a form of data collection. It could be qualitative feedback**. It could be in product feedback and people say 'yeah this is useful, this is not useful or whatever'. This whole part is on being able to **reflect on what we work on** and then to **iterate further if it's necessary**. And then iterate again… Once, you've monitored, you've **gathered enough material to understand again what could be your next step**. What do you think? It's good, you did a good job. Thank you. I agree. Go ahead, yeah. Mine is pretty much the same, even though like I draw it as a sort of a straight line but it's not a straight line, right. So it's like **a lot of mess at the beginning**, which you here are trying to either like **look at the data**: **what is currently out there, what are you you having to make of the study, what is happening**. If you **don't**, **then** obviously it's a very sort of **heavy reliance on the research**, right, to **understand** the '**what**'. If you have the 'what', you usually need to **understand** the '**why**'. So again, **where the research comes**, we do **lots of like qualitative research** as ▮▮▮▮▮ said, we **go to the field speaking to the users**, **making sure that we are building products that are aligned with user needs**, so we are **not just building** but are actually making sure that we are **solving** and that there are some sort of user problems. How do you talk to the user? Do you actually talk to them or is it all online? No, no, no, we actually go to the field, so we travel around the world to meet the users. **We go to their offices, we invite them to their offices, we organise events, they come to the events, we speak to them**. Okay. **We gather feedback at different levels**. Cool. What do you mean by different levels? So, we have research functions then we have other functions that regularly speak to clients and we gather feedback on a regular basis right. But that can be sales (events) and so on. I called it the '**unknown**' phase or the '**discovery**' phase where you have like '**data**' and '**research**'. Once that phase is sort of done, you have some sort of '**findings**' that you break **to the team**, right. And that's where like… Team means like engineers… **Everyone in the team**, so like everyone is… Different roles, right? Yes, different roles, **cross functional**. Like you guys could work together on something. We do work **nearly from the start** because I always want ▮▮▮▮▮ to have to **context** on what is happening. She, I don't wanna speak for you, but **you also want to see what the users are saying again**. So, there's different roles in each stage as well? Yes. Sometimes the team is going from the beginning to the end? The way, I think we see it, but it's maybe up to all team as we say before like processes or something that you create. It's quite free yeah. **We are all in a design function** and we all design but we have **different approaches** to this, so **it's not like it's in silo** and then ▮▮▮▮▮ would do something, then give me a report and so on and so on and then I would create design no and then I give the design to an engineer and then it would be very isolated. It's something that is… Something very flowing. **It is very flowy. If there is a need where I can jump into something that is more visual design heavy and if there is a need I can jump into something that is more user research heavy because we got the context. Obviously we are all focused on what we are strong with..** yeah, definitely but it's slightly more free. **Yeah it is very fluent**. So, **we enjoy this together**. I know you mentioned like you bring in all the people, but could you specify like what kind of job roles are joining. So our team, so yes I don't want to speak for all teams at facebook, but **all teams here are mainly made out of three types of designers**, product and strategy, research and product design, there is usually a few **engineers**, they could be full stack or back end or front end depending on the product. We usually have one, what we call **PMM** or more marketing oriented person that would help with the strategy and is also very **involved in the user interaction**. And obviously we have one **product manager, here to be the glue of all those people**, helping us to have like **one big picture** and then **strategically put the milestones of what we are building**. What might you think. Data analyst. **Data analyst and data scientists**, we actually have

two different people, that's not the case in all teams. But in all teams, since we are **very experience based**, we have one data scientist that is here for more data... analysis strategic analysing, in a **strategic perspective**. And we have one analyst that is more here for experience or **making sure that the data is related to the product and to do results**. I hope we were not missing anything. Where did I stop. Right, so... You were at the design point right? Yes so, why I put like 'design' here because like Marine actually comes in, like I said the '**findings**' and then **starts to sort of design or create like our first mocks that are then sort of tested with the user**. So again we are involving user at this sort of stage of the **process where we are trying to go from one prototype to another one**. I don't know, **how many do you have to actually create before you go to** like euh. Once again, it depends on the project and the skill. Yeah but again, **we do several groups here and involve the user**. So that's what like it's slightly messy here because we have to go again, then end of... And then we involve an '**engineer' who actually builds it** and then we sort of **iterate** it or **monitor** it, while like we want to **make sure that the user experience is good** so we **don't want to launch at a 100%** but we **start with a smaller audience**. We do like a sort of AD test and **look at the data**... So, you said that you bring data analysts and data scientists at the stage of 'design' but yes they aren't managing really big data I think and if you start the project, you normally are using the data, manually collected data, like doing some observation or like a survey kind of stuff. Is there any involvement they can actually contribute more with that data? So we have some internal data basically. Qualitative data more right? No. So data analysts or data scientists deal with like quantitative data only. So my question is if you start the project, you would normally have more qualitative data, if think about the design approach like observation or like interview kind of stuff or focus group or user study mh that's interesting because they are data scientists I guess... but if anyone else has joined, then they more like deal with quantitative data right. Yes so, it depends on the project again. So we always start to look at what the data is telling us, all the quantitative data right because that is driving some sort of direction. Obviously we have say the different roles like the PMM who would do some sort of strategic thinking. They might say like oh you know **this is like happening in the market**, we should go explore it and then **that's where we would gather the qualitative data**. This is then again dependent on the project like what we are trying to achieve with the particular project. So there is like not the right approach I would say. May I ask you what PMM is? It's marketing manager. Project marketing manager. So they look at what is happening in the market, **look at the strategy**, more of a high level sort of. Maybe to add a little bit on the data scientist or the data analyst. They are not... I am not considering that they are only collecting data. **They got an approach that is very user-centric in the sense that they are able to understand what type of data is important or how to create the model to actually collect the right data so a score to evaluate something or the right matrix that would evaluate another thing**. They are not only gathering stuff. Actually they should have strategy about data. Exactly, yeah. In that sense it feels like research and data analysts are working **very closely together** because some of those 'findings' are based on their abilities to align on what they are looking for **collectively**. Am I correct? Yeah. Can you think of any challenges like at the first stage, when you were working with data scientists or data analysts? **Messiness** or **amount of data involved**. I think we have individual challenges, right. Like working together, so we always **try to find** a **representative sample**, making sure that we are speaking to the right people, and all those things which is sometimes difficult right. Then reaching the audience and things like that, so I guess those are the practical difficulties, but then like we have, like each of us has like different challenges like for research for example, you are getting **into the unknown**. Like you can have like an interview script but when you are getting over from the conversation **there might be new themes that are emerging**, things like that. **You don't know which steer is it gonna take**. So I think then that's what I have to look after like **after like five interviews** and see, **is there anything interesting, is there anything that we should explore, to look at**. And that happened like **several times**, so like during the research project, it's like a completely **different spin**, because we found something relevant to research data... That's a really good point. And data is probably facing something similar when you would assume that those are the information that you are looking for but like **collectively then you discover that it might be something else or you might reorient what you were looking for**. If you think something, of a very challenging project, previous challenging project, I know you only worked over around one year here but if you think about like a really challenging project, then could you explain what challenges you faced in each stage? Which one was the... Which one is the most challenging one? You can, if it's

not confidential, you can explain a bit of the account of the project. That's probably confidential, but I can try to explain the challenges by saying general. I think I will not talk about the one I think of but maybe the other one. Ok. Mh the challenge is... in understanding you say? it could be when you're not sure what you need to understand. it's more related to the... **So you're discovering stuff and then delivering stuff and then monitoring stuff and then realise that it's not going exactly the way you think but it does not come from a bad understanding, it does come from us not being able to see what we need to understand**, if that does make sense. Is it related to defining the right problem? Mh, it could come from different things, it could come from, ... we are in a big company and **one of the challenge that we are facing as a really big company is alignment on information and the context that everyone has**. Because we are so in each **work on different things** and then **sometimes it overlaps and sometimes it doesn't**. And the challenge is to have **everyone** sort of **on the same page**. And this is a daily work. I think, we've grown both a lot working with that challenge in mind and this has an impact at different stages of the project. So, it could be 'delivery' is easy, it could be like oh between design and engineering there is a gap between what design was expecting to be built and then what has been built. 'Discovery' could be: we thought it would be this piece but actually it's like this and it's involving more work because we didn't cook out well the things. 'Understand' could be oh we thought we could work on this but it's not what we're working on and this has an impact on the line and 'monitoring' could be oh no one actually put the **structure** in place for us to monitor or things like this. And then, so most of this, correct me if I'm wrong, but most of this is **a lot of communication** yes and this is affecting the... And I'm **not sure if I've seen this in other companies I've been working with at that scale**. Yeah I guess it comes with as you said in the beginning this is like a big company. You're not working on the project, **you are working across multiple teams and the communication gets lost**, right. You have **different functions, you have different teams, you have different projects**. And trying to manage it on a daily basis right. So... I'm not sure what is the scale but to give you an idea. There may be around **100 people I'll I interact with every week**. So that's a lot of different people with different function, with different context, with different teams, with **different goals individually**. Do you also work with somebody let's say in Austin or something? Not Austin but we have teams we work with in San Francisco for instance. So I could imagine, so that's the head office, so you have to always communicate. Yes, on certain projects, yes we do. It's mainly with them? Mainly with the Californian office, not with the other smaller ones? It depends on the project, it might happen that is, we have a huge team, so that is based in Seattle, a few teams are based in Singapore, sort of related to what we are doing as well. Ah ok, so it also depends on the project. Yeah it depends on the project, but it doesn't necessarily mean that we have to communicate with someone in one location. Well it depends on the project and on what we are trying to do. So there might be more of a certain role maybe in Singapore or something. Possibly yeah. Ok. In all things we are less affected by this but there are a few teams. I am thinking of a few teams that are actually split in two. So they literally have the same goals and the same alignment but they are, one in London and one in Menlo Park. Yeah ok. So we are not affected by this much but it happens. Thank you. Did you go through any like challenges each stage as well? I think ███ mentioned, and I mentioned quite a few times since the 'discovery' where right it's like **you don't know what you are going to find and which direction you gonna go** and I think that's the biggest one for me and then there are like small ones like with research, you are trying to make sure that the **findings are representative of the users**, right. And that we are **telling the right story** and then **the story lands with the team**. Yeah, so it's, I mean there are like different challenges. You have **timeline challenges**, right, you are working under strong pressure. Can I add another challenge. ja **Processes: it's very freeing**. And then **making us very autonomous and independent and then being able to make our own choices**, **but not having processes and having to create it yourself could be also something that is creating blockers**. Because if you didn't create that alignment piece on how you gonna do things with your team, **then the day where it happens where you like trusting each other to do the things** but you are not aligning your processes, then nothing is happening. So yeah, I agree it's linked to communication but **processes are pros and cons at the same time**. Did you go through all those stages or challenges independent. So that one, prototype, testing. I guess with **testing and prototyping, again you are trying to gather feedback** from like a larger audience, so you can be like actually make the decision whether this product is going to be bold and making sure that the feedback is I guess representative of the audience. So, at some point they need to get to a conclusion and say yes this is

what most of the people say right and the feedback that we gathered and we can go with this sort of decision. And that's challenging as well right. Like **you make the call**. And you are trying not to make the wrong call, if that makes sense right. Then we obviously monitor and have to see if there is anything we need to review on that but yeah it's tough. How would you manage the challenges in each stage, how would you define... So you're getting representative audience from both sides, making sure that the sample is right. Do you use any criteria, do you build or...? So, I mentioned that I work with like **the data here to get representative sample and the deadlines are gonna be tight** whatever you do, so again like **making sure that the findings among the team is important**. I think **close collaboration across different functions** is important and good communication with everyone. Just to make sure that everyone knows what is happening. Yeah, I don't know. Mh, that's a good call like something that is part of the facebook **culture** also, it's **fairly horizontal**, so no one is telling us what to do which is also **great and scary** at the same time but at **each stage you need to evaluate**, if you're like as you said, doing the right thing and **checking with your peers if actually you are collaboratively doing the right thing**. Yeah. ████: And sorry, where does both of your work lie, I guess in terms of stages, like are you more front end or does it really vary. It varies. So it's based on the projects but what we try to do with, so we don't have that many, I'm speaking just for my function right. So we don't have that many researchers and there is always more researchers needed right. So we call this like let's say the strategic piece here, right. Like you're already finding where the, what production we built and so on. So most of the priority, ok this is giving the priority but we balance it with this piece as well because we need to make sure that **whatever the outcome out of this strategic piece is**, then it's again like **being tested and then built and iterated upon**. So I guess it's a very hard **balance** between these two. Between like the **strategic work and the tactical work** and the strategic work and the bits the tactical work, so this takes more time right. So this is giving always the priority. This is for your job role, that this takes more time. Yeah, probably yes. What is interesting compared to other companies is that I have worked with, that **this part is actually as important as the other parts** and there is this thing where once the problem is corrected, correctly... how is the monitor ready **if your problem is correctly phrased** or the sentence correctly defined? **defined**, then it's **already half solved** and we are probably doing this better than other companies, meaning that **we spend a lot of time on defining really what we have to solve before jumping into solutions**. So **once we are there we are actually more confident that we are building the right things**.

I think I've done most of the questions but I missed the one question by asking you about your job role and the challenge you do at the beginning of the interview, so would you do that now? And your name and your position.

Ok, shall I start. So, my name is ████, I am a product designer and my role is to help the different people around me building the right solution for the right users. It involves a bunch of different things from strategies to prototyping and visual design. Visual design probably being only 10% of my work and all the rest being able to understand flows, narratives and storytelling behind the experience. That's it.

So, my name is ████, I am the user researcher and what it actually entails is to make sure that whatever products we build are aligned with user needs. So, looking at the space, like the problem in general and how can we sort of interpret that into product. But it doesn't necessarily mean that we like find a problem and then we jump into like building something right. So it doesn't say that's the case. It's just, it really depends. But yeah we use like different like sort of qualitative and quantitative methodologies to extract those insights, making sure that, everyone in the team is aware of what the user needs and problems are and that's even like with for example again engineers in fact they are thinking of some sort of solution. They just don't say like oh this solution is something that we should do but they think about the user problem first and then they see how the problem can be fixed with some possible solution if that's the case.

Can I just add a couple more things? Yeah, go ahead. So, if you maybe out of your past experience but if you would ever deal with external agencies. If you compare this kind of thinking approach or something, like you say, it's layered and it can have loops and stuff, it always comes around, but and

I am studying more on innovations, how, if you maybe compare to like what other agencies are or maybe even advertising agencies or design agencies or something have in place. And how do you think how effective is this to nurture any innovation what facebook does? Let me think of this... What do you take of, do you... I think we earlier discussed over... that you might take as well maybe like the Stanford design thinking process or something, you can choose yourself, take elements of certain thinking processes for your own team at that time maybe as well, so compared to that or do you choose that. If you want to start go ahead. To be... Let me think of a project where we **I think there were a few layers here...** Yeah. **that might effect you as an individual, as a team or as an organisation or even at facebook level that could be very positive or that could actually effect innovation.** The fact that we are very independent and everyone trusts each other to make the right call or the right decision overall. First of all some sort of innovation, first of all to **see things in a creative way** or **to allow different perspectives, to be open**. So this is pretty positive. And the more challenging part: this is an incredibly challenging company with a lot of scrutiny, with a lot of challenges, and this **might create fear of innovation because innovation is breaking something that you know is working well maybe or changing things radically but for what?** This might be a challenge. What do you think? Yeah I guess, I think you touched upon a few things that I was sort of thinking about, is like **for innovation you need time**, you need time, **you need resources, you need this sort of headspace** that you might not always get, right. And that could be that barrier towards innovation. But like, we try, how we try to sort of force our innovation is I guess it's like each function has different sort of viewpoints on certain problems or a certain area and us coming from different backgrounds and different functions, is, and **getting into a room together, I think we are able to come up with solutions that are creative, that are again aligned with our user problems to our user needs**, right. And we do this every three months now, that we would get together but speaking of our role right, we meet every week right, for like team meetings and things like that but thinking about like strategic stuff, it would be every three months were we sort of sit together and try to refine our strategy. And is that the overall strategy of facebook or for the team... yeah **for the team. And once again, this is very horizontal, so there is no seniority or genority that would make your voice more or less loud** and I think **this is a great space for innovation in that sense is that any point of view will be taken into account.** So, it's **very co-creation.** Yes it is. And then **we like to build on each other's ideas**, right, like once the person says something is like oh yeah but also... you know, so it's a very good, again it's a **good way of coming up with some sort of new products or new features** that you know we are going to...

And may I ask you, what is your personal definition of innovation? Do you have anything that comes to your mind, spontaneous? **Disrupting the environment in between opportunities.** I think that would be my form of innovation. Well I would say probably **any form of change that would hopefully improve an aspect of form and society.** Something like this. That's cool. Thank you so much.

And can I ask you just a few points of the visual design aspect of your innovation in facebook but also within your design kind of approach. It's very quick, you can just say yes or no or you can say a sentence. I know you only said you only do that 10%, visual design. Probably something like this. But I see the whole office is really visual, I think that's helpful. I think you do more, come on. A little bit more. It's a very good environment. It depends what you mean by visual, because could be visual in yes I am creating interfaces. But it could be **visual meaning**, I am helping my team visualise the things we are looking for and those would not be just web interfaces, it could be also, diagram, charts, **any scheme that would communicate**. It's whatever you define as your own visual design. Exactly. Yeah, so in that sense, maybe I am doing more, you're right.

So how do you think visual design helps you in your innovation, in decision making for example? Uh. Do you think it helps or it doesn't? I have one example. Sorry I didn't want to only ask Marine, but I thought she was more of the designer, so... Mh it is a tough question, because the thing that I love doing are related to systems, I am very much about logic and like in how things are like because altogether. Coming together. And **I tend to see visual as the cherry on top.** Where things are so clear in my mind, I can just open my computer and doing **almost in one draft**, this is more or less my approach and I know that a lot of other designers even here at facebook. This is why I don't want to

make it too generic or **certain things through visual design**, meaning that they will make different iteration and then through this **different iteration, they would understand what they want to get out of this**. I think just specifically to your example, I think who would, I guess Marine's visual, **we can create some sort of understanding across the team, as the environment again is like very complex** and it just helps it's she is like being some sort of like diagram or anything right, even like MBP right. So it might help here already. Eh, yes. And then the prototype as well… That is true, **I definitely help research to visualise the result of the first pitch**. Not even that but even with your sort of understanding of like what does facebook look like or **when you create some sort of a prototype**, you, I think **you bring the team together and everyone can provide their feedback**, so I think **it's very critical to have some sort of visuals**. That's interesting that I am not considering all those aspects as visual but they're all in a way.

Just a list of a few things, it can be very short as well. The second thing is just like the first thing. Do you think visual design helps in problem solving as well? Yes. Yes, in that sense yes.
Do you think it helps articulating your ideas, I think Radka mentioned how you articulate something. Do you think, actually visual design helps in your whole company's presentation? It does. You like this kind of environment? **I think it does, especially with that skill it's important to, like through visual we communicate ideas or values that we are all sharing collectively**, so yeah.
And do you think visual design helps in **establishing partnerships**? Oh definitely yes.
Do you think it helps engage people, maybe like not partners, but like employees mh what do you mean maybe newcomers or engage people with other stuff. Yeah it could help. **The situation where it was newcomers and the fact that you have some sort of visuals to display how for instance we work in our space** your idea you something, **how does it work**.
And do you think it helps you enter new markets, maybe if facebook, I don't know how you get another app or something, maybe even to enter something new Sure. what hasn't been done before… **Designers here have uncovered new business or user opportunities**. That's good.
And just two more. Do you think visual design helps differentiate yourself from competitors. Oh what do you mean by competitors? Maybe other social media companies, it's mainly focusing maybe on branding here, personally, but maybe you mean something else. Yes it does. But let me be slightly more precisely. **For two almost identical products or services are considered the delights of visual design can make the difference on people being more comfortable using the one or the other**.
And do you think, I mean visually, it even helps improve the quality of an output, any of your, what you team is working on. Yes, do you think it helps in the **quality** of things? I think so, **I hope so**. Thank you very much, thank you so much, thank you for all of your questions. Thank you. Thank you, I would say, I found it really interesting…

How important is innovation to your company?
Innovation is really impotant to our company, essentially we wouldn't exist, if we didn't do innovation. You know what, we are trying to create some new value from nothing and commercialising that value – so that's a big part of innovation. So I would say, innovation is a massive part of Red Ninja.

Does it play a significant role in developing new products and services?
Innovation plays a significant role of us developing new products and new services. Yeah, it's fundamental to the development of these products and services, if we didn't do this, our business wouldn't exist.

Do you have any innovation processes already formalised at work?
Yeah we've got, I guess we use several innovation processes which you will know about. I guess we use the design thinking process which comes out of the d.school in Stanford. So that's a big part of what we do, I guess you could call it human-centred design as well. We mash that up with a bit of 'lean startup' methodology, which is kind of you know, creating the minimum (amount of) viable products, getting feedback and incrementally building on top of that. Early products or prototyping until you got a product that you are happy with. So we like of kind of start quick, build something, get feedback, iterate and just go around that loop. I'd say they are probably the to most important innovation processes for us.

Do you think this applies to visual design? Any vis. des. what you like, whatever catches your eye. So, does design help in innovation processes e.g.
• in decision making?
Visual design we are talking about now. Yes. Yeah, I guess, I've always been a keen advocate on the benefits of visual design. Maybe just because the way I am, I am more of a visual thinker, I struggle with lots of words on a page and whenever I'm giving a presentation it'll be mainly images, so I'm more around visual communication than necessarily written communication. So yes, it does play a big part. I think, if we can visualise some of the innovation which we are aiming to create or implement, it helps people get around the idea of our vision. So, we've used visual design via animations, infographics, brands for logos... And I think when people see this sort of, the detail of a sort of, around some visual communication, it can help them have more faith in an innovation process and then buy into, perhaps a product or service that doesn't exist yet or they've kind of seen it. So they're saying, see it to believe it, I think there is some merit in that.
So but do you think, visual design helps you with decision making processes (I have a list of stuff, so it's just like...) So I would kind of just repeat what I've just said, visual design does help with decision making processes. The most important decision making process is normally around resource, can we dedicate resource to this innovation project? That might be (an) internal resource, or that might be an external resource and we would always use some sort of visual communication or visual design to try and divert resource in the right way or you know to get the decision that we want.
• do you think it helps with problem solving? Does visual design help with problem solving? For me personally it does, being a kind of visual thinker. It's aehm, if I can see something, it's easier for me to understand it. I am somebody who is... I am dislexic, so I struggle with big chunks of text, my mind will wander, it's very difficult for me to read a report. So, if we can have something more visual or something broken up in the right way, into more managable chunks, I am more likely to engage in it and I'm more likely to read it. And I think a lot of the stuff that's impacted me, from you know a learning or education context, probably throughout my life, is it always had some sort of strong visual design element to it.
• (I think you've already answered this.) Do you think visual design helps in articulating new ideas?
Yes, I think visual design helps to articulate new ideas... It's so much easier to maybe develop a visual design of some concept, rather than you know create those concepts physically. So in many ways, a visual design can be the first prototype of a new product.
• Do you think it helps in improving your company's presentation? 100%. Yes.
• Do you think it helps establish new partnerships? Yes. So I think, something I have always done over the years is, trying (to) create a clear and strong brand, maybe online brand or print brand around a new business or a new project and I think if, often if you look good, people trust you more and I think

that's all around the power of visual design.
• Do you think it helps engaging people, also others... like your own employees and stuff? Yeah..., visual design helps engage people, both internal, stakeholders, employees and external stakeholders and employees. When a lot of the work which my team does, is unseen for a long time, you know it's not like my team are building a car or an aeroplane, where you can see the steering wheel might attach to the, I don't know what are they attached to(?), the bonnet, no, the aehm floor or the seats might attach to the floor or the window might attach to the door and you can kind of see it come together. The products, that we make, are generally digital. So most of the kind of content, or most of the Intellectual Property or the stuff that makes a digital product is code, it's difficult to see and if you can't see it, you can't understand it. You know, it's difficult to know, is a hundred lines of code better than ten lines of code, it's above all very subjective. So in our sector, you get long periods of time, where you can't see any progress, so you know, it's all based on kind of trust and stuff like that, but if you can visually communicate some of this stuff, which you are making, it gives the team more confidence, that this is a real thing and it's happening.
• Do you think, a visual design output helps you enter a new market? Do I think visual design could / will visual design help us enter a new market / any output? Brands e.g. Got it. 100%. Visual design helps us enter a new market, this could be a brand, it could be some animations, it could be a website and the slicker it looks and the better it looks, the more confidence the new market has got for you. So I have no doubt, that when we enter a new market, whether it's a new country or a new sector, one of the first things that people will do is google – us, google the company, and then..., that's all visual.
• Do you think, it helps you differentiate yourself from competitors? I think this has been one of our big strengths over the years. So I'm in the tech world and I think it's changing, you know, I'm seeing a lot of chief design officers in Silicon Valley and design thinking's kind of become a thing over there but in the UK most tech companies were kind of engineer-led, so they were quite traditional and they didn't care about visual design and you know, you can look at some great companies with great people but they look like, their website is still like they're in the 1990s. So we always took a modern approach and wanted to communicate in a understandable and kind of plain English and fun way and I think, that's, we did that through embracing visual design earlier on, even before we'd perhaps got much else besides the company. So I think it's something good to have in the DNA of your company.
Ok, great.
I've got two more questions, but if you want to (first finish eating)... No, I can carry on. Ok. • Do you think, visual design improves the quality of the output? Aehm, probably sometimes. I don't think there is a yes or no here. I('ve) worked on products which have had the most amazing visual design and branding, digital kind of communication assets and the product failed. Or you know kind of failed to a certain extend. So, not necessarily. Aehm, I think a lot of it is down to the people, the people involved. But it can help, aehm, galvanise teams and act as a catalyst to bring those teams together but you know ultimately you need the right people.
Thank you.
And lastly,

how do you define innovation? Your own personal definition of innovation. How do I define innovation. This is one of those words (isn't it), you use all the time and I... have to sometimes google this stuff by myself. You know, what is it? I think for me innovation is, it's around creating value that doesn't already exist and implementing that value, so you kind of have a positive result. There is probably a more succinct way of explaining that, but I think innovation is about actually having an impact, so it's not research, you know I think research is a lot for the academics. You know (they...), we could go research a certain area or a certain topic but does that actually have any impact on the world? Does it create wealth, does it improve someone's life, does it improve someone's health? If it does, if that research does do those things, that's innovation. If it doesn't, it's just research for research's sake, so yeah, it's implementing new value that doesn't exist in a certain area to create value.
Thank you very much.

How important is innovation to your company?

Very important; innovation is at the heart of absolutely everything we do at Asteroid Mining Corporation. So, I mean… We are an innovative company from the very exit(?), Asteroid Mining is an industry which doesn't exist, so by… essentially everything we do is based on innovation and innovation is at the very core of our being. Once we've actually progressed through the start-up phase, then innovation will be less important but for at least the next, sort of two to three years, innovation is the core of all our work business and…

Because you are the first one as well…

Yes, we are the first people that try to mine an asteroid in the UK, so it has to be innovative…

That's amazing.

Does it play a significant role in developing (your) products/services (innovative processes)?

Yes absolutely, I mean, because we are the first asteroid mining business in the UK, most of the things that we do are based on innovation and based on sort of identifying new processes and new sort of technological opportunities… and by sort of having those opportunities and by taking advantage of them, (like) innovation is so critical to that, because we can identify markets and opportunities which are just emerging, and then by it being innovative and being open to those innovations, then we can take the advantage of them. So that's probably one of the more improtant parts of our project.

Are innovation processes formalised at work (already formalised, or still in the process)?

I wouldn't say it's formalised but, I wouldn't have anything in particular qualified or written down, but (I mean) all our innovation processes are based upon, sort of, the technology that can tell the satellite and **a lot of the time the technology development becomes clearer as you sort of progress the project, so when you realise that you need sort of to set an implementation(?), then you start again to think about a different approach for that**. Things like that, but it all… **it's not an immediate process. The innovation sort of presents itself as you go along towards the project.**

Does design help in innovation processes in
• decision making?

Absolutely, I mean, essentially, because at the minute we are looking at an investment brochure, so that has to be all designed by focusing on the design elements of that; that is what makes it visullally interesting, that's what makes it sort of engaging, direct to its audience, to its target audience that is investors. **So the design that defines this is absolutely critical to the wellbeing of the business and the overall technological development as it depends on good design**.
• problem solving (when you want to resolve any proplems)? Yes.
• (when you want to) articulat(e)(ing) new ideas? Absolutely.
• imrproving your company's presentation (e.g. branding process)? Aha.
• establishing partnerships (elaborate with regards to the investment brochure)? With the design led approach to the investment brochure, what we have to do… **We've already done the technological development for the innovative and technical side of things but we then need the design to come in and make that technical innovation accessible to the investment community.** (So) **By having accessible innovation and by breaking down what we're doing into manageable, understandable chunks, then that makes things a lot easier for sort of the overall project, just by being with potential partners and say to them, this is what we are, this is what we are doing, and this is the way we expect to do things.** So it's all a bit sort of that work of opportunities / of capabilities.
• engag(e)(ing) (these) people? Absolutely, **I think design is absolutely critical to everything that we do**. Because, at the end of the day, **with good design with an innovative, exciting company,** if you're not well designed, if you don't look good, if you don't have a good corporate identity, you're not as interested in any(?); **if you have a good corporate identity, if you have a well designed product** and you have a well designed investment brochure, **then that makes it a lot more compelling**, isn't it, **it's an opportunity; because it reflects the ability of the company**.
• entering (the) new market(s) for you? Yes, I would say so. I would say design is … we're looking to establish the market, after all, so, by sort of breaking that down, sort of show the design steps, the innoavtion, then by obviousely taking that design element and **showing the innovative steps we are**

**taking as a technical company**, by breaking those down, **using design, and by sort of by making that more manageable and more understandable, then that obviously helps us massively as a company**. Especially as we are looking towards gaining investment sort of (person?).

• differentiation from competitors (outside the country)? Absolutely. I mean, we are, as far as I am aware, the only company in the world, which is looking at, sort of first data mining and then looking more towards the platinum side of asteroid mining. As far as I'm aware we are the only company that is focusing more on that. So the others do more like water or... They're all focused on water extraction, they see an economic viability in water extraction from asteroids, I don't personally see... I believe if you're looking to mine asteroids, you have to be looking at the shortest, largest to ton, we are talking about x 15 your timescale for development anyway. For a 15 year development like I've said, you are going to need to find something which is economically viable in that time, and I don't think water is economically viable in that timescale, but I believe that platinum mining is.

• (a creative imput will) improv(e)(ing) the quality of (your)(the) output? Absolutely, I mean creativity is very much in the heart of what we do (laughing), I would like to think, we're a creative company, so, by having sort of like creativity and **by having that sort of creative design element to what we're trying to do, I think it absolutely adds value to (sort of) our project**.

How would you define innovation? **(Laughing.) Struggling(?) to do things which other people have never done before.**

Thank you so much. Ah my pleasure.

How important is innovation to your organisation?

Oh… **It's crucial. It's one of the most important things. Without innovation – I don't think, we would be able to do anything. Considering that, everything we do is very novel and new to us. So, yeah, we innovate every single day, when we work on projects – we come up with new solutions, we brainstorm, we are expanding horizons.** So and I also think that innovation is very important to the space industry as well – as a whole, '**cause space is something that not many people / organisations do. So every time we do something, well most of the time, it's doing something completely new.**

Does it play a significant role in developing new things, new projects, new products/services (innovative processes)?

Yeah absolutely, I mean, **I cannot honestly imagine coming up with a new thing without innovation**… It makes sense. **It is nearly impossible to do something without innovation, if something new is created without any innovation whatsoever, then it's just mainly putting two things together, without actually changing anything. Maybe that's in itself new but, you know, the core elements haven't changed.** That's right.

Are innovation processes formalised at your work, the things that you do?

Yeah what about them? Are they formalised / actually happening or still in the process? Ah, yeah **we do follow the engineering project cycle**. **We do start with looking at the mission, then we look at what our design has to fulfill in terms of requirements to be able to perform that mission. And then we can brainstorm from there.** Let me just clarify, when I say design, I mean engineering – design, not graphic design, which has a bit of a different definition. Do you want me to explain right now? If you want to. Engineering design is essentially designing not only how things look good but also **how they work, how they perform in their function**, like this one(?)… Function. **It is a kind of a formal process, to reiterate we look at the formal mission, we derive the requirements, we brainstorm, then we come up with initial designs, we look at feasibility studies** – so is it possible to do it from all different sides of the spectrum, from electrical engineering to mechanical engineering to software engineering, all those things. **And then we try to kind of piece them together. There's a lot of nail-biting (?)** in the engineering process as well, because obviously something may be perfect on the mechanical side but might be extremely hard to cored **(?)** in the software side. So, there is always this back and forth, especially when we are doing something completely new.**

Does (creative) design help in innovation processes (just imagine e.g.) in
• decision making? (e.g. what I am helping you with at the moment – brand guidelines etc.)

Let me think about this one. I do think it definitely helps. **The most obvious benefit is that it helps attract other people who maybe able to provide a fresh insight into the process itself. It may also create a clarity of who we are and the clarity of purpose of what we do. This is actually a very important thing in engineering, like prioritising…** – what is a priority at the moment – is it – how it looks like, is it – how fast it goes, things like that. While, like Graphic Design in itself, doesn't necessarily influence the final product that much. It definitely provides this kind of clarity of, ok **'This is who we are, this is our brand, this is our organisation, those are our goals'.** I do think, it's kind of important to create this, again, clarity of what their organisation is, and because of that other goals become more apparent, so… I don't know if I'm explaining it correctly. Yeah. No, absolutely. There will be a few more things on the list, so it's not just that… So it's just supportive, part of the actual outcome. Yeah absolutely. **Another major advantage of having this sort of creative process, is that we will get to communicate what we do to people who may not exactly be, you know, technically knowledgeable.** And half of the time it's just pure technical language, which is something that my organisation really struggled in the past. We couldn't, we tried to invite people from non-STEM (forces?) into our organisation, to ManSEDS, to I don't know, with say the accounting part, or maybe managing inside or like PR things, but it was very hard to explain to them what we do and I do think that, you know, **a picture tells more than a thousand words**. It's definately easier to just show something than try to explain with words. I agree.

• does creative design help with solving problems? Or is it a similar answer. Not directly, but I do think, they utilise the same skills, **so if someone is in creative design, they actually tend to be better at coming up with solutions. Just because they have this, I don't know…, synopsis connections in**

**their brain.** But yeah, I do have some people, because we do have alot of group projects in our courses and people to think they usually take on tasks of actually putting it together, in like InDesign or something, that people actually create the layout, those tend to be the most creative thinkers when it comes to engineering processes as well. That's interesting. I do think, that just the creative part is what is really crucial to the engineering process and to coming up with a 'good' innovation (can I say that?).

• Does it also help to articulate new ideas? Oh, absolutely. Absolutely, if..., yeah I cannot even stress that enough... if someone can express anything, like a graphic performance (?) **even if it is just data visualisation, like picking the right colours, picking the right tables or whatever. They are usually much better in explaining things as well than a person who just slaps an Arial black and white table...**

• improving your company's presentation (I think you already answered this)? Absolutely. It's the most important thing.

• establishing partnerships (do you think it will help finding sponsors or something, funders...)? I do think so. **I do think that the creative design will definitely help with brand recognition which is very important a world where we**, you know, **strive to get as many sponsorships as possible and companies want to**, you know, **get something in return and if we have that recognisable brand, then they will be more likely to support us, because ok, those are those people, you know, this is oh... I've heard about that, I saw the logo. It's definitely something, I think, that will help contribute to our sponsorship, partnerships of any kind.**

• Do you think it helps engage people, maybe your colleagues, do you think creative design can help...? Yes, I do, **I do think that with creative design we can make things look more professional? And I do think it's a very important part of we call it student retention, so at first, when the people come to university, they'll sign up to like millions of societies but then obviously on their job, once they start getting into their classes and developing certain interests – so we always try to achieve like a high retention rate, so they're as many students who entered, to later still be in the society. And I do think that just because we look professional, it will help us, because the quality of the workshops is already there, it's just the package to come with it**, comes with the package helps improve... Ok, great.

• entering (the) new market(s) for you, like new something? I don't think markets apply for us, but, sorry, I do think it can help enter new forces (sources?), ok, in terms of student membership, because right now we are just that technical society where nobody else can even come through the door, **I think because it is just so daunting for non-STEM students to just come in and just see just all those scratchy tables, 3d designs and they don't understand this. But I think with creative design, we can make it more** approachable. That's a good word, thank you.

The last couple of things... • Do you think, it helps with the differentiation from others like... Oh, absolutely. 100%. (maybe in your case another UKSEDS organisation)? That's actually, **I can give an example that the best UKSEDS branches, besides us of course, they tend to have their own, kind of, brand, (set of?) own logos, they are different from the kind of organisation that we are in, and those also became the most active ones and the biggest ones, the ones with the most amount of successes. Yeah, it definitely helps, and also for those it's also easier to get a partnership just because they're different, because otherwise they're just like, oh, they're just a small branch at the (uni?), they're just interested in that thing but having a** separate identity **kind of says, we are more than that.** Ok, great.

And the last question of this set is... (I think you already answered that.) • Do you think, creative design helps improv(e)(ing) the quality of the actual output, of an actual project? Yes, I absolutely think that. Well, you know, **we always like to think, we judge things on quality, but that's not always the truth. We judge things on actual quality and how it looks like, like people who enjoy something – just because it looks nicer – much more, even if it is something purely technical. And that's the truth, like, no matter how good you are, if you can't say how good you are, then you're not that good.** Ok, great. Thank you.

And the very last question...

How would you define innovation? Ok, woah, your definition... ok, you can take some time if you want, **for me innovation is making connections, where there haven't been any previously – for a**

**specific purpose. So, if you just slap things together – I don't think that's innovation.** Yes... **I do think, there has to be a specific purpose for which you, you know, combine those things, you come up with something new... Like, even just like creating something, it's always just putting things together that haven't been put together previously, even if it is just like simple logic and something that's already been done. That's still innovation in my eyes. But it always has to be for a specific purpose.** Yes. Yeah, it doesn't matter, like I said, **it doesn't matter, how much you play around, it has to be for something, to push something forward... And I think, that's what innovation is.**
Thank you so much.

How important is innovation to your organisation?

Very important. It kind of teaches you about the future, doesn't it, **so innovation is the way forward. It's how you evolve as a society, as human beings**.

Does it play a significant role in developing any new products or services?

Definitely.

Are innovation processes formalised at your work, the things that you do?

Are they formalised already / are they complete…? No, **there is always evolving. So, we kind of think, we try to take everyone's ideas as a whole and kind of combine them together.** So, more people, more ideas.

Do you think (visual) design helps in innovation processes in

• decision making? Yeah definitely. **I guess everything is about visual – aid kind of thing. You make all the decisions around how you see, how you perceive it first.** It's like when you're buying a house. You don't want somewhere grotty and grimey, you'd want somewhere clean and nice. Somewhere you'd see yourself in. Happy, do you know what I mean. It's like a personality thing. Yeah, exactly, **it comes across visually**.

• does design help in problem solving, do you think? Ehm, yeah. **It's all about kind of ease as well, so, the better the design is all evolved for the user. So, in order to make it as user-friendly, in order to cause the user less stresses, in order to make it as versatile as possible. And so, that's all down to design, I think visual design as well, stuff like, kind of connecting, it's a way of kind of connect to the user.**

• Do you think it helps in articulating new ideas? Yes, definitely. **It's like when you brought up these blue colours, sky and sea, everyone knows, it has a call on effect as well**, do you know what I mean.

• improving your organisation's presentation? 100%.

• establishing partnerships? Probably. I think, **the more professional you come across, the more other companies would want to kind of join in with you and it's all about the way you present yourself**, isn't it, **which again comes down to websites, comes down to logos, comes down to brand image and that's all through visual aid**.

• Do you think it helps engaging people, especially maybe newcomers, new students? Yes, definitely

• And do you think it helps enter new market(s) / new horizons / departments? Yeah, I think **the more kind of well known we make ourselves, the more kind of branches we can connect to**. And so I think, the things which grab people is design and so…

• And do you think visual design will help you differentiate yourself from other competitors e.g. the other SEDS groups. Yeah definitely. Ok, because right now your logo is based on the UKSEDS one. Yeah, absolutely. **Everyone has the same logo and I think, we just need to cut ourselves apart from that. Make ourselves a bit different.** (that's really good)

• And do you think, in the end of the day it might even improve the quality of the output, any output? The thing is, it's kind of… I think, **the way we work as a society, the more kind of you come together, the better it is. And I think, even down to the fundamental designs and the visual aids, it's kind of getting everyone excited**. Do you know what I mean, everyone excited being part of this society. **And the better that kind of vibe is, then the better we work together**, isn't it. Yeah, it does. I was really excited about this, to show you this (design work).

And it's already the last question…

So, how would you define innovation? Innovation. What's innovation for you? Innovation for me, it's kind of – **it's evolving… The old ideas into something new, making society better as a whole.** What do you mean by better? So, **it's kind of looking for solutions**, isn't it. **It's like taking what we have now and making it better, making it more advanced, making it, you know eco-friendly for example, making it, so it's more versatile, making it, so it's simpler design**, do you know what I mean. **So, everyone can use it, so it's evolving**, do you know what I mean?

Sounds really good. Thank you so much. No problem. Is that it?

Hi ▮▮ from ManSEDS. Hi. How are you? I'm good.
So, I'm just asking you a few questions on innovation mainly.
So, how important is innovation to your organisation?
So, in Manseds it's very important, because, well, **in honesty, we need, we wanna obviously develop new things and achieve high goals, so for instance in the past few years we try or may try a tracking device that we call the Picco-Tracker and now we gonna develop a balloon carrier so that invent certain laws that means we have to depart a permission which increases the launch date, the timescale of the launch. Instead of just going out and launching it, we have to wait like 30 days.** So, it's very, very important.
Ok, I guess you just answered this as well, does it play a significant role in developing new products and services? You just said about the launching...
Yes, **the further role is actually making use of cheaper products and modifying them. So like cracking a GPS unit, so it does work at a certain altitude, which they're usually fixed to not work at and stuff like that.**
Cool, so do you think innovation processes are formalised at work, what you do?
Formalised... Do you mean like a... They are already happining? Or are they still... Oh yeah, definitely happening.
Does (visual) design help like what I am doing, kind of branding or anything. Do you think it helps in your innovation? Definitely, **I need to see things to work with them, so if we all are going on imagining and not writing it down, that makes lots of work go wrong.** So, it definitely helps.
• do you think it helps in taking decision? Yes definitely. It helps find... **obviously figure out, if you write it down then it's a lot, that's like the essence.**
• do you think it helps even in problem solving, or do you not think (it's fine not to agree also...)? Yes, do you mean like design as in writing out what you're doing? Mainly I'm asking about graphic design, like visually communicating. Yeah, **having a good space and being able to show your ideas**. It's definitely an important part.
• Do you think it helps in articulating new ideas? Yes, definitely important.
• Do you think it would help your organisation's image, the presentation of your organisation? Yes, definitely. Not incredibly my area, but would certainly improve. Altogether, yeah. Yes.
So in what area are you actually? Last year I was the Project Leader for the High Altitude Balloons. And this year, I'm social psychedelic, I'm passing on the role of Project Leader. Great. Not that I don't want to do it anymore. It's just to give someone else the experience.
• Do you think visual design is helping establishing partnerships, also funders but also maybe like sort of getting new students into the...? Yes, **visual design is extremely important for that, because like having a universal brand, like looking is one thing. A lot of the time when I'm talking to people, they are not quite sure what's going on, because we don't have an individual logo, so they are like is this part of that? So, having one, making it clear that's our own, is the one thing that's very useful.** Cool.
• Do you think it helps even to engage people, like once they are in the organisation, do you think it helps maybe with brochures, webdesign I don't know, something like that? Yes, **I think it helps engage people, because once you're inside, it's like a a lot of projects, you still have to know what's going on with that project.** So, that's why we do these subdivisions as well.
• Do you think it helps differentiating yourself from a competetitor, maybe in your case not so much a competitor but maybe like from CranSEDS or something, do you think it helps you differentiate? Yeah, it definely helps, **like having a better website, it always makes you look more professional when you're applying for funding. Since like all the SEDS compete for the UKSEDS funding, but if you look very professional, it's extremely helpful. And like obviously we compete with other teams, it's got to be the intimidation tactic and you can involve in rocketry and cansats.** So you still have competitions between each other? Between other teams, that are part of the competition. Of UK-SEDS. Oh, yeah, well not exactly but it is still a competition. But I'd say, **if you look better you probably get a bit more funding.** Not from the UKSEDS itself but from competing (affiliations) with the UKSEDS. Ok, yeah.
• And do you think, visual design helps improve the **quality of the output** even, like maybe even if your balloon would have a nice branded logo on it, like the cars you know, do you think it would help? Definitely yeah. **We have a logo on ours and it always looks cool, having a camera coming down.**

That's good. So, in case somebody else is finds it, they need to know... Yes as well, **we have a sign on it.** **where it belongs to**.
And the last question, quite important for my research as well. How do you define innovation? What's your definition? Oh, **I'd say it is problem solving and then applying that solution. I think that's innovation.**
Ok cool. Thank you ▮ Ok, thank you.

Hi ▮▮▮▮ from Manseds. Hi. Can I ask you a few questions? Yeah, no problem. So the first one is: How important is innovation to your organisation?

I think, **it's quite essential because for example innovation plays in a lot of parts, not only in the design but also in the management or resources like for example at the start of our, of the year, we had a budget but then we found, I guess innovative ways of spending that budget to achieve our goals like... our budget was far too big but then we had to be innovative of what we were given and act upon.** You have become quite creative, have new ideas. Yeah.

Does it (innovation) play a significant role in developing new products or services or processes? **I guess by definition, a new product needs to be innovative or else it doesn't gain market attraction.**

That's right, ok. It's self-explaining. Yeah. **If it's new then it's innovative, somewhat.**

Do you think, innovation processes as such formalised at what you do, at your work? Can you define formalised? Are they already there, are they already in place or do you think they are just going to...? I think, **it's kind of an organic process, you can't really plan innovation – you can plan it, you can promote it, but I don't think it's there at the start. You don't say 'be innovative' and you go, you're kind of given a task and you kind of work towards it and that's where innovation comes.**

Do you think (the) visual design, which I am referring to, like branding and stuff like that, do you think it helps in innovation processes or in any innovation in e.g.

• decision making (do you think it helps take decisions)? Let's see your focus on decision making I guess. For example. So... I can't really think of an example. It's just what gets into your head really. E.g. **the theming of everything, that could aid that, because ultimately you want to make less decisions, you want more decisions to be already, like, made** yes **and that saves time and maybe resources.** Ok.

• So, do you think, visual design helps in problem solving, if you have a problem, does it have a solution or... Do you think... does it help find a solution? Visual design? Like visual design, like graphic design, like branding. Definitely, yeah. **On engineering problems, the first thing you do is, you sketch what you want to achieve and you've got a lot of rough sketches and you work towards your design, when e.g. in 'Rovers', we first rough sketch it, then we put it into 3D modelling, then model it, then it gets fabricated and tested. So, yeah, the first step I think most engineering innovation comes from graphically designs.** That's interesting...

• Do you think this visual design might help improving your organisations presentation, your image? Do you think, it will help the look? Yeah, definitely there is a potential help. I don't know now because it hasn't been finalised yet but when it's finalised, then it probably will. It's not only referring to mine, it's like in general, like e.g. Apple website or... Do you think visual design helps? Yeah, definitely. Yeah it **makes your corporate or your organisation more focused**. Definitely. Ok.

• Do you think it even helps establish new partnerships, like funders or maybe gets new student into the organisation, do you think it might help? Yeah, it would help yeah. Ok.

• Do you think it also helps engaging people, so like once you're inside of it like all your colleagues, do you think some creative design helps? As in? Engaging, like keeping you engaged, maybe like for a festival that you have brochures or outlets or something or like your brand altogether. Does it help wayfinding... Yeah definitely.

• Do you think it might help enter new markets, sort of like enter something new, a new field, maybe not a market but a new department, maybe that's also in reference to finding funders? Can you say that question again, I'm sorry... Do you think visual design helps in entering new markets? Yes, I do think so yeah. Ok.

• Do you think it helps differentiate yourself from other competitors, maybe like in the UKSEDS you have different departments, you have CranSEDS and so on. Yeah if you've got... Do you think it will help you set apart from them? Yeah, **the only thing that sets us apart from other related societies is our image I guess, until they get a peek and into what we actually do.** (nodding) **So, the first image is quite important.**

• And do you think, visual design even has an impact on the quality of the output, like whatever product you're doing, like a rover or balloon or something, do you think it helps with the quality, a good brand for example? I think, I'd say, **if the visual design is** I guess, **that people are working on it would more... would be willing to dedicate more to it.** Because we are a student society, **if everything is professional, then it sets a tone for everyone to do things that are necessary to achieve and look**

**and feel.** That's a valuable answer. Thank you.

And the last question is a generic definiton of your... what do you think innovation is? **The process of which goals and aims are achieved... The process of which finding different ways to achieve a predefined goal.** Yeah I don't have like, I think that's yeah. Ok.

Thank you very much. I'm sorry. That might be a bit vague but yes, it is a bit vague... That's totally fine, thank you so much ██████

Hi ███ from Manseds. I'm just gonna ask you a few questions about innovation.

So, how important is innovation to your organisation?

It's quite really important to what we do. And **what we are trying to pursue is trying to keep up with technology and try to bring our students to know what is out there and also be part of it**.

Ok that's great.

Does innovation play a significant role in developing new products and services or processes?

Yeah innovation does affect what you've just mentioned.

Do you think innovation processes, the process as such, is already developed or formalised at your work, at what you do? What do you mean by innovation process? Formulised, is it already there in place, so the process itself of innovation (is it already there or do you think it's still happening)? Ah ok I see. There isn't that much at the moment as a process in place. So, yeah…

Do you think visual design, like for example what I'm doing – graphic design or anything like Apple computers or something like that… Do you think visual design helps in innovation processes or in innovation altogether in

• decision making (do you think it helps making decisions)? Yeah, I do think **it's a big, big effect, influencing to what we're doing and how people see us**. Ok.

• Do you think it helps solve problems even, do you think it finds a solution to a problem (helps find)? Mh, in this directly I might say no but maybe subconsciously that somehow will be influencing… Ok. But directly, I won't say there is as strict. That's fine…

• Do you think visual design helps articulate new ideas (Do you think – to a different person)? Yeah, it will be… yeah. Ok.

• Do you think visual design helps improve a company's presentation or a company's image? Yeah, definitely.

• Do you think visual design helps establish partnerships, like e.g. with sponsors or maybe even like to get new students coming into your organisation? I think, it's also similar to the previous question. **How you present an, it also effects a sponsorship and connections**. It's all similar. Do you think so, ok.

• Do you think (that's also similar) it helps engaging people, like e.g. at your innovation festival or something. Do you think like posters or like flyers or something. Do you think visual design helps engage people? Yeah. Ok.

• Do you think even visual design helps entering new markets, maybe not in your case so commercial but like enter something like a new competition or a new department you are opening or something like that. Do you think visual design can help with that or branding? I think, yeah, **visual design will be able to… helpful**, yeah.

• Do you think that any creative design helps differentiate yourself from other competiton, like e.g. CranSEDS let's say or something. Do you think it helps differentiate yourself, set apart? Yeah, **if we have our own image or the logo on, it will definitely stand out from the original SEDS and branches.** Yes.

• And do you think this visual design approaches help improve the quality of the output, like any product you're doing, any rover or anything, do you think, for example a brand, it could be something else also, could help the quality of it as such? Like e.g. in a car, I am just saying from my simple mind, a car looks really good with a proper logo on it or a proper brand sticker or something. I see, yes so, in that case yeah, yeah… **if you have a professional looking or a logo on a product or in our case our project item, it will look much bring it to the next level or…** Yeah ok. So maybe like an Apple logo on the computer or something like that sets it apart or like how the way its layed out like at the key-board or something maybe, I think it has some sort of impact right? Yeah.

And the last question is… You can take some time if you want. How would you define innovation? Your personal definiton of innovation. Innovation. Mh. **I think innovation is creating new stuff or being creative or bringing something for it into new.** So, I think in general mh, how do you want me to answer, in what type of… Your personal, just personal just what you think about (nothing with cre-ative or anything – I mean not with my…) What is innovation for you, personally. I mean personal… Ok. I think, so e.g. **having a new, in engineering (context) you could design a brand new structure for say that could be lighter and with the same strength. That's some form of innovation there from an engineering point of view.** Yeah, so I think yeah, since I'm from an engineering background, I guess **innovation is getting new stuff out, e.g. graphene.** If you could utilise graphene, like **graphene**

**discovery is a thing, but if you could utilise it, commercialise it into a product, that would be an innovation rather than just a discovery.** Yeah, so...

Oh that's fantastic. Thank you so much. Is that everything? Just ehm, yeah.

How important is innovation to your company?
I would say definitely, it's very crucial really. It's about, obviously developing new products from satellite data. New satellite data, that is now freely available due to the open data policies, that the European Space Agency have provided since the start of the Copernicus programme. This really gives us a fantastic opportunity as a new commercial company to use this kind of data and produce products that then we can sell onto others. I would say, you know, five years ago, we didn't have this kind of opportunity... That's wonderful. So this is something really unique.

So do you think, (I think you just answered that) does innovation play a significant role in developing your new service and your new product?
Yeah it does, obviously, what we are trying to do is create respill information for our stakeholders to help inform them and provide better practice in terms of wildfire management and monitoring in the UK. So, sometimes, what we have to do, speak with them and really find out, what is the critical information that they need to obtain from the new satellite data that's available and that's really the innovative part of it, but it's sort of working alongside and communicating with who those products are going to be for at the end, it's a really essential part of what we do and our service. Otherwise we may produce things that are just, you know products which are going to be completely irrelevant to those who are working on the ground.

Do you think, you have an innovation process in place, do you have something written down, is it formalised?
Ehm, I would say certainly some of the outputs of my PhD, this was like a formal process, but now this was working with older satellite data and technologies. So, it's like, we need to translate into some of the data that are now more recently coming online. So this is processes that will need to be updated and refreshed and obviously then tweaked in terms of, depending on who the products are for. So which are the end users: is it a conservation group, is it fire services, is it utility companies, is it for insurance purposes, legal reasons. So then, the very end product can change, depending on who our audience is. Yeah definitely.

And do you think now, it's coming to design. Does design help in innovation processes e.g.
• in decision making? Do you think visual design helps in decision making?
Aehm. Well, I'd imagine visual design helps in terms of potentially when someone is looking for a service for a particular product and then deciding who to chose. Ah ja. Then which company looks the most professional in terms of design may factor into the decision process of who then they decide to chose to go ahead to do this work. So, it's giving that level of professionalism and also I think, subconsciously like feeding through ideas in terms of what our company is all about. So, you know, that we're a company that is looking at wildfire in the UK and the way, you know as we discussed the design, does that convey that message or not, I think that would be kind of quite critical in terms of knowing the choices that then potential clients make.
• do you think visual design could help in problem solving at all? Aehm problem solving. Can you give an example, I mean something. Maybe if you lay it out visually to a client or something, I guess you that with you presentation anyway. Yeah, certainly... ...is quite visual but it has to have the design aspect to it. I mean, I suppose visual design in terms of problem solving, you can say no possibly, I don't know.
• Do you think visual design helps in articulating new ideas (as a tool)? Yes, I do. I think it would certainly help in terms of communicating to others, say if the company is going to go into a new area, so tweaking the design, so bringing in, say we decide to go and do work overseas to work with tropical wildfires, then we could tweak that design and that would give indirectly the message that the company is going into a new area of work. I think as well, that's not something that we've discussed, but I suppose, maybe the design could be adapted for different stakeholders, for these different clients in some way. Maybe when you got to do presentations for example, yeah definitely so because I think a design, one design might appeal more to one particular organisation than another, so like with utility companies, I'd imagine the type of design that they're used to is very different to something say from the National Trust and again for the fire service. These are quite different being systems? of organisations and the way they work and actually what their priority is, so with utility

companies it's profit, with the National Trust is probably profit there too but it's more around con-servation and obtaining new supporters like new members, with the fire services it's all about saving lives and it's a public sector organisation opposed to an NGO or a commercial sector, that's ehm, maybe the use of design has to be adapted depending on who you are communicating to. Your voice can be flexible. Yeah. Ok.

• Do you think, (I think, you answered this in the first one) do you think design can help to improve your company's presentation? Definitely, because in a way you want to keep that professionalism throughout from the point where you meet someone with a business card to how the company is promoted online and the vision and the way we looking at being presented in that way through social media. So making sure that follows through to then actual brochures and things that you can pass on to people. And also, when we are approached by others, so for example, we've been approached by Copernicus to provide information in graphics but their publications are, when we were appoached for example by the media, so radio and TV and maybe making sure that our language is sort of using the right kind of words to describe ourself and keeping it professional in that way. That's wonderful.

• Do you think design can help establish partnerships? Yes. It can help but it could also potentially hinder us, I suppose it's a double-edged sword. In essence, I suppose, if your design doesn't come across as appealing, then it could in a way stop people from maybe approaching you. So, it's a careful balance really, I'd imagine. That's interesting.

• Do you think it helps engage people, also like maybe new students or volunteers or something like that or just clients? Ehm. Yes I do and actually again, a really good design can help facilitate that process, but a poor design can actually put a block to that process. So, for example, if your website is designed in a way that is not accessible, that doesn't use accessible fonts, off putting colours, looks overly busy, then I'd imagine it puts people off that contact to use the company. So, it's not something that almost seems obvious but in a sense it's something that is kind of, it's sort of hidden there in our subconscious somewhere, Yeah, I know. but then it can switch on someone to become excited about your company, or subconsciously switch them off and think actually I'm gonna look over there because that company looks more professional or they're communicating the right things to me or presenting the content in a more accessible way to me. And I'm inclined to make the Envi-roSAR website accessible to everybody and I think there are some potential quick wins by obtaining help from someone like yourself who is a professional in this area of making sure that simple things like colours and fonts and language are done in the right way, so that everyone gets the most out of the site. Ok, that's interesting.

• And do you think, design could even help you enter new markets, like you mentioned you may want to go to South America or Africa? Yeah, yes and again I suppose keeping the design quite simple is useful really and making sure again that things are developed in the right way. So, in some countries, you know, you have to consider more technical issues like band width and things like that for access-ing sites. And also how design translates to smaller screens, will people have access to those kinds of devices, that kind of thing. So that's something that probably needs to be considered. And also reaching out to new audiences, so making sure that again, the language, the words used, the colours used, don't have some different meaning in other cultures. So sometimes, you know like one colour can mean one thing in the UK but somewhere else it might mean something completely different and not be received in the same way. Yes. So I think having that awareness as well of ok what mar-ket you are entering into and like understanding maybe branding from their perspective and what works well in that country which might be quite different to the UK. And so, I suppose if EnviroSAR do go and start branching out further afield that is something that we need to maybe keep an eye on and be aware of and even some of the biggest companies in the world don't believe in what's in this area, they haven't done terribly well in terms of entering new markets Yes, I know. with their branding and their design. So, yeah I think it's critical. It is another critical factor in terms of real success somewhere else. It's very good, I like your opinions.

• Do you think design can help (it's not much more, maybe three more things) can help differentiate yourself from a competitor (maybe, I think you don't have a direct competitor but somebody who like who is quite similar), do you think it can help you differentiate yourself? Yes and I do think in a sense we do have other services that are kind of producing products like us but not necessarily like for broader areas, more regional areas, so we've got like the ?? information system for example at first which is run by the European Commission, but it's that sort of very kind of that you know top

down approach led initiative. I suppose what we're trying to come across as, as a company, we're a little bit more bottom up approach, like trying to work with the client and get the best on that kind of basis. So, you don't want to look too strong, so that's also differentiating, if you mean look... Yeah I suppose we want to look like a service where, you know, we can provide something more bespoke and where we can develop with the client, not like ok this is the service and that's it, there's no discussion or any bit of the development, so I suppose of kind of having that open approach, getting that across in terms of with the branding and you know that we're there as well and kind of communicate with our clients. Fantastic.

• Do you think, design can improve the quality of your output altogether, like if you had a branded brochure, if you have your website? Yeah, I do, so even like, it goes further I would say than brochures and business cards, some of our, like what we're finding with working with a couple of clients is that they still put a lot of emphasis on that kind of hard copy output, like the map, so having a design as well which when you output your maps which are like, which are the probable? products at the end. We created something initially with the logo and like the key but if we could put the branding theme through say, the map output as well, that would go, that would work really well. So, it's more becoming your identity, it's not just a style or something applied to you, it's really you, I mean this should be you. Yeah, it goes from the beginning to the end of the process, so if someone approaches and they say, you know can you put together a quotation for example, so you would put that branding, the design through the quotation and then maybe they ask for a report. Like our job, we've just done, we had to produce a report, so that again would feed through into the report that is provided to the client. And then, the same with the invoice and then like I said some of our outputs is as well as the electronic copy of things, so sometimes the actual data output, then the map, we call it like a map layout, maybe having that design going through the layout...


(This recording got cut short here, before the last question 'What is your definition of innovation?'. The answer to that question can be also found in the questionaire.)

Hello, my name is ████████████ and I have worked with ████████████ on EnviroSAR. So, I'm sure ██ must already have filled you on the process.
Yeah. Lovely. Thank you for making time for this. So, how important is innovation to your company?
I think that's how we started the company to begin with. It was originally the fusion of our PhDs. So ██ obviously did (most of the) all the technical part and she had the innovative idea, so to speak. She wanted to create a company that would (process satellite...) create maps by processing satellite data that could penetrate through the clouds, because that was something that was missing in the field of monitoring fires and wildfires in the UK. The problem with the UK is that it's covered fully with cloud most of the time and therefore to get clear images, cloud-free images is almost impossible. So that was more or less, you know, the theme of her PhD that she then innovated into a product and a company. And my PhD was very Social Science focussed and oriented. It was all about creating the links or using the links that I had created with the communities in the Peak District National Park, because that's were we would start. So essentially, I knew all the key stakeholders that we would then approach with our product and our company and sell it to them. Of course tailor it according to their own needs. So innovation-wise, it was really important, because we could show to the funding companies and our customers that we were two young women that we created an interdisciplinary company with interdisciplinary products, bringing our knowledges together and hence that was one part of the innovation.

Ok that's beautiful. So I think you just answered this already, so does it play a significant role (the innovation) in developing new products and services? Do you want to add anything? But you just said about, that you developed the new product out of this idea of your PhD thesis of your combined...
Ja...

Ja, ok. And are innovation processes as such, do you have formalised one at work?
Ehm, so I'm not a you know business expert. As part of the, I don't know if ██ mentioned that, we applied twice for the Copernicus Masters competition, which is like working for the European Space Agency, we got funding for that idea, EnviroSAR, so again, that was part of you know a success of our innovative idea. As part of that prize, if you may, we received eight months of bespoke business training, because both of us were academics, I had no idea what return of investment was or you know all these managerial sort of things. So, we were also trained in innovation and innovative thinking. From what I remember, because that was a while back, it was all about getting to know each customer individually and try and apply our idea and try to innovate the idea in a bespoke way, so what each customer needs, it's not like one size fits all, so we would work on a ... I remember we had a massive whiteboard where we received the training and it started like with a timeline, so we started with the idea of an inception, what does the customer need, what is missing from (his business) their business model and then slowly start creating dendrograms and graphs here and there, following a time pattern. So, let's say, from the first meeting with the customer we find out these things, but we already know what we think they may need and then we find out what they do actually need and then together with them start developing things and then together with them we collaboratively, we adapt, we adjust our product for them and hence, sometimes that can lead to further innovation because they might want to use a product in a different way that we have not envisaged. So for example in the case of EnviroSAR, they might not want to monitor wildfires only but might want to also monitor flooding or other physical disasters or snow cover or you know other things apart from what we originally intended to do. So you find a very unique solution to (every need)... for every different customer. And I suppose that covers innovation as well, right? Definitely.

And do you think design helps in these innovation processes in e.g.
• decision making? What do you mean by design? So I can understand what you mean. Any visual design input, so like e.g. finding, I don't know like what you said about the tables or something what was visual. Yeah it was really helpful. So do you think this helps? Definitely. So I don't know how things normally work, you know in designing a business model or helping new customers enhance the business model but for both of us, we found that having to map everything out on the wall (Exactly.) wall with nice symbols or even images or icons or pictures that can fit here and there, allows you to paint a picture much more clearly, rather than see bullet points on a piece of paper. Yeah, Exactly.

Yeah.

• Ok, do you think it helps in problem solving (there is lots of small (points))? Yeah. Do you think design helps with problem solving as well? Definitely, I think for me, speaking from my personal experience, I have got photographic memory and I am a very visual person rather than accoustic. So by being able to see it on a you know like a canvas let's say, I was..., it helped me a lot to come up with new ideas or you know, put things together or even connect people or connect the product with (you know) processes further down the production line, because I have that visual, that you know like a map let's say. And I think you just said that as well...

• Does it also help you in articulating these new ideas (to like a new customer)? Well definitely, some people are not very good with words but they are better with drawings. So, sometimes, especially if you have customers that are non native speakers of English. You know, language can be transcended by using graphs and paintings, so you can draw something and give them exactly (the) a description of what you want. That's right. So definitely.

• And do you think, (like let's think of a nice company whose design you really like) do you think it improves a company's presentation? Do you mean the website or... Like a website or even a whole identity, you know the business card or like brochure or something. Definitely, ja.
OK.

• And do you think design even helps establishing partnerships? Definitely, so I mean from, you know I suppose examples are always better. I read a research some time ago, I think it was with Gail, when we were actually thinking of what colours to use for the EnviroSAR logo and we were drawing from other successful tech giants out there. And the fact that they were trying to use the whole palette of colours like Google, green, yellow, orange, bright engaging colours and that definitely is the first step to attract people. Because if you have got the logo or a website that has bright good colours, they feel inviting, they make you feel even happy. That's right. That always plays good with the psychology with your customers, definitely. And of course it can help attract or push away customers. Yes, that's right. So you also think bad design might push away... Definitely, not just bad design but also non user friendly design, if it confuses people, if it uses words that are difficult or that are a bit slang or technical, not for the everyday person, That's right then it can deter people from using it.

• And do you think design can help engage people, also like maybe employers or like new maybe other students who might help you on a project or something like that? Definitely, because yeah, if it is an attractive design, if it's interactive design that can be playful, people will be more inclined to engage with you and your product, ja.
Ok, great.

• Do you think like in EnviroSAR's case and you talked about bespoke new products and stuff, do you think design can help enter new markets, like maybe a different area of the same market but like...? Definitely, so one example could be (of a) different market could be a different age group right, because for example so far, we're just targeting professionals but in the future we might offer services that are for younger people as well, because with the advancing of technology you know, if we created EnviroSAR in a very smart phone user friendly app, younger people could have it on their phone and they could checking who knows... So, definitely, that would help attract a new market.
Ok, that's great.

• And do you think design helps differentiate yourself from competitors? I think it's one of the really key elements, because even before your customer knows how your product looks like, design of your business card, of your website is like the first thing they see about you, so it's like... It's like a window right? it's the window yeah, it's the first impression you give. So, if it's professional and inviting and you know with nice colours and it looks interesting and intriguing, it can definitely capture people's attention, definitely.

• And (this is the last of these smaller questions) does design help improve the quality of the output, do you think even? So if you have a new product. Aehm. Well it depends again what (do) you mean by design. If you mean the software? So just the visual one. No, because if the quality of the product is not good, then the website can't help you, you might have the best website, really inviting and attractive etc. but your product may be slow, may be faulty, may not meet your customer's needs, may not delivered to them in the time they needed to, delayed. So, of course even if you have the best website, your product's quality must match the quality of the website. That's right. Very good, interesting to know.

And the last question is, how do you define innovation?

Oh, ah. That's a nice question. You can take your time, if you want to. Ok, aehm, I think innovation is about pushing boundaries, not following what other people have done and it's about being fearless and thinking outside the box – thinking in a blue sky way. What is the ideal that I would love to do? Because like the same goes, only the sky is the limit and in our day, with the advancement of technology, there are very little limits in how much you can innovate for example. So it just takes will, determination, vision and obviously then you have to find a good funder that can fund your idea to make it happen. But eh, it's all about yeah being fearless and following the dream that you have and not feel deterred that what if I don't have funding, I don't know anybody, I don't don't don't don't don't… It's about, you know, forgetting about all that and just following through.

Oh that's beautiful, thank you so much.

I'm ▮▮▮▮▮▮▮▮. Hi ▮▮▮▮ from EnviroSAR. So, how important is innovation to EnviroSAR / to your company?
It probably underpins the main values of EnviroSAR I would say because EnviroSAR set out to develop, I guess, innovative solutions. And, aehm, innovation is a bit of a buzzword at the minute, but yeah that's essentially, we are looking at a problem and our solutions are based on that problem. Ok. And add a column if this is, I think **we try to, any problem that we would come across, we would try and come up with new ways using satellite imagery specifically like radar, to try and solve it**.

Ok, wonderful. Does it play a significant role in developing new products or services? Innovation? Yeah. Aehm, yeah, **I think you've got to be innovative to be / to have new products in the first place, otherwise, you know, you're just recycling the old products**, which / that's not something which the market needs or there be a demand for because that product will be already out there.

Ok. And do you think innovation processes are formalised at work? Is there any process? Innovation process? Then probably not. It may well be, I think I don't really understand the term or what the processes are that we go through. I think it's a specific process that you define in the end the day. Aehm, I'm not too sure about that one. ...to follow each time... I'd say if there was a process we'd follow, it would be, you know, **a customer would come to us with a problem, we'd look at potential solutions from a satellite perspective**. Ones which include solutions which already exist, so things which are quite common and also consider the basic – how we can apply theory from..., **theory which maybe has not been points of practice yet and try all that and test it out and see if that could be potential products that could be developed**. Ok. If that's a process...

Do you think visual design helps in these innovation processes or innovation (as) in general, in e.g.
• decision making (do you think it helps maybe a client to decide whether to take you or not)? I think **from a marketing perspective definitely. I can see how maybe visualisation could help to make a client understand, you know partly to understand concepts which tend to come with innovation.** You know innovation tends to be something quite new, so that's something. So, **e.g. with radar, a client starts to understand that, so we have little graphics I think wich explain how radar works**. I think in that prospect yeah.
• Do you think design helps in problem solving? As in graphic design? Yeah graphic or visual, anything, maybe just to map out something. I guess so yeah. Maybe, I personally haven't used much **graphic visualisation in the design process**. I'd say the extent would be a few scribbles **trying to** (you know) **understand something going on**. That was it. Ok, that's fine.
• Do you think, design can help articulate new ideas? Yes. I guess so, because that's easy especially coming from like a maybe more of a scientific background. It's difficult to you know **explain what terminology or a theory to practitioners or like laymen who don't understand, like people just want to use a product for their own needs, like ecological needs**, they don't want to have an understanding of like all these terminologies, all these processes. And I guess **visualisation would really help them being concise with stuff** like that.
• Do you think visual design improves a company's presentation (like the identity of a company)? Yeah definitely I think. **Definitely graphics and any sort of design that then sort of is key to the image of a company, not just the, as much as the products. You know it's easy to say in a list what a company does but it can be more impressing or give a lasting impression, obviously it's coming through graphic design.**
• Do you think design helps establishing partnerships (maybe with different industry partners but also academically, also clients – any partnerships)? Aehm, I don't know if it would do it directly, it doesn't have to, to be direct? So maybe like a brochure or also visualising a process. Yeah in that perspect then yes. I guess it does just sort of help in a means in which it's **maybe easier to communicate or between academics and different businesses. It's a bit more of a, everyone can relate to a visual rather than (you know) text, especially when it has to be targeted at a specific audience.**
So you say it's sort of more indirectly. Yeah I'd say so.
• Do you think design helps engaging people, maybe like other students, not just clients? Definitely yeah, I think, **the example I'd go to is websites, that's where universities or space companies and start-ups, you know you really get a feel for a company based on their website if they're using you**

**know certain graphics – that can be quite exciting, it sort of forms its own – yeah it is an image of a company and if they're using nice, sleek designs and I also maybe wrongfully but ehm I expect that their services would be sleek and it basically represents them.**
Ok.
• Do you think design might help enter new markets, or maybe of an existing product – open up a new department of that, a new area, maybe you are offering prevention for fires but maybe it offers a new niche? I think... Yeah, I think, I know **we definitely could do better on the design front where prevention... of that prevention and product would be targeted at the non-space industry sector. So we could do more which design targeted the colleges, which is I don't know maybe less text and more images I'd say. Whereas if we'd had more, we're talking, we're trying to work with or collaborate with other businesses in the space industry, I guess we'd have to alter our visualisation and graphics based on that to be more, maybe or less so on the basic images and more text.**
It's an interesting view.
• Do you think design, especially visual design can help differentiate yourself from competitors?
Yeah, I guess, because **you need to have that brand a bit more, make it a bit more memorable**. So the one I always think of is a company called 'Astrosat' and they, you know they have got their image from the web... Their website is aehm, **I sort of form an image of them based on their website and the graphics they use and that sort of thing**. So, I think, it's important.
• Do you think design helps improve the quality of the output as well, I think, you just mentioned this about the markets, so... If, maybe the quality of how it's disseminated or... Maybe it depends how you evaluate the quality of a product. **If a product is helping more people, then that's maybe a higher quality product than to help more people, you need to reach more people, which is done through, you know, visualisation or advertising.** But I'd say, just from the product itself, I would find, it is more to do with the design of it from a coding side or you know process, like more of a remote setting.
That's really interesting.
It's already the last question, you can take your time, if you just want to explain a bit more, it would be interesting to know your point of view. So, how would you define innovation? What is your definition.
My definition. I am not a fan of the word innovation because, ehm it's overused yeah it's the same, I think nowadays it's just a buzzword, the same with like destruction. **To me innovation is simply to come up with ideas, to solve – problem solving. It's that simple.** I think innovation is used nowadays to show technology, that is new technology, whereas innovation was having a fridge instead of a pantry or just the basic, you know, there was lots of innovativeness like this in the past. Yeah I think... Just too overused... But yeah...
Ok, that's great thank you so much.

Ok ███ I'm just gonna start. Ok.

So, how important is innovation to your charity?

Very, because I think, if you think of the way the world, the future of young people, their life, their personal lives, their working life is gonna be affected by the digital technology industry for all the different changes that are taking place. The one common thing that's gonna be important is them as people, their creativity, their ideas, their innovative ideas, thinking differently. And for me innovation is about thinking about what you are faced with, thinking about ideas you have, problems that you need to deal with and about solutions and how to come up with new ideas, how to address problems, part of that is about collaboration, part of that is about talking to people, asking the right questions, listening, you know, thinking differently, you know, not staying with the same old ways and especially when you know their experience of the workplace, their expectations, different employers they're going to have is gonna change quite dramatically in some areas. So it's about that independence of mind and ability to see things in a different way, so yeah, critically.

Ok cool.

Do you think innovation plays a significant role in developing new workshops in your case?

Yes I do. I think a balance between things that you know will work but trying to do things in a different way. So one of the things with the whole Constructing a Life on Mars project is about giving them a context or a metaphor that they can understand and relate to. And then feeding into that, new development, new technology, so they can see how 3D printing of buildings, which seems weird actually seems to make sense when you go to Mars, because you can't go and buy lots of bricks and wood and slates. You know. And it's also (important) from the environmental point of view even on the Earth now. So AI Space Factory have just won another new competition, an award about innovation. So I can send you some links on that. And do they use the sand or something? Yes, whatever is around. Cool. They mix that with this kind of material that's quite natural and then print. And I think the idea is, you can knock the building down and dig it back into the earth. That's fantastic.

Do you think, at your work, are innovation processes already formalised or are they ongoing and flexible? No, I think they are just intuitive and made up. Ok, cool. And that in a way, that's the way I work, so I'm working with a group of engineers who are incredibly organised, who run, ███ runs multi-multi million Pound projects across the world, you know, three or four at the same time and with hundreds of people working on it at all different levels, from Nobel prize scientists. So, he needs to be quite structured. But within that is a creativity, whereas mine is pure ideas and connections you know. So. Which is good to starting to work with people like that because I need to get more structure but it can't constrain the way I am. Definitely yeah and I think that makes it so individual. Yes, definitely.

So, do you think design as in visual design, what I'm doing, helps in innovation in e.g.

I do, I think it can help communicate ideas and it can help communicate what you are trying to do to other people and open their eyes and get them interested because if their initial perception of something, through what they say: ah that's just a bit boring, if it gets them asking questions, then they'd say what is this, but if it's not too off the wall because obviously some design ideas get a bit crazy. You know, yeah I know, but it's almost, if you can get across the ethos and the theme and the psychology in a way of what we're trying to do, which is about innovation, it's about collaboration, it's about creativity, to solve problems but also stimulate an interest in asking questions and looking at what's going on around them.

• And do you think visual design helps in decision making e.g. (for your workshop...)? Yeah, I think so, because I think, being able to sketch out ideas, being able to put ideas down visually as well is really important. Yeah. Because it's not all in your head, you can actually just draw ideas out and collaborate and discuss.

• So, you already mentioned, design helps in problem solving, but what do mean by that? I think it helps you visualise the information and the ideas and the problems you are facing. You know, so you can sketch out... Depends how your mind works in a way but I think mine increasingly works and links and relationships and how things work together. So if you can draw out a visual map on paper of an increasingly complex, like ours is gone, you know it's expanding all over the place. So to be able to draw that out and then think right, who is working on that, what, how does that link with that, how does that, what's coming from. And I'd say even just having a big sheet of paper and a pencil and drawing out, can help you organise... make sense of stuff, that's right... yeah definitely. Yes, definitely. And you can then communicate and share that with other people, who can then contribute to it.

Just talking about it… Because I tend to go, change all the time, so to actually have something down where you can focus yeah.
• So I think you just said that already. So you think it also helps articulate new ideas? Yes, yeah. Ok.
• And do you think it could improve your company's or your charity's presentation altogether? Absolutely, yeah, definitely. So even that video, just sending that out, it's so well done, it just makes you cry really. Oh God, and it was a really chaotic day, how good yeah, but it makes it look really smart and organised and very professional. Straight away people go, you know that people really pretty experienced, it going, that's superb, that's fantastic, so straight away they think, this is something, I want to get involved in, mh definitely. And then people who really were involved like ███ from Lancaster University can share that and they feel good about being involved. And their colleagues see it go, I want to get involved in that.
• I think, you just answered answered all my other questions. I think it establishes partnerships yes as well and engages new people? Yeah definitely.
• And it even enters sort of new possible… (I mean I wrote down markets, but it doesn't apply to yours, so sort of…)? I think, it gives it credibility and it gives it value. And it kind of opens people's willingness to get involved and investing and you know…
• Do you think it helps you differentiate yourself from other charities that are out there? Yeah, definitely it's similar… There is a comment, I sent you a comment there. Phil, our chief trustee who is an incredibly serious engineer. So this was his quote, which is fantastic, really gets across what we are about. So, it's so much more that a flyer. Yeah. It's actually to see it, you see the people, see the emotions, you see the atmosphere, that is aehm… Definitely.
• And do you think design helps improve the quality of the output altogether, like you just mentioned with the video, it looks more professional? Yeah, because I think it creates a framework, so you can then you know stuff you use to share what you've done has got a much more professional edge maybe edge… Like that film, I couldn't have made the film, I couldn't, it would have been sh… But whereas he has just merged it all and that animation at the beginning, just straight away takes you in, ah this looks nice. Ah ok lovely. And then you got this story. Yeah, maybe I can draw from that for the planning bit as well. Yeah of course you can, use that. If you want to use examples. Definitely. Or even take clips of that and just say, look this is, you know… Definitely.

And the very the last question for the interview now is just… How would you define innovation? So, what's your personal definition, because it's such an odd word, isn't it? Innovation. I think it's a number of things. But one is, taking what you already know and it's in front you, and reinterpreting it and reconstructing it and putting it back together to give you new ideas or new suggestions or new ways of working or thinking. And it's also about completing new ideas, which always has to be based on something but you might not know it. You might be faced with a problem that people are trying to address but you are coming in from a different way. Do you understand what I mean?
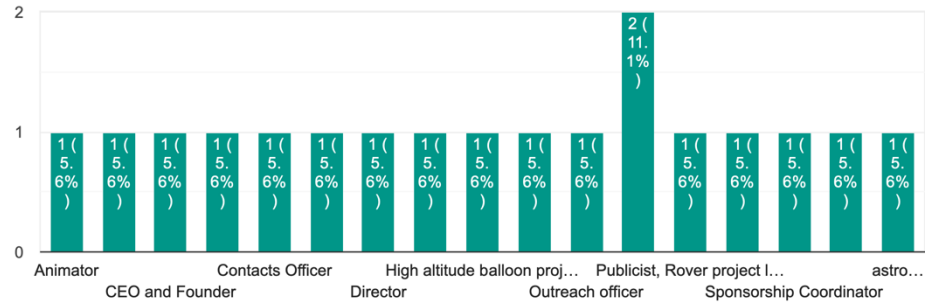I do understand definitely yeah. Thank you very much. Yeah.

**Appendix 7**

**Online interviews summary**

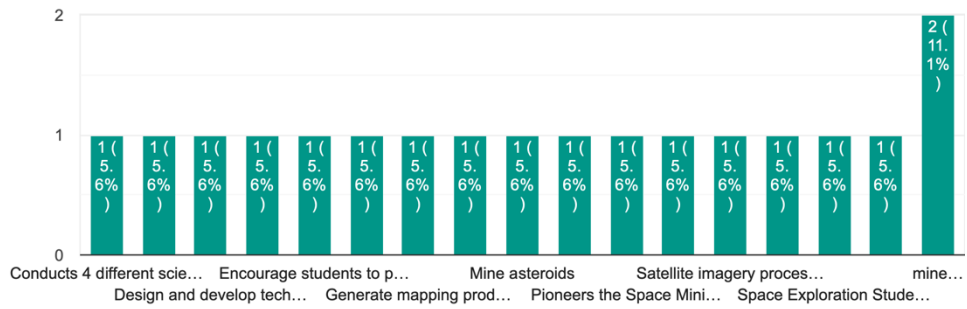| Timestamp | What is your role in the organisation? | What does your organisation do? | Is innovation important to your organisation? | Does innovation play a key role in the development of new products and/or services in your organisation? Please explain. | Are innovation processes formalised in your organisation? | And finally, how would you define innovation? |
|---|---|---|---|---|---|---|
| 8/21/2018 13:34:34 | Animator | Software applications | strongly agree | Yes. When tackling societal problems that require technology to solve, innovative and creative solutions are required. | Yes | The application and creation of new and groundbreaking ideas through technology. |
| 8/21/2018 18:04:41 | CEO | Design and develop technology. | strongly disagree | We have a design centred innovation R&D process that enables us to develop new products and services. | No | A new way of doing something which is an improvement on the existing way. |
| 1/18/2019 12:44:21 | astrogeologist | mine asteroids | strongly agree | Yes, the company is pioneering a new industry | No | Doing something new or differently to push the limit of what has previously been thought impossible or adequate. |
| 1/23/2019 15:34:54 | CEO and Founder | Pioneers the Space Mining sector in the UK | strongly agree | Innovation is at the very heart of what we do at AMC, as we attempt to push the limits of human ability and influence out from the Earth into Deep Space. Every day we encounter problems that no one has ever had to think about before, which makes for a very satisfying, if sometimes terribly hectic work schedule. AMC often seems several years in front of the current trends, which means that design plays a critical role in explaining our processes to our audience. | No | Imagining the impossible - then finding the phone numbers of the people who can make it happen. |
| 3/18/2019 22:45:01 | Head of Investment | mine asteroids | strongly agree | yes, it uses some of the most innovative technologies | Yes | Making human life easier through access to technology and knowledge that is for the first time available |
| 3/26/2019 12:55:02 | Chief Science Officer | Mine asteroids | strongly agree | Yes as some of the technology we require is yet to be implemented. Innovation will be necessary to design this technology | Yes | creating solutions to current problems |
| 6/10/2019 11:37:40 | Project leader | Organising and leading the Rockety team and it's activities over the year | strongly agree | Yes, we often have to create and come up with new solutions for many of the challenges that our teams face. | Yes | Creation of new ideas/products |
| 6/10/2019 11:37:57 | project leader | Design and build rockets, rovers, satellites and high altitude balloon experiments | strongly agree | Yes we want to come up with economical and environmentally sustainable ways to get us closer to space as well as test equipment and perform experiments at the edge of space | Yes | |
| 6/10/2019 11:57:37 | Publicist, Rover project leader, Balloonian Chief engineer. | Provide a recreational platform for students to pursue their academic interests in space and | agree | Most of the projects (to my knowledge) use a very Macgyver approach to problem solving, so small scale innovation is vital. | No | Integrating unusual or new design into existing/understood products/constructions |
| 6/25/2019 18:16:08 | Contacts Officer | Space Exploration Student Society, have many projects related to space | strongly agree | Yes, we need to innovate to keep ahead of competitors | Yes | Thinking ahead of your time, thinking ahead of other similar organizations and thinking out of the box |
| 6/26/2019 9:46:29 | Sponsorship Coordinator | Conducts 4 different science and engineering projects to do with space, that are undertaken by teams of students | agree | Yes. Innovation helps the students to decide and help create new ideas for the society | Yes | To innovate is to come up with a new idea or way you can imagine a solution or method that would help benefit a product or a system. |
| 7/5/2019 10:53:25 | Project leader | Develop high altitude experiments and launch them | strongly agree | It is extremely important, it's what the project is all about | No | Identifying a problem and solving it |
| 7/16/2019 11:12:12 | Digital Lead | design and technology, often health related through government grants | agree | Innovation is a difficult term because of its over use - it certainly plays an important role in product development, but often too much focus is put on innovation through buzzwords rather than innovation for the good of the project, you don't always have to reinvent the wheel! | Yes | Identifying the outcome of a desire to do better, to reimagine a service or product which fails to serve its purpose fully, or one which needs updating. However, it is often used as a blanket term in an attempt to convey dynamism and company 'freshness' rather than a thoughtful and important process. It is for this reason that the term innovation is tarnished for me, so many things which posit themselves as innovative are really attempting to signify newness rather than actually engaging in thoughtful and useful development - it is more for the purpose of marketing than it is for the good of the end user. |
| 7/16/2019 12:13:33 | Outreach Officer | Increase awareness about space related activities | agree | Innovation is used in the organisation to design mechanisms for the rockets/rovers that has been designed | Yes | |
| 7/19/2019 9:23:37 | Outreach officer | Finds institutions where you can make people aware of the organisation and the work | agree | Yes as it leads to new research and ideas | Yes | |
| 7/19/2019 10:22:32 | Treasurer | Encourage students to pursue the exploration and development of space | strongly agree | Yes, as we develop technologies to allow us to launch rockets, reach the edge of space, etc. | Yes | Innovation is the creation of new ideas and methods for doing and making things |
| 2/24/2020 9:18:10 | Director | Generate mapping products from satellite data for wildfire management and to assess moorland and heathland recovery in the UK | strongly agree | Yes. Basically our company focuses on extracting useful wildfire information from a range of satellite images pre, during and post wildfire events. Therefore, using new methodologies and approaches for obtaining that information and providing to our customers is central to the company. | Yes | Developing a new process or product which produces useful information and insights for our clients. |
| 2/28/2020 16:30:16 | Research and Development Lead | Satellite imagery processing and analysis | agree | We aim to be innovative in the services and products we provide. I think products/services are inherently innovative if they are "new" | No | Similar to "disruption", a buzzword for organisations/businesses. I believe innovation is simply the improvement of an existing product/process or creation of new ones, which should be standard practice in business. I think the overuse of the term has led to innovation for the sake innovation, rather than truly useful innovations (celebrating the new rather than useful). |

# Charts

## What is your role in the organisation?
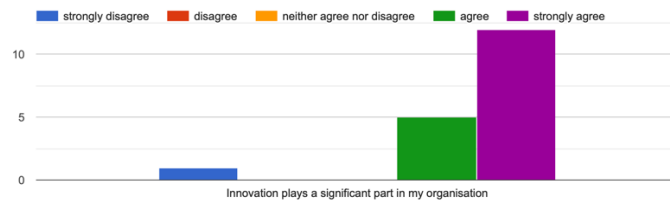18 responses


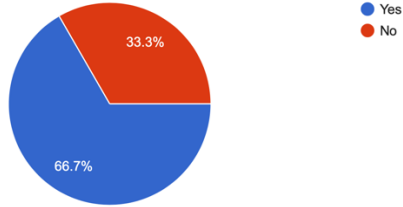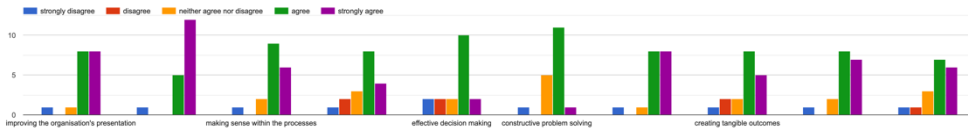
## What does your organisation do?
18 responses



Is innovation important to your organisation?

# Are innovation processes formalised in your organisation?

18 responses



- Yes
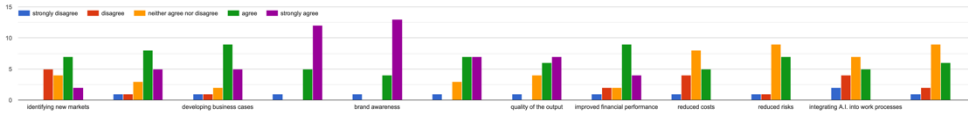- No

33.3%

66.7%

## Design adds value in innovation through ...



- strongly disagree
- disagree
- neither agree nor disagree
- agree
- strongly agree

improving the organisation's presentation | making sense within the processes | effective decision making | constructive problem solving | creating tangible outcomes

## Design helps the effectiveness of innovation processes in your organisation by...



- strongly disagree
- disagree
- neither agree nor disagree
- agree
- strongly agree

inspiring people | establishing client relationships | fostering partnerships | generating user insight | cultivating empathy of users | tackling assumptions of individuals and groups in inf

## Nearly there. Design contributes to innovation through...



- strongly disagree
- disagree
- neither agree nor disagree
- agree
- strongly agree

identifying new markets | developing business cases | brand awareness | quality of the output | improved financial performance | reduced costs | reduced risks | integrating A.I. into work processes

**Appendix 8**

**Feedback forms**

# Company Feedback

**Name: Lee Omar**

**Company:**   Red Ninja

**Student's Name:**   **Janett Adler**

In what sector is your organisation?   Design & Technology

**What were the opportunities and challenges of working with TNW?**

Opportunity - access toi talent to work on real life industry projects.

Challenge - the business needs change so fast, sometimes its difficult work with an academic who is new to the business.

**What did your organisation contribute to working with TNW?**   Mentoring

**What new insights and/or benefits have emerged from the relationship?**   - A high quality brand for an innovation project.

**Are you developing any new products or services based on your work with TNW?**   Yes, we are developing a new Artificial Intelligence transport product

# Company Feedback

Name:   Mitch Hunter-Scullion

Company:   Asteroid Mining Corporation Limited

Student's Name:   **Janett Adler**

In what sector is your organisation?   Space Mining

What were the opportunities and challenges of working with TNW?   Working with Janett has proved hugely beneficial to the development of AMC. By taking a design led approach to the overall corporate image of AMC we have inherently added value to the business. I faced no real challenges with the project at all; Janett was a consummate professional and covered all bases of the project admirably.

What did your organisation contribute to working with TNW?   AMC is the pioneer in Space Resources in the UK. By presenting TNW with a blank slate of an industry; AMC allowed TNW the opportunity to conduct an innovative approach to design innovation in its most practical application.

What new insights and/or benefits have emerged from the relationship?   Janett's approach to design massively contributes to the development of space technology through a stylish functionalism which thoroughly represents the industry. Working

together; Janett developed AMC's business cards which were very much clean; with a touch of flair added on the back by myself in the form of some spray paint; adding a subversively utilitatarian element.   While our investment brochure is now considered publication ready which has been a major boon to our self confidence as a business. Design has allowed us to go past the technical difficulties and allow a visual recognition and thus regular acceptance of Asteroid Mining as a concept.

Are you developing any new products or services based on your work with TNW?   Working with TNW has allowed AMC to move forward into the investment stage of our business model; a significant development in our history which will have a major effect on our overall business. TNW really has transformed AMC.

# Company/Organisation Feedback for TNW Student Project

Your Name and role:  Zuzanna Nagadowska, President

Company or Organisation Name: Manchester Students for the Exploration and Development of Space (MANSEDS)

TNW Student's Name:  Janett Adler

In what sector is your organisation or nature of business?

MANSEDS is a non-profit student organisation located in the University of Manchester, whose goal is to promote space exploration and development through educational and engineering projects.

What were the benefits of working with a TNW Doctoral Student?

The student provided expertise and skills needed for an organisation rebranding. They understood the organisation's vision and goals, as well as the organisation's members' ideas and suggestions, and implemented them in the design process.

The student was mindful of the requirements given.

The student was aware of the organisation's activities and sought information about it on their own.

What were the challenges of working with a TNW Doctoral Student?

The timing of the project has made it difficult to involve a bigger number of organisation's members and to schedule meetings that are convenient for everyone involved.

The designs and the design process overall were very risk-free and somewhat lacked bravery and experimentation.

What did the TNW Doctoral Student contribute to your organisation?

Thanks to the student, the organisation has a new main logo, as well as 4 departmental logos. Moreover, the main colours of the organisation have been changed. The student has also chosen a set of fonts and general visual guidelines for official documentation and marketing resources. Finally, the student has made suggestions regarding merchandise and website visuals.

What new insights and/or benefits have emerged from the relationship?

The organisation was able to create a more compelling documentation and marketing visuals, as evidenced by the stakeholders' feedback.

The new brand guidelines have helped define the mission of the organisation better and create a new interest among prospective sponsors and prospective members.

Are you developing any new products or services based on your work with the TNW Doctoral Researcher?

The organisation's website is undergoing significant remodelling. Moreover, the student's designs will be utilised for general merchandise, including clothes and wearables, stickers and miscellaneous items.

Thank you for completing this feedback form. Please email completed form to c.coulton2@lancaster.ac.uk

# Company Feedback

Name:   Gail Millin-Chalabi

Company:   EnviroSAR Ltd.

Student's Name:   **Janett Adler**

In what sector is your organisation?   Geospatial intelligence for hazard mapping, in particular the mapping of wildfires in the UK and the recovery of moorlands and heathlands thereafter.

What were the opportunities and challenges of working with TNW?   The opportunities was to work with a design expert to (a) review the current branding of EnviroSAR Ltd and what needed to be changed to get the right kind of messages across graphically about the company (b) Discussing with Janett other companies approaches to their graphic design and identifying examples which 'worked' for EnviroSAR and ones I felt didn't work (c) Understanding good combinations of colour (d) How  branding is not just the website but runs through everything from letter headings, to business cards, to company literature and of course the website too. There was no challenges as such in working with TNW. Janett is very professional in her approach and provided everything that she said she would on the times agreed. We both kept to appointment times so I feel the process was very smooth.

What did your organisation contribute to working with TNW?   I hope I was able to provide Janett with some insight into the challenges that a new tech start-up faces in the space industry. Enthusiam for the area that I work in and context of where the initial design work for the company came from and how TNW would help to drive EnviroSAR to look more professional and help us to get to the next step in developing

the business. We have provided some one to one interviews, feedback about the designs that Janett produced. Our plans on how we will take these designs forward in our work.

What new insights and/or benefits have emerged from the relationship?   The new insight for me is really simplicity of design helps to create a more professional brand for EnviroSAR Ltd. The original logo showed a flame below the word EnviroSAR and Janett through several meetings has convinced me that a more subtle design approach has a bigger impact and allows the person interacting with the design to put their own interpretation on something which is more subtle. I am very pleased with the final logo design and I am looking forward to using it in the future.  Janett has also offered to help me in the future to drive the design forward if I secure someone to redesign the EnviroSAR website and she would be happy to work with them. This is something I may decide to act upon. I hope Janett has the benefit of another interesting space tech company to include as part of her PhD analysis. I have really appreciated and enjoyed the relationship I have built up with Janett. I have found her to be very approachable and receptive to my ideas.

Are you developing any new products or services based on your work with TNW?   I aim to redesign the website so I can implement Janetts work for this and better promote EnviroSAR as a company. I would like to develop a new geoportal service which would allow potential users of EnviroSAR to view our products online and the graphic files Janett has provided me with would be used for this.

**Appendix 9 Conference papers**

**4D Designing Development Developing Design:**

**Meanings of Design in the Next Era**

October 21-23, 2019, Ritsumeikan University, Osaka, Japan

(Adler et al., 2019)

# DESIGN VALUE IN FUTURE TECH ORGANISATIONS
## How can design communicate innovation?

Janett Adler, Dr Jea Hoo Na, Dr Martyn Evans

Manchester School of Art, Manchester Metropolitan University, United Kingdom.
janett.adler@stu.mmu.ac.uk

**Abstract:** Determining how design adds value to the communication of innovation in the field of future technologies in response to the UK Government's Industrial Strategy, this research is anchored in visual design as a driver of creativity and a contributor to innovation in the satellite and space industries. The originality of the research is to foster transformative opportunities in line with the Industrial Strategy in North West England to communicate novel ideas and to enhance the development of products, services and processes by creating conditions that are conducive to innovation. The hybrid of theory with practical elements is achieved through projects with partners in the industry, collaborative research, observations, field notes and visual material produced as part of the research process. Design value in case studies is tried and tested through a tailored design process. Problem solving approaches are generated through brand creation and development to visually communicate innovation activities.

**Keywords:** Design value, Communication, Innovation, Satellite and Space Technologies

## Introduction

The research projects explore how design and creative techniques can contribute to growth and prosperity, fostering impact in the region.

As design is increasingly recognised as a driver for user-centred innovation (The European Design Leadership Board, 2012) and organisations are advancing by embedding design into their innovation processes (Bason, 2015). The hybrid character of future tech and creative design serves as a pioneering instrument and concurrently as a consistent quality asset. Design can enhance productivity and visually communicate future technology (Transformation North West Cohort, 2018).

As part of a larger study, two collaborative mini-projects involving brand development and creation in future tech organisations in England's North West were conducted as case studies. The first case study was designing a brand for an intelligent transport application aiming to enter a new market. The second case study involved a start-up company that mines asteroids, that the author has worked with to create a brand identity to improve communication for prospective funders. Even though the nature of the projects and organisations differed entirely from one another, the same creative approach was applied throughout this research.

1

## Background

*Creativity and innovation*
The following paragraphs discuss visual design and its relationship to innovation in the wider context relevant to the Industrial Strategy (BEIS, 2017).

In an extensive study Cooper et al. (2016) discuss design value in innovation. The study demonstrates design's contribution can be measured, however difficult, through the relationship it has to innovation. Design is focused on successfully developing confidence in products and services through understanding its strategic position, nuances, and through identifying its factors. It helps to make sense and take decisions. As an iterative process, design directly advances innovation whilst also supporting marketing and the brand building awareness and loyalty (Cooper et al., 2016). Inspiration drives an idea through to conclusions. Design represents an iterative problem solving approach. Users act as co-creators. Design is innovations-friendly, eases adoption, creates relationships, it helps transform organisations (Hernandez et al., 2017; Tech City, UK 2017).

Andi Davids, Senior Strategist for the design agency Superunion argues that creativity is a process (Superunion, 2018). Davids describes the source of creativity as producing ideas – which help solve problems and inspire humankind. The application of ideas to a business' problems and the profit of solving it is a creative process. The creative process is a tool for change, it encourages collaboration and cultivates empathy. Challenges can be overcome if approached in new or novel ways (Superunion, 2018).

George Cox defines creativity as the generator of new ideas, either in "new ways of looking at existing problems, or of seeing new opportunities, perhaps by exploiting emerging technologies or changes in markets" (Cox, 2005).

Design is helping businesses in the UK develop innovation opportunities, become more productive and profitable (Benton et al., 2018). With applied design thinking, businesses can grow. Products can reach new users and the workplace becomes more effective as people are at the heart of design. As an adaptable, powerful tool the implementation of design results in a 20 times increased business revenue (AHRC, 2013).

Teresa M. Amabile, Professor of Business Administration observes that: "Figuratively, it is impossible to escape the reality that corporations must be innovative in order to survive." Creativity in individuals and innovation in organisations are profoundly interconnected. Amabile defines creativity as the generation of original, practicable ideas of a person or small team, whereas organisational innovation is the effective execution of creative ideas in that organisation. (Amabile, 1988)

Innovation activities are accelerated by the impact of building a brand. Creating user insight helps the organisation to make better decisions and to improve the quality of their products and services (Cooper et al., 2016). Furthermore, design visualisation creates a conversation in the innovation context (Hernandez et al., 2017).

*Design process as method in literature*
The Design Council established the four stages of 'the Double Diamond' that summarises most designers' processes. The first stage 'Discover' depicts background information of the design problem. The second stage of the idea finding process 'Define' clearly outlines prospective ideas brought forward from the first stage, for which then design routes are generated in the third stage 'Develop'. These initial solutions are repeatedly evaluated before the process is finalised with the fourth stage 'Delivery' creating a working concept. A creative approach can be demystified, utilising and iterating 'the Double Diamond' throughout the process (Design Council, 2019).

Accomplished Graphic Designer Michael Bierut expressed his process after frustrated attempts as, to get to know the project through information and conversation with the client and through probable prior experience. Meanwhile, and this might occur before all information is gathered – an idea takes shape – unexpectantly and difficult to comprehend, "like magic", for which then a valid strategy is determined, with a priorly persuaded client proving to be helpful (Bierut, 2018).



Figure 1. *Maker / Magic / Doer.* Image credit: *Bird & Gorton (2019)*

Creative consultancy Bird & Gorton uses a similar 'approach'. When "Maker" and "Doer" come together, "Magic" unfolds, where the two overlap, as shown in figure 1 (Bird & Gorton, 2019).

*In the future – case studies explained*
Each generation may have their viewpoints on technologies of the future. This research identified intelligent transport and space mining as such technologies.

*Intelligent transport*
In Back to the Future Part III (set in 1885), Doc Brown predicts people will run for fun.
"Doc: And in the future, we don't need horses. We have motorized carriages called automobiles.
Saloon Old Timer #3: If everybody's got one of these auto-whatsits, does anybody walk or run anymore?
Doc: Of course we run. But for recreation. For fun.
Saloon Old Timer #3: Run for fun? What the hell kind of fun is that?" (IMDb, 2018)

Further, faster, more affordable as well as safer and punctual travel is made possible through satellites. By road, rail, in the air and at sea journeys become interconnected, creating a complex transportation system. Different technology works together in seamless connectivity, positioned via satellite. Satellite technology serves as a platform for increased transport efficiency, situational awareness and enhanced user experience, bringing together the best of technology. Space data is instantly updated and shared with each other, cutting response times and congestion, creating wealth through integrated logistics (Catapult, 2018).

During the first project 'intelligent transport' knowledge was gained on how satellite technology is used in day-to-day traffic. Whilst contributing to the organisation's innovation by developing a brand language – that is a system of communication for their new to the market app, it was discovered, that 'AI Traffic Flow' is a multi-modal approach to improve productivity of intelligent transport between two major freight feeders in the North West – the Port of Liverpool and Manchester International Airport. Based on a technology design and development project for ambulances, the smart traffic project uses space data via GPS controlled sensors managed by big data principles to ensure green light corridors for, but not reduced to, trusted traders and suppliers moving through the entire urban transport networks that can cut congestion, idle and response times.

Through digitalisation as a tool on-demand, a multimodal future enables smarter cities (Intelligent Transport, 2018). Space data is precise and accurate, it is everywhere, every time. With constellations,

sensors embedded in junctions, bridges and buildings, satellite technology serves as a foundation for autonomous driving, automated parking, recharging, emergency services, air traffic etc. Through design, development and its operation, satellite-based technologies implement navigation and communication with consideration of time and scope in economic terms (Catapult, 2018). The intelligent transport system uses this satellite technology to enable better and more efficient flow of traffic for the users.

*Space Mining*
"Mining the skies is no longer a subject of science fiction stories and movies". What makes space mining profitable is the staggering market value of asteroids. The space mining sector determines probability of asteroid exploration by satellite. With a qualified asteroid in place, its features direct the mining approach. (Sukumaran, 2016)

The second project 'space mining' involved developing a brand of an aerospace start-up and pioneer in UK innovation. The space mining organisation is targeting the off-Earth commercial market with ground breaking technologies that will enable extraction, processing and use of materials from many millions near Earth asteroids (NEAs). At this point, the organisation is generating data to estimate NEAs, finding investors for their first satellite to launch in 2020 ahead of asteroid mining activities.

Asteroids contain large amounts of precious metals (Lewis, 1992), to a greater extent than earthly materials, advancing the economy by "trillions of dollars" (Jamasmie, 2017). They depict an overflow of valuable material that is conducive to space development. NEAs are likely the best starting point for mining activities, due to its reachability, diverse resources and mining achievability. Precious commodities originating from space might soon outrun earth resources (Sonter, 1997). Asteroid Mining is a practicable ecological alternative for the approaching shortages on Earth (Ross, 2001). The aspiring space mining sector with its high profitability indicates a likely shift into a new era (Lewis, 2014), it is compared to a new gold rush, that is hopeful to be beneficial to all people, acting as a driver of human space exploitation (Sterling Saletta and Orrman-Rossiter, 2018). The commercialisation of space exploitation fosters prospective space colonisation and infrastructure (Ross, 2001).

## Method
The mini-projects undertaken are practice-based, which involve the production of creative visual work. This draws upon engagement with key stakeholders in organisations to better understand their innovation, and through the application of design expertise, to help to visualise this. The intention is to 1) understand the nature of innovation, 2) work with the organisation to visualise their innovation, and 3) determine (in collaboration with the project partners) the potential for improvement of innovation and what role visual design may play in this.

The research aimed to pinpoint visual design as a driver for innovation. The two case studies were set in organisations working with satellite and space technology. Through action research, an imminent problem that needed solving was identified, as well as reflection, on how to improve the problem solving process as a benchmark for others. The empirical evidence was analysed primarily qualitatively through framework analysis, via record of direct observations and experiences, a design process was identified and a brand strategy applied to each case and then compared and feedbacked on.

*Design process in this research*
Based on the Design Council's double diamond and Bierut's as well as Bird & Gorton's design approach, a new design process was developed for this research as a practical design method employed in the two mini-projects. This process has elements of design thinking approaches with divergent and

convergent elements, as well as a more complex element in the ideation phase which was previously identified as 'magic'. It is divided into five stages:

| KNOWING | PACE | CRESCENDO | REFLECT | RECOVER |
|---------|------|-----------|---------|---------|

The first stage KNOWING is to determine the organisation's needs, to understand its values and gain insight of its current innovation processes. The second stage called PACE is part of the ideation and making process, where a creative orientation originates and the branding process accelerates. The third stage CRESCENDO was the actual creation of a design route, the peak of the process delivering visual outputs that aim to communicate the organisation's innovation. The fourth stage REFLECT is to articulate feedback and advocate design application. And lastly, RECOVER stands for impact, connection to other mini-projects and to leverage future tech innovation. This process then iterates and can be compared to one another. The various stages often overlap and intertwine, generating a complex structure, unique to the organisation it is applied to.

## Findings

The design process was applied and duplicated into the two case studies within organisations: an intelligent transport and a space mining project. Each stage of the brand creation or development process had input from the industry partner, during which data was collected through research observational notes, surveys, interviews and feedback.

### Case Study 1: Intelligent Transport Project

Case Study 1 was conducted between March and July 2018, where the company aimed to accelerate their innovation by creating a cohesive brand language that reflects the technical nature of the project. The company was also seeking to utilise the project as an umbrella activity to help them move forward to introduce their new product to the market.

KNOWING – After an initial briefing from the partner organisation, the requirements for a brand language emerged for the smart traffic project. This involved developing a brand language which could now serve as a foundation for brand communication supporting new business development opportunities. PACE – This stage included the research on how brand language can be used to communicate the innovation process whilst identifying a suitable font, form, colours and illustration style. Key to this research addressed the exploration of how visual design can leverage innovation in future tech companies.



Figure2 *Logo development – from tilted square to free flowing shape.* Image credit: J. Adler (2018).

PACE – For the company's brand new smart transport project, the initial idea was a tilted square or diamond shape with four sides / corners pointing into the air or space, rail, road and sea connecting freight etc. via different modes of transport, see figure 2 and 3. CRESCENDO – During the process of creating the logotype, it became evident that the design needs to adopt a flexible role within development projects. The naming process (PACE) as part of the branding process had three parts, with the chosen name for the brand 'AI Traffic Flow'. CRESCENDO / REFLECT – With 'flow' in the name, the idea of the tilted square had to become more flexible in shape – an unconfined, more organic, yet interconnected shape was formed, within the parameters of the shape of a diamond with four sides.

5

A gradient of traffic light colours with the green light prevailing has helped shaping the logo for the new business case, as shown in figure 2.



Figure 3 *AI Traffic Flow, screenshot from explainer video.* Image credit: Red Ninja (2018).

The logotype was key to the company's brand development, with its shape and colour palette, adaptable to further brand applications, as shown in figure 3.

*Case Study 2: Space Mining Project*
From October 2018 until April 2019, the collaboration with a space mining organisation culminated with the creation of a tailored, flexible design strategy. The priority of the project was to attract investors for their first satellite launch in 2020 ahead of asteroid mining activities, using ground breaking technologies that will enable extraction, processing and use of materials from near Earth asteroids. The project involved brand development to communicate the organisation's innovation by promoting an optimal market position, concluding with a visual portfolio that also intends to assist the internal structure of the organisation.
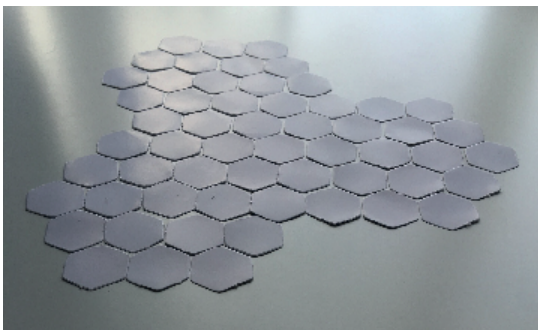


Figure 4 *Hexagon shapes to create a visual of the logotype.* Image credit: J. Adler (2019).

KNOWING – The space mining organisation's needs and wants were clarified during a conversation with the CEO and a variety of colleagues, e.g. engineers, geologists and designers, in the beginning of the project. The need of an investment brochure was most pressing to find additional funders for the upcoming satellite launch. A professional identity was desired with a business card specifically as a first impression of the start-up's brand when attending events etc. PACE – To advance the development of the organisation's brand, a creative orientation – an initial concept of prospective imagery, fonts, layout and colours, was designed to get an idea, how the identity is anticipated to look and feel.

6

Figure 5 *Creative Orientation (p6/10).* Image credit: J. Adler (2019).

CRESCENDO – A font was determined for bold, extended headers that represents attention, power and the horizon, urging slow reading to make keywords memorable. Depicting a contrast to the element of brand language and different uses of copy, the font for shorter text is geometrical and contemporary, and for main text a distinctive serif font was selected, that is easy to read. A thin line was formed as the brand element, complementing delicate perfection and contrasting the logotype's hexagon shapes. The line depicts quality and weightlessness – near zero gravity, that is pointing upwards in the reader's direction, diagonal, indicating floating in space and open-endedness, that symbolise excitement, anticipating growth. The amber shade depicts energy and looks confident and cheerful, combined with impartial, yet sophisticated warm grey tones, it creates a spectacular mood, especially when applied to imagery, see figure 5. REFLECT – In combination with the existing logotype and characteristic hexagon shapes, the brand was developed to create meaning directly linking to the organisation's innovation by building confidence in the organisation's propositions. The response was, that presenting a coherent, professional identity acts as a conversation starter that is adapted and further developed in the organisation's processes.

RECOVER – both case studies.
In response to the Industrial Strategy, the two mini-projects discussed in this paper address issues such as the improvement of productivity by developing innovative opportunities, entering new markets and improving access to information through design solutions as a communication tool between entrepreneurs and funders. The projects depicted support for local SMEs and start-ups, and as a result, a shift in thinking and value to the region (North West of England, UK). During the projects, creative thinkers sat on one table with engineers and business people among others as a catalyst for collaboration, stimulating innovation. The projects highlighted that within activities of cross-industry collaboration, there is a need to listen to a variety of voices to understand and balance collective perspectives and use this to inform the project development. Future technology has been opened up to a traditional workforce, e.g. whilst industry partners may think millions need to be invested to improve roads and build bridges, small interventions like sensor technology can be the answer, as a result of different ways of viewing the problem. A designer can help visually communicate this. Furthermore, creativity assisted in introducing new audiences to advancements in technology, instigating excitement of exploring developments with the organisation, ingeniously combining new technology with traditional ideas.

## Discussion
The first case study, the intelligent transport project offered the opportunity to create a brand and through this development, the author was able to communicate the underlying innovation. These activities could lead to a business case to enter new markets.

7

A brand can serve as a transformative tool and a quality asset to a company. It helps the user to gain confidence in a product, service or process, increasing profit and productivity and advancing other innovation activities. Design visualisation instigates conversation.

Concerning the second case study, users can get excited with space exploration and exploitation. Brand development here can lead towards securing of funding by generating a professional identity that improves the organisation's presentation, helping to establish partnerships. The promotion for an optimal market position is crucial at a stage where funding is still needed for a satellite to launch prior to space mining activities.

## Conclusion

The hybrid of visual design communicating innovation in the field of satellite and space technologies was the driver for this research. Two collaborative case studies including a brand creation for an intelligent transport application and a brand development for a space mining start-up were examined. In the context of the UK Government's Industrial Strategy, visual outputs helped build a business case to enter new markets and advance communication with prospective funders. The contrasting projects applied the same design process, that was tailored for this research, resulting in a complex structure. The process was divided into five stages, namely KNOWING, PACE, CRESCENDO, REFLECT AND RECOVER that inform, generate and advocate new approaches to solve a problem, creating opportunities conducive to innovation.

Possible further case studies not discussed in this paper that include brand creation, development and application, are established in the fields of space engineering, education in space settlement and remote sensing.

A next step and additional opportunity for the evaluation of research findings, may involve the presention of the bespoke design process and findings to a creative agency in order to get alternative perspectives through feedback during interviews.

## Acknowledgement

## References

AHRC, 2013. *The Value of Design*. YouTube. ahrcpress. https://www.youtube.com/watch?v=nNy1wxnFq8Y (Accessed 29 Sep. 2018).

Amabile, T.M., 1988. *A model of creativity and innovation in organizations*. Research in organizational behavior, 10(1), pp.123-167.

Bason, C., 2015. *Why the world's leading organisations are looking to design*. Design for Europe. http://www.designforeurope.eu/news-opinion/why-world-s-leading-organisations-are-looking-design. (Accessed 30 May 2018)

BEIS., 2017. *Industrial Strategy: Building Britain for the future*. London. https://doi.org/10.1049/ir:19930092 (Accessed 29 Sep. 2018).

Benton, S., Miller, S., & Reid, S., 2018. *The Design Economy 2018*. https://www.designcouncil.org.uk/resources/report/designeconomy-2018 (Accessed 29 Sep. 2018).

Bierut, M., 2018. *Now you see it and other essays on design*. New York, NY: Princeton Architectural Press, pp.20-21.

Bird & Gorton, 2019. *Our Approach — Bird & Gorton*. https://birdandgorton.com/our-approach (Accessed 20 Jun. 2019).

Catapult, 2018. *Intelligent Transport Programme – Catapult*. https://sa.catapult.org.uk/our-focus/intelligent-transport (Accessed 10 May 2018).

Cooper, R., Hernandez, R., Murphy, E. and Tether, B., 2016. *Design Value: The Role of Design in Innovation*. Lancaster: Lancaster University.

8

Cox, G., 2005. *Cox Review of Creativity in Business: Building on the UK's Strengths*.
http://webarchive.nationalarchives.gov.uk/20120704143146/http://www.hm-treasury.gov.uk/d/Cox_review-foreword-definition-terms-exec-summary.pdf (Accessed 12 Dec. 2018).

Design Council, 2019. *The Design Process: What is the Double Diamond?*. https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond (Accessed 21 Jun. 2019).

Hernandez, R., Cooper, R., Tether, B. and Murphy, E., 2017. *Design, the language of innovation*. (26), pp.1-14.

IMDb., 2018. *Back to the Future Part III (1990)*. http://www.imdb.com/title/tt0099088/quotes (Accessed 7 Sep. 2018).

Intelligent Transport, 2018. *Intelligent Transport's top five lessons from InnoTrans 2018*. https://www.intelligenttransport.com/transport-articles/72027/intelligent-transports-top-five-lessons-innotrans-2018 (Accessed 29 Sep. 2018).

Jamasmie, C., 2017. *Luxembourg shoots for the stars with fresh space mining deal*. MINING.COM. https://www.mining.com/luxembourg-shoots-stars-fresh-space-mining-deal. Accessed 18 Jun. 2019.

Lewis, J. S., 1992. *Extraction of volatiles and metals from extraterrestrial materials*. Lunar and Planetary Laboratory, The University of Arizona, p.5.

Lewis, J. S., 2014. *Asteroid Mining 101: Wealth for the New Space Economy*.

Ross, S.D., 2001. *Near-Earth Asteroid Mining*. Space Industry Report, pp.1-4.

Sonter, M.J., 1997. *The technical and economic feasibility of mining the near-earth asteroids*. Acta Astronautica, 41(4-10), pp.637-647.

Sterling Saletta, M. and Orrman-Rossiter, K., 2018. *Can space mining benefit all of humanity?: The resource fund and citizen's dividend model of Alaska, the 'last frontier'*. Space Policy, vol. 43, pp.1-6.

Sukumaran, P.V., 2016. *Mining Asteroid Resources*. Journal of the Geological Society of India, vol. 88, no. 1, p.125.

Superunion, 2018. *Creativity is a process, not a discipline*. https://www.superunion.com/insights/creativity-is-a-processnot-a-discipline (Accessed 5 Jul. 2018).

Tech City UK, 2017. *Tech Nation 2017*. https://technation.techcityuk.com (Accessed 29 Sep. 2018).

The European Design Leadership Board, 2012. *Design for Growth & Prosperity*. Helsinki, Finland: DG Enterprise and Industry of the European Commission, p.46.

Transformation North West Cohort – Adler, J., Blackwell, B., Costabile, I., Kallegias, A., Kowalska, P., Latham, G., Omar, L., Partha, C., Pialorsi, V., Robins, J., Street, J. and Wareing, L., 2018. *Driving Industrial Strategy for North West Growth – the Role of the Creative Industries*. Transformationnorthwest.org. https://transformationnorthwest.org/wp-content/uploads/2018/06/2018_TNW_Driving_Industrial_Strategy_for_North_West_Growth.pdf (Accessed 18 Sep. 2018)

**Design Thinking Research Symposium 13:**

**Expanding the Frontiers of Design: A Blessing or a Curse?**

**March 22-24, 2022, Technion, Israel Institute of Technology,**

**Haifa, Israel**

(Adler et al., 2022)

# Design communicating space tech innovation

**Janett Adler**, **Jea Hoo Na** and **Martyn Evans**

Manchester School of Art, Manchester Metropolitan University; janett.adler@stu.mmu.ac.uk, J.Na@mmu.ac.uk, Martyn.Evans@mmu.ac.uk

**Abstract**. This paper explores the role of visual design in the high-tech sector in the UK. It presents a design thinking model suitable for communicating innovation values of UK based satellite and space tech organisations. It comprises findings from five case studies involving design-led brand development and creation. Research challenges were identified during the process of combining design with future technologies, including the development of an effective problem-solving approach that helps build business cases to enter new markets, enhancing communication with prospective funders, and establishing a professional level brand identity that is representative of innovative organisation culture. A new design thinking model was developed using a hybrid of case study and grounded theory methodologies through engagement with industry partners in the North West of England, UK. These together inform, generate and advocate solutions for enhanced collaboration between design and the space tech industry.

**Keywords**: brand creation, communication, design thinking, innovation, space technology

## 1    Introduction and literature review

The research explored how a bespoke design thinking model and subsequent design practice can effectively represent innovation culture in space technology organisations. Therefore, the aim of this research was to establish the effect that design can have on communicating innovation and technology, chiefly the impact design can create in the industry. Hence, the objective of the secondary research was outlined as a contextual review with literature search directed at the presented overlapping areas, see Figure 1. As an industry of the future with enormous potential for growth and a vast area for new inventions and exploration, has always been and still is an inspiration to all generations. With the Space Sector Deal of the UK Government's Industrial Strategy, a policy intended to boost the UK economy, a 'new space age' has taken off (Satellite Applications Catapult, 2018) and productivity is increased where space collaborates across sectors (Space Growth Partnership, 2018). The five projects conducted for this research explore how visual design and creative techniques can contribute to growth and prosperity, fostering impact in the region, fuelling the imagination of prospective audiences, and communicating new ideas to a world that is constantly adapting and adjusting itself.
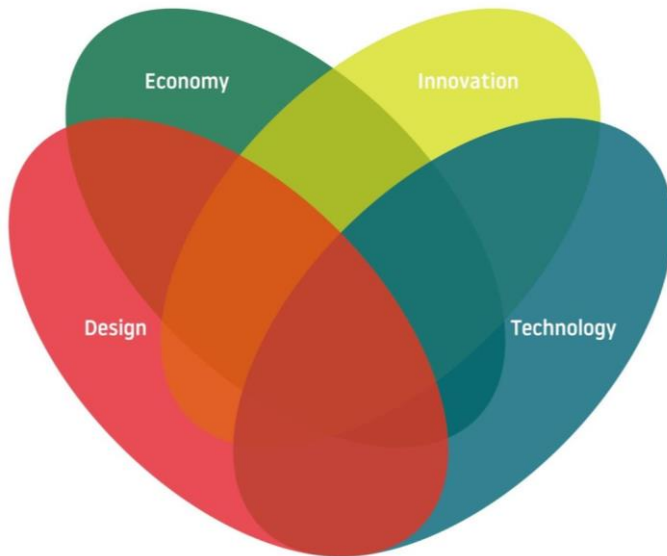
**Figure 1.** Overlapping areas with possible emerging themes.

The relationship of design and innovation in space tech was the key driver of the contextual review that served as a platform for the work with project partners. How visual design can contribute to growth of the economy by communicating space tech innovation was the core question that helped examine the relationship of the emerging themes. Here are some of the insights the author found.

Design generates competitive advantage, it contributes to the success of new products and adds value to businesses (Hernandez et al., 2017, Verganti, 2009). Design helps to give meaning to a product and helps make sense of a task (Verganti, 2009). Design is one of the main drivers for innovation and productivity, it advances economies and proposes clusters (Hernandez et al., 2017). Design skills achieve long-term productivity and portray innovation (Design Council, 2017). Businesses are in need of new patterns in innovation with value creation, idea generation and implementation, motivated leadership and commitment (Parmar et al., 2014). For design this means: differentiating to advance markets; developing new products; creating business opportunities and managing change; improving brand value that is inclusive, growth that can be exponential, needs and desires that can be understood, and ensuring employees are satisfied and new markets established. Collaboration allows interaction and informal communication that are conducive to innovation. Design thinking is capable of evaluating organisations' challenges (Borja de Mozota, 2006). Design helps businesses develop innovation opportunities, and to become more productive and profitable (Benton et al., 2018). With applied design thinking, businesses can grow (AHRC, 2013).

Organisations are advancing by embedding design into their innovation processes (Bason, 2015). The hybrid between future tech and creative design serves as a pioneering instrument and concurrently as a consistent quality asset. Design can enhance productivity and communicate future technology to new users (Transformation North West Cohort, 2018). In a steady progression, design is increasingly linked to branding. It is capable of learning about new audiences and working strategically, breaking through to new markets (Verganti, 2009).

As the author created and developed brands for partners in the industry, it was crucial to build a base through researching the areas from background secondary resources about design, economy, innovation and technology respectively.

## 2  Methodology

The research methodology can be understood as exploratory in the context of this empirical research. It was a hybrid of scientific inquiry with the dynamic of creative input. Research in the field of visual design can be an analytical as well as a practical tool, bringing about critical thinking and mature design practice (Noble and Bestley, 2011). Two intertwining methodologies were used to produce holistic insights from contrasting evidence. Together, case study and grounded theory methodologies foster exciting research that has had minimal attention up to now. From an interpretivist perspective (Salmons, 2016), involving the research aim from the start, data collected during case studies was analysed through coding concepts and categories, and recognising patterns (Chun et al., 2019), concluding in grounded theory. As an ambassador for all project partners, the researcher examines the data and explains it, creating a new hypothesis that is open to change (Pettigrew, 1997), while obtaining a perspective that encourages a flexible process (Mills et al., 2009). Grounded theory operates as a way of analysing all contexts, e.g., qualitative secondary research in the form of literature review, and primary research from case studies and therein focus group discussions (FGDs) that include workshops and in-depth discussions with industry partners. Through a design thinking process, case studies generated both low- and high-fidelity prototypes. Exploratory interviews with stakeholders in person and online together with feedback served as further primary research resources that attempted to relate back and link up to the secondary research at the beginning. The methodologies were concerned with the main aim that focussed on objectives, as seen in the research structure, see Figure 2.
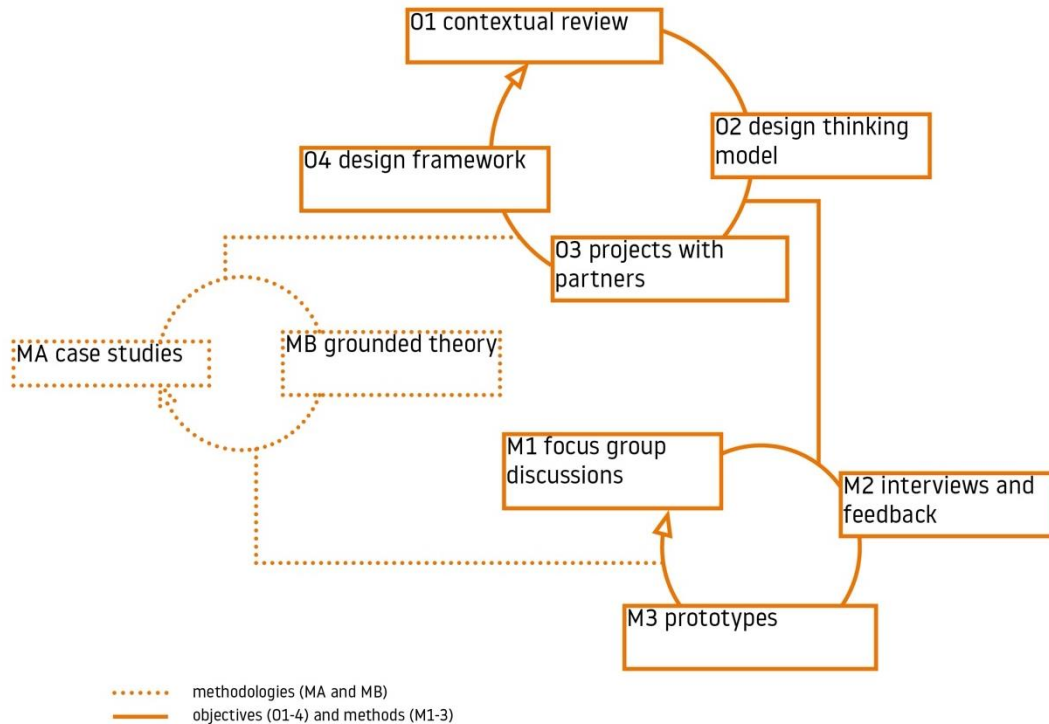
**Figure 2.** Research structure – the relationship of research objectives (O1-4)), methodologies (MA and MB) and methods (M1-3).

The aim of this research was to answer how communicating the values of space tech organisations through a design thinking process can work towards creating a culture of innovation. Using the sequence diagram (Figure 2), the research aim could be broken down into objectives that could be fulfilled via methods to create new, thought-provoking knowledge. The core question was examined using case studies (MA) and grounded theory (MB) as this research's applied methodologies. This included initial coding, the interrogation of all collected data, and the creation of concepts, concluding in a theory to methodically establish the hypothesis (MB). The data investigated was collected in focus group discussions (FGDs), interviews, feedback and prototypes (M1-3) through the five case studies with project partners (O3). It was generated through testing and failing (Silverman, 2017) and prototyping again in a constant loop (M3), using the design thinking model (O2). The benefits were that through coding, data could be explained and the interdependence of methodologies, methods and processes promoted practicable quality (Chun et al., 2019). However, when looking at data and producing theory (MB), a constraint implied that the research may lose some of its energy and become passive (Krippendorff, 2006). The researcher's chosen combination of the two methodologies with a substantial amount of practical work as case studies (MA) helped create a unique dynamic interrogating grounded theory (MB).

As part of the contextual review (O1) the researcher was analysing background literature, working with organisations (O3) and interviewing its employees (M2), using an interpretivist research philosophy (MB) with a focus on innovation of satellite and space technologies, design and its contribution to innovation that were anchored in the Industrial Strategy of the UK Government.

The author undertook workshops as part of focus group discussions (FGDs; M1) in collaboration with colleagues as well as industry partners (O3) in order to establish a design framework (O4), through grounded theory (MB) that implemented primarily qualitative research, and identified a matrix which served as a map as part of the design thinking model (O2).

When thinking about the research approach, its epistemology, theoretical perspective, methodologies and methods are exploited (Crotty, 1998). Primarily constructionist – through a tailored design thinking process brands were created or developed with lo-fi (low-fidelity) prototypes along the way that meant that the prototypes embodied knowledge. Figure 3 depicts the cross-fertilisation of the various methods used in this research, creating a landscape of both case studies and grounded theory methodologies, all in the relationship of theory and practice.
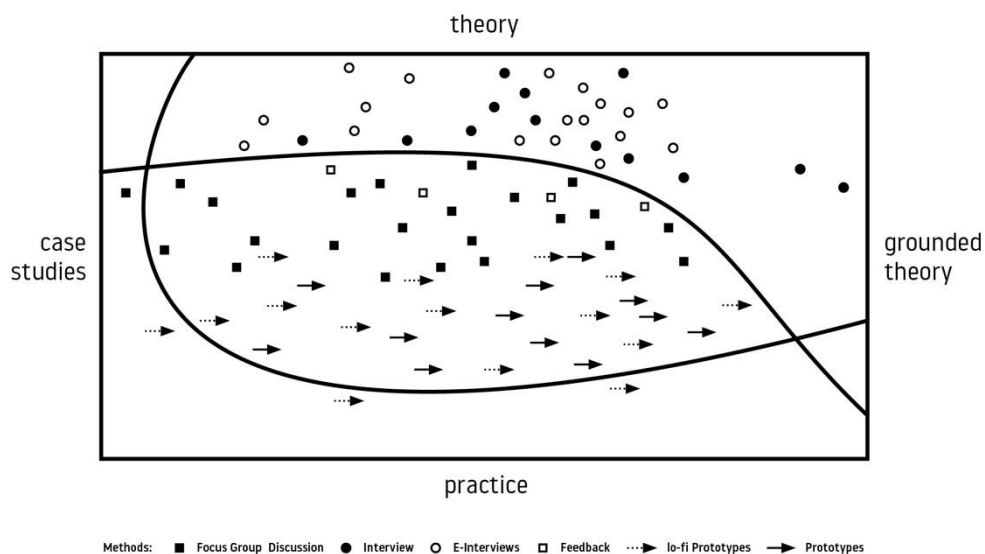


**Figure 3.** Landscape of methodologies with methods used in context of research practice and theory.

Though research may seem to be a idea that is remote from design practice, it can be a motivating force for makers. Intuition rather than creating meaning? Thinking, albeit not too structured, and analysing when creating visual prototypes, helped evaluate new insights. This is design research in its most applicable way: using a design process for design practice is the combination of making and thinking (Frayling, 1994).

## 3   Design thinking

The author gained advanced insight from literature sources and interviews that helped create a platform from which a bespoke design process could be derived, which is both practicable and can serve as a base for all future case studies. The author's own experience as a design practitioner with a background in visual design, particularly in branding, has helped shape the design thinking model further, because "Branding has become such a well-known concept, that both in the public discourse and academia most people are well aware of the business dynamic of a good brand…" (Schroeder and Salzer-Mörling, 2006:145).

The literature search generated a couple of key sources that helped evaluate the author's tailored model. With its 'Double Diamond', the UK Design Council established four stages – 'discover' 'define' 'develop' and 'deliver' – that summarise and support many of the designers' processes. A creative approach can be demystified, utilising and iterating the stages throughout the thinking process (Design Council, 2019). The Hasso Plattner Institute of Design at Stanford has also been instrumental in individual and organisational understanding of 'design thinking' as a corresponding process. This goes through six stages: 'empathise', 'define', 'ideate', 'prototype', 'test', and 'assess'. The design process is not essentially linear and can be enacted according to organisations' or individuals' requirements, enhancing their innovation methods. Design thinking can be applied to existing challenges at work, employing design tools, and respecting collaborative approaches and personal growth in the process. The design thinking process helps develop insights through re-evaluation of perspectives, it appropriates the creation of prototypes that are then tested in relevant conditions to assess their value, with repetition and refinement of the individual stages to generate new working practices, techniques and equipment (Stanford d.school, 2019). Different design agencies' approaches, such as Fitch, Superunion, Pentagram, Interbrand, Landor and Wolff Olins, also matched up with the Design Council's and Stanford's design thinking processes.

The author interviewed a UX Designer and UX Researcher at a large social media company to gain further insight into the influence design thinking has on their work and the people they work with. Aside from the significance their adapted processes have for innovative thinking, the UX Designer also specifically identified the use of visual design to establish partnerships from a new business perspective: "For two almost identical products or services [to be] considered, the delights of visual design can make the difference in people being more comfortable using the one or the other" (UX Designer, 2020). Branding played a crucial role in distinguishing an organisation or a product from competitors, and interviewees also highlighted the importance visual brand applications play in being perceived as more innovative than their competitors.

To advance an approach tailored to the satellite and space sector, a new design process was developed for this research as a practical approach, and employed in five projects. This process has elements of design thinking approaches with divergent and convergent activities, as well as a more complex feature in the ideation phase which can be understood as "magic" (Bierut, 2018:20-21). This model is divided into five stages, see Figure 4. However, rather than working simply stage by stage, the various stages are to be seen as a holistic investigation, where parts often overlay and intertwine in a constant loop of iteration within individual stages as well as some or all stages together, generating a complex structure, unique to the organisation or product to which it is applied.
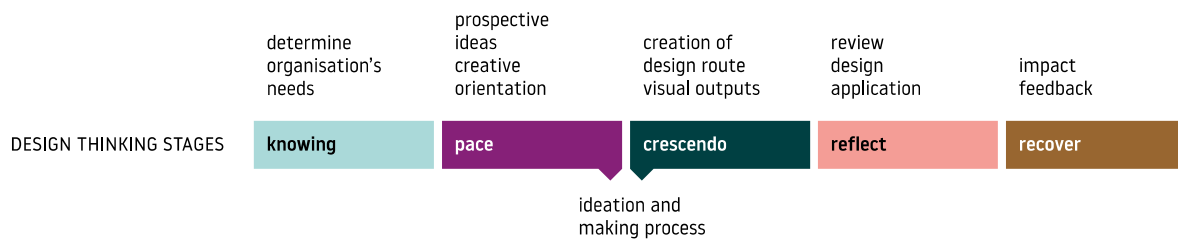
**Figure 4.** Design thinking model – individual stages.

The names were developed on reflection of each stage's specialism. The first stage KNOWING is to learn to understand and determine the organisation's needs, to listen to its values and gain insight into its current innovative projects. The second stage PACE means progressing steadily, and is the first part of the ideation and making process, where initial ideas are taking shape, a creative orientation originates and the branding process accelerates. The third stage CRESCENDO, where ideas and making culminate, is the actual creation of a design route, the peak of the process delivering visual outputs that aim to communicate the organisation's innovation. The fourth stage REFLECT is to review, revise, to apply and advocate design elements to a publishable output. And RECOVER stands for impact in connection to the UK Government's Industrial Strategy to help productivity in adding value to the economy, and in articulating feedback from the partner organisation and its stakeholders. This model and individual stages iterate as the author tailors them to each project independently without restriction, which then can be compared to the other case studies in order to draw overall conclusions.

Augmenting the design thinking model, the author created a design thinking activity map (see Appendix) that served as an analytical framework, summarising as well as comparing key elements of the work done with partner organisations that were useful to the research. It is a model that unfolds how different types of analysis were carried out and directly links to the research aim. The distinctive design thinking stages are presented in relationship to the input, actors, activities and output of each case study.

The individual case studies of collaboration with project partners are presented in the following sections with found data interpreted for the reader.

## 4   Intelligent transport

The author designed a visual language, using the design thinking model to communicate innovation in the first project, 'intelligent transport', that uses satellite technology to improve traffic flow. The visual output in the form of a brand assists the company in building a business case to take the project onto the market.

Intelligent transport is a multi-modal approach to boost productivity in freight transport for two major freight feeders in the North West – the Port of Liverpool and Manchester International Airport. Based on the design and technology company's earlier project that allows ambulances to get through traffic faster (GOV.UK, 2017), the smart freight project uses space data via GPS / VPS controlled sensors managed by big data principles to ensure green light corridors for, but not reduced to, trusted

traders and suppliers moving through the entire urban transport networks that can cut congestion, and idle and response times. Intelligent mobility is achieved, addressing future industrial, political, societal and environmental challenges (Catapult, 2018).

The technology company aims to communicate their innovation by creating a cohesive brand language for their intelligent transport application that reflects its smart nature. The company was seeking to utilise the project as an umbrella activity to help them move forward in introducing their new product to the market.
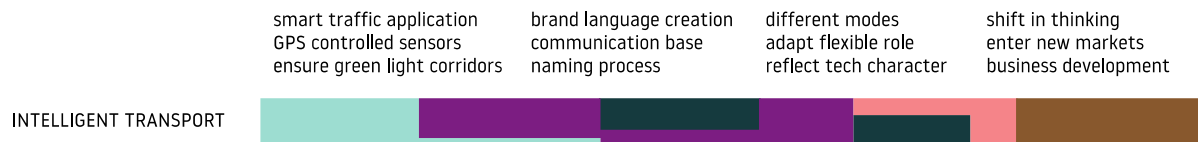
| | smart traffic application GPS controlled sensors ensure green light corridors | brand language creation communication base naming process | different modes adapt flexible role reflect tech character | shift in thinking enter new markets business development |
|---|---|---|---|---|
| INTELLIGENT TRANSPORT | | | | |

**Figure 5.** Design thinking milestones. Intelligent transport.

KNOWING – Through FGDs, the author gained insight, into how satellite technology is used in day-to-day traffic. After the initial briefing from the partner organisation, the requirements for a brand language emerged for the smart traffic project. This involved creating a brand that could now serve as a foundation for brand communication supporting new business development opportunities.

PACE – This stage included research on how brand language can be used to communicate an innovative product by establishing form, colours, and a relevant font and illustration style.

The activities in this first part of the iterating design process included: contextual observation; decision matrices and mind mapping; and the creative orientation as an output with designers, with the digital lead and CEO involved (see design thinking activity map in the Appendix).

**Figure 6.** From tilted square to free-flowing shape, creating brand language.

PACE – For the company's new smart transport project, the original idea was a tilted square or diamond shape with four sides, corners pointing into the air or space, rail, road and sea connecting freight etc. via different modes of transport. CRESCENDO – During the process of creating the logotype, it became evident that the design needed to adapt a flexible role within the development of the project. PACE – The naming process as part of the branding process had three parts, with the chosen name for the brand 'AI Traffic Flow'. CRESCENDO / REFLECT – With 'flow' in the name, the idea of the tilted square had to become more flexible in shape – an unconfined, more organic, yet interconnected shape was formed, within the parameters of the shape of a diamond with four sides. A

gradient of traffic light colours with the green light prevailing has helped shape the logo for the new business case, as shown in Figure 6.

Here design outputs involved prototypes of the brand name, a design route and brand elements, the author was collaborating with one of the animators and the digital lead. Brand guidelines were created as well as a business model canvas. The author learned to adapt when finding the brand name, changing the direction of the design route; lo-fi prototypes helped embed that change.

RECOVER – The logotype was key to the company's brand development, with its shape and colour palette being adaptable to further brand applications, e.g., the author worked closely with one of the company's animators to create an explainer video to exploit and apply the visual design elements developed for this project. For the CEO of the company, the project was an opportunity to access talent for real-life industry collaboration that resulted in distinctive brand creation for an innovative product (Intelligent transport CEO, 2019). In response to the Industrial Strategy (BEIS, 2017), the project depicted support for a local SME, and as a result, a shift in thinking and value to the region, and it addressed issues such as the improvement of productivity by developing innovative opportunities, e.g., entering new markets. During the project, in FGDs, creative thinkers sat at one table as a catalyst for collaboration, stimulating innovation with engineers and businesspeople, freight and logistics specialists and a transport director. The project highlighted that within activities of cross-industry collaboration, there is a need to listen to a variety of voices in order to understand and balance collective perspectives and use this to inform the project development. The role of creative thinkers included facilitation and visual communication in these collaborations, enabling cross-pollination of ideas that were not previously considered. As a result, making future technology more receptive to more traditionally minded employees and partners, who may think millions need to be invested to improve roads and build bridges, small interventions like sensor technology can be the answer, as a result of different ways of viewing the problem.

The researcher created a brand language for this particular project which could then serve as a foundation for publications and brand applications as well as deriving businesses from it. The author specifically looked at how brand language impacts the company's innovation to cultivate a shift in long-term thinking, entering new markets and developing new business, while identifying suitable visual design tools. Lessons learned include adapting to change within the ideation and making phase, and that good communication in FGDs prevents misunderstandings because of the problem being well defined.

## 5  Asteroid mining

The second project partner is looking for funders for a first satellite launch ahead of asteroid mining activities. The author developed the brand to communicate the organisation's innovation and promote it for an optimal market position.

The collaboration with the space mining start-up culminated in the creation of a tailored, flexible design strategy. The priority of the project was to attract investors for a satellite launch that would then

allow activities to follow, using ground-breaking technologies that will enable extraction, processing and use of materials from near-Earth asteroids. The project involved brand development, concluding with a visual portfolio that aided in promoting the start-up externally, and to assist the internal structure of the organisation.
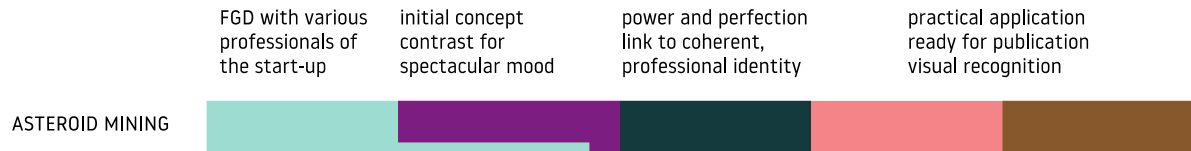


**Figure 7.** Design thinking milestones. Asteroid mining.

KNOWING – The space mining organisation is targeting the off-Earth commercial market. Asteroids contain large amounts of precious metals (Lewis, 1992), to a greater extent than materials on earth, potentially advancing the global economy (Jamasmie, 2017). "Mining the skies is no longer a subject of science fiction stories and movies" (Sukumaran, 2016:125).

During a FGD with various professionals in the company, the CEO, engineers, a geologist and designers, the need for a professional identity including key elements such as an investment brochure was found to be most pressing to find additional funders for the upcoming satellite launch, as well as a business collateral for presentation externally and structure internally.

PACE – To advance the development of the organisation's brand, the author designed a creative orientation – an initial concept of prospective imagery, fonts, layout and colours, to get an idea of how the identity was anticipated to look and feel.



**Figure 8.** Creative orientation.

CRESCENDO – The Microgramma font was determined for bold, extended headers that represent attention, power and the horizon, urging slow reading to make keywords memorable. Depicting a

contrast to the element of brand language and different uses of copy, the Silka font for shorter text was chosen to look geometric and contemporary, and Noto serif font was selected for the main text for a distinctive yet easy-to-read quality. A thin line was formed as the brand element, complementing the brand image depicting 'delicate perfection' and contrasting the logotype's hexagon shapes. The line depicts both quality and weightlessness – near zero gravity that is pointing upwards in the reader's direction, and diagonal, indicating floating in space and open-endedness that symbolises excitement, anticipating growth. The amber shade depicts energy and looks confident and cheerful, combined with impartial, yet sophisticated warm grey tones, creating a spectacular mood, especially when applied to imagery, see Figure 8.

REFLECT – In combination with the existing logotype and characteristic hexagon shapes, the brand language was developed to create meaning directly linked to the organisation's innovation by building confidence in its propositions.

RECOVER – A coherent, professional identity acts as a conversation starter that is adapted and further developed by the organisation. The design-led approach was valuable in creating the corporate identity, but it was also considered as a beneficial tool to developing the business. For the pioneer in Space Resources, the opportunity to conduct an innovative approach to design that represents the industry is the most practical application, yet one that challenges the norm. With the investment brochure ready for publication, the organisation is moving forward to the investment stage of the business model, helped by the brand development to become visually recognised and the Asteroid Mining concept to be accepted. A professional brand contributed to the start-up's confidence, a momentous development in the organisation's history with considerable impact on its business (Asteroid mining CEO, 2019).

## 6   Space engineering

A rebrand was welcomed by the third partner that is working to explore and develop space with four subdivisions, including lunar and Mars rovers, rocketry, space balloons, and cansat, which are can-sized satellites. The space engineering organisation aims to attract more sponsors, partners and potential colleagues with enhanced presentation through new brand creation.

This project immediately had an entirely different dynamic to the design thinking process, see Figure 9. The student society concerned with space exploration and development is based at a university in England's North West and is successfully involved in worldwide competitions as well as workshops to educate and encourage the next generation.
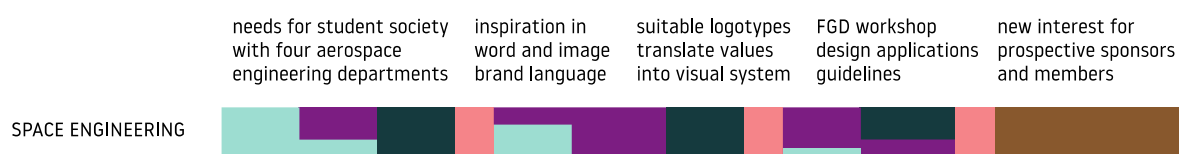


**Figure 9.** Design thinking milestones. Space engineering.

KNOWING – The UK Space Agency is increasingly working together with academia with an interest in research and development of space tech innovation (Grossman, 2020). The space engineering partner has four departments. 'Rovers' has its focus on robotics with distinct teams from diverse backgrounds for a lunar and Mars rover that will go through a design and quality process to create a working object for a challenging environment. 'Rocketry' concentrates on robotic, hybrid rockets. The department is concerned with self-landing mechanisms and looks at a possible launch from a space balloon. The 'high altitude balloon' moves comfortably into the stratosphere, this department is science- and practice-focussed. 'Cansat' is short for a satellite, the size of, and moreover a satellite built in, a can. A cansat is usually launched from a research rocket in order to imitate an industry-like satellite with its duration from first design to review following a flight. A diverse team of students working in science, space technology and engineering, is entrusted to this organisation. All departments are engaging in projects individually or collaborating together and with stakeholders (Issuu, 2019; Manseds, 2019).

The first brief was to find a suitable logotype for the organisation as a whole, with the knowledge that there are sub-departments to follow. While learning about the organisation's values and what it wants to convey, the question arose as to how these can be translated into a visual system that works. PACE – The original creative orientation involved finding the right inspirational words to describe values that could then be decoded into images in the aerospace engineering context.

CRESCENDO – The character inspiration already started extracting a number of ideas on potential colours, typography, brand language and illustration style. The insight for the primary colour 'sky vs sea' came from looking back to earth from space. Supplementary colours were established alongside six secondary colours to have a comprehensive choice for versatile usage. The Ailerons font as the basis for the organisation's main logotype, made up entirely of the letters in its name, is integrated into the space environment and has a timeless look. Another font, Bariol, was found for the tagline and text in contrast to the main logotype and to allow more of the organisation's values to come through, having a friendly and accessible appearance. REFLECT – A clear-cut, delicate logotype in the space context is used to set the organisation apart from other branches in the UK and internationally as well as serving as an umbrella to the four different departments.

KNOWING – Rover, rocketry, balloon and cansat depict the sub-divisions of the student society with the objective to create a coherent and accessible brand. PACE – Appropriate for a replay mode, logo icons were the most suitable with recognisable graphics, characteristic for each separate department, yet together identifiable as one organisation. The circular shape indicating the movement in orbit, that is infinite, limitless and complete.

**Figure 10.** Logotypes for primary brand and sub departments.

CRESCENDO – The initial prototype logos were of great detail within the parameters of a circle and of previously determined colour and imagery palette. REFLECT / KNOWING – During a FGD workshop, co-designing with department heads and the organisation's president included mind mapping, card sorting and scribbling, a simpler design was preferred that can be scaled as needed.

PACE – In-depth insight helped the author uncover the visual implementation of the various departments' characteristics allowing for interesting angles, contrasting shapes and cropped elements, see Figure 10. CRESCENDO – With moving, yet captured logo icons, brand guidelines were created including proposed brand applications for strategic design use on different types of layouts and brochures, websites, and on textiles etc., and use of illustrations e.g., in explainer videos, flyers and posters. REFLECT – This project has become much more layered, with reiterating elements to solve a complex task for an organisation that wants to set itself apart from other branches and its parent organisation nationally and internationally, and to bring about a varied brand that makes itself and its divisions comprehensible.

RECOVER – Creating a brand for a space engineering organisation has resulted in a valuable kit that translates a name into an identity to share the interest of space exploration and development and to address prospective members, partners and sponsors. The design thinking process and subsequent successful rebranding work by the author was the result of integrating the organisation's interests and activities by understanding its ambitions and preferences. This project provided the evidence that design can help understand innovation through visual communication, which encourages funders to consider higher-risk yet innovative organisations that create new products, facilitating the growth of entrepreneurial thinking in the region (Space engineering President, 2019).

# 7 Remote sensing

The fourth partner is mapping wildfire patterns via satellite earth observation (EO) data. By understanding and exploiting the power of visual design, the remote sensing company is able to reach new audiences, and initiate enthusiasm in the space industry and the nature of its work.

The remote sensing start-up's new brand was created to enhance its presentation. The award-winning company is interpreting radar data with a flexible approach to expanding the organisation's offer. A professional identity was requested to set the brand apart and convey the right message to the audience.
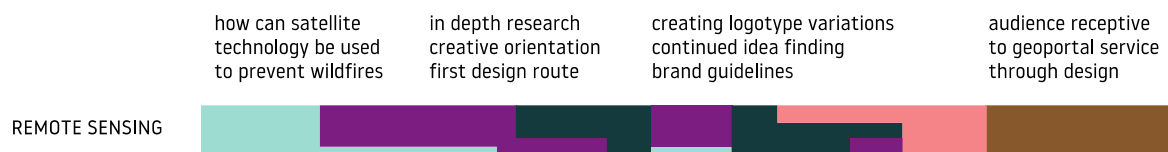


**Figure 11.** Design thinking milestones. Remote sensing.

KNOWING – Firefighting efforts spent on moorland and heathland can be cut significantly if not completely by monitoring wildfires using remote sensing techniques that help restore the affected area by reseeding (Copernicus Masters, 2016). Variations of moss can hold water like a sponge and help the area to be more resilient (The University of Manchester, 2018). Through EO data, carbon can be detected and models created to help restore peat and improve wildfire response mechanisms (EnviroSAR, 2020). Open source satellite data makes it possible to uncover patterns in the context of landscape and its protection, and imagery from space can be a tool comprising different remote sensing techniques (Discover Magazine, 2015). The company's breakthrough occurred after significant media interest in a wildfire in a North West moorland in 2018. With land mapping and experience in geomatic benches, the start-up wants to present itself as doing justice to nature and also to emerging technologies with an underlying sophisticated tone. The author and the CEO undertook several FGDs to seek co-innovative opportunities.

PACE / KNOWING – Initial ideas involved finding a layout system for all kinds of text as well as a colour study. With research into comparable companies and prospective clients, the colour palette may remind one of, but need not be immediately connected to, nature. Another visual element is the background in layouts such as the website, which may primarily be white, as this is associated with light and with earth observation, a service that is coming from space to the planet (and not the other way around). As a supplement charcoal grey is used for typography and e.g., book covers rather than black for legibility and accessibility. In order to develop the brand language, the author obtained knowledge on how satellite technology is used for conserving landscape and how fire destroys vegetation and kills animals due to loss of habitat.

PACE – For the creative orientation to establish a brand language, inspirational words were found that arose through researching the company and its immediate surroundings. The words were then translated into images, which helped define colours and patterns. Typography was established,

depicting a hierarchy with DIN, a realist font, and the robust serif Caslon and visual elements together helped create a basis for a layout that could then be specified for website applications.

CRESCENDO – The first draft of the design route was set out with a logotype based on the sans-serif font with a flexibility of surrounding patterns inspired by satellite imagery that can adapt to different applications. For the desired accessible branding, a professional look of the bespoke service needed to be followed through all platforms, including social media, in order to captivate viewers.

Element of KNOWING with PACE again – The CEO favoured a flame that was part of the old logo and, following many conversations, by combining ideas of patterns inspired by the perspective of satellites, radar pulses and the visual translation of flames, a solution was found for the logotype and favicon that leaves room for interpretation to the viewer, see Figure 12. With the company's approach to dynamic mapping generating more detailed predictions in terms of fuel and fire risk, visibility, safety and curiosity in brand presentation were not compromised by aesthetics and preference.



**Figure 12.** Full layout and book cover. Use of brand elements.

CRESCENDO again with REFLECT – With a recurring loop of design stages, patterns that emerged were refined in an organic approach. Ideas were communicated and evaluated against design criteria, highlighting visual and functional elements of the brand, which can speak for the company and build flexible structures that can be adapted to a wide range of applications. The ability to co-brand with national and international organisations as well as projects became an important aspect to include in the brand identity. Brand guidelines have been developed combining visual elements with possible future assignments across physical and digital spaces.

PACE – A combination of technological and natural aspects of the company required additional translation, creating more rhythmic phrases and a meaningful adaptation of the brand.

REFLECT – Short as well as detailed brand guidelines that include all design elements were created for both in-house use and external suppliers.

RECOVER – Feedback from the remote sensing company comprised the value of design expertise and the role of design as a communication tool to customers and funders by visually providing the right kind of messages. By understanding and exploiting the power of visual design, the company is able to reach new audiences, initiate enthusiasm for this start-up in the space industry and the nature of its work, and to enhance the receptiveness to its ideas. A professional presentation helps develop the business and takes the design forward into e.g., a geoportal service online. With competitive advantages in applying elements of effective visual design combined with EO technologies, cross-industry collaboration is stimulating innovation (Remote sensing CEO, 2020).

## 8    Space settlement

For the unfinished fifth project, the author generated a creative orientation and worked towards brand development, brand application and guidelines. The partner is established in the field of education in space settlement that develops workshops aimed at high school children. The project was halted due to the restrictions of the COVID-19 pandemic, which resulted in physical workshops being suspended.

In this non-profit organisation, young people take charge of their future skills through trying and testing construction, communication and societal scenarios on Mars. What technologies do we take to Mars? What would we want to create there? How could we communicate? And what would the ethics be like when we land there? Using tools that embrace virtual reality, data security, 3D printed buildings, sensors and the Internet of Things, workshops simulate settlement on Mars. The brand creation project was interrupted halfway through the design thinking process loop with a number of lo-fi prototypes created, which can serve as a practicable platform that is useful to the organisation's future brand strategy, see Figure 13.
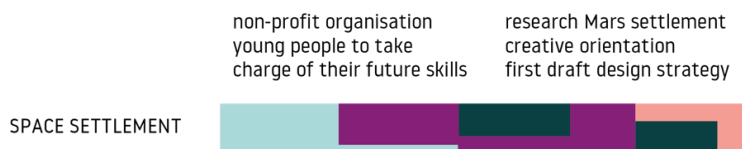


**Figure 13.** Design thinking milestones. Space settlement.

KNOWING – Mars is the reason for numerous space missions. It is the most explored and most approachable planet in the universe (IntechOpen, 2020). Collaborative tasks in Constructing a Life on Mars workshops, aimed at high school-aged children, include role play of a range of professions and activities. Different team challenges arise in a space environment and are of tangible, intellectual and societal character. Participants are given confidence to take charge of a career in a constantly reshaping world that functions in a digital form (Waters, 2019).

**Figure 14.** Martian Sunset. Brand applied to backdrops.

PACE / KNOWING – After thorough research into Mars settlement scenarios and technologies useful in workshops, the author developed a creative orientation. CRESCENDO / PACE – During further conversation with the partner, the first draft of the design strategy was created. The logo is based on typography for flexible and dynamic application with the chosen font looking engineered and intelligible, reflecting the company's values. Figure 14 displays a backdrop with the Martian sunset gradient resembling energy and determination. REFLECT / CRESCENDO – Through strategic use of design elements that creatively combine digital and analogue ideas, the charity that helps people get into employment, can build its main brand on the project's brand language. Innovative use of visual design can activate awareness of digital skills needed in the future of work.

The author gained insight into space settlement scenarios suitable for high school-aged children through mind mapping, FGDs, interviewing and empathetic modelling (see design thinking activity map in the Appendix).

## 9  Discussion and conclusion

The insights gained through the case studies are valuable independently as well as collectively as they fostered a deeper understanding of the application of a bespoke design thinking process to a specialised industry, tailoring individual stages of that process to the projects, and connecting design practice and design theory.

The first case study, the Intelligent Transport project, offered the opportunity to create a brand, and through this development, the author was able to identify and communicate the organisations underlying innovation values providing the potential to enable the organisation to to enter new markets.

The second case study involved in brand development in the context of the exploration and exploitation of asteroids and supported securing funding by generating a professional identity that improves the organisation's identy and helped to establish partnerships. The promotion for an optimal market position was crucial at a stage where funding was still needed for a satellite launch prior to asteroid mining activities.

The third case study, Space Engineering, focussd on an organisation that supports projects involving lunar and Mars rovers, self-landing rockets, space balloons and can-sized satellites. The creation of a brand helped to define the organisation's identity and set it apart from parent and sister organisations. A significant element of the rebrand was to enhance organisational image and set a platform for more effective communication to sponsors, partners and potential new members.

With the fourth case study, which uses satellites to help prevent wildfires and maintain natural resources, a professional presentation enables the organisation to develop further and to reach new audiences. Creating a brand for a company that uses satellite data has become a tool for cross-industry collaboration that is stimulating innovation.

The evolving fifth case study uses a space settlement scenario to engage young people in workshops highlighting digital skills needed in the future of work. A creative orientation and first design route provide the industry partner with brand elements useful for application of the organisation's Mars project as well as its main brand.
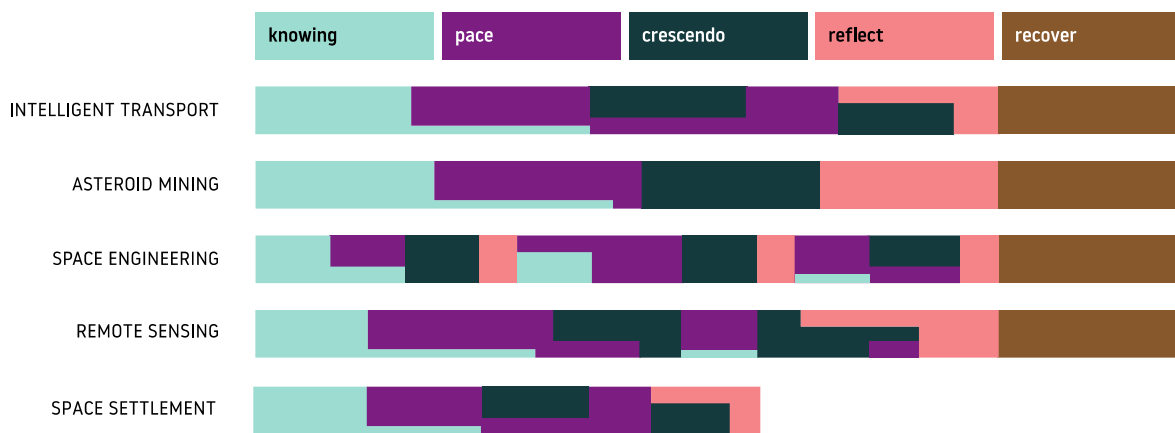


**Figure 15.** Design thinking model – all case studies.

When comparing the five design thinking models that supported brand creation and development, the individual stages varied considerably depending on each project (Figure 15) but all stages were evident in all case studeis. Case study one and two commenced in a fairly similar manner but then saw differences in the ideation and making phase of the process when Intelligent Transport had to adapt the different modes idea to a more flexible one after the naming process, while asteroid mining was more straightforward going from creative orientation through to identity creation with iteration within each stage. The design thinking process in case study three immediately had a completely different 'vibe', as with the organisation's four sub-divisions the structure was much affected by iterative approach due

to the larger variety of design elements addressed. However, within iterations, similar patterns emerged. In the fourth, a unique rhythm became clearly visible as the stages of the process were aligned to distinctive design features depicting the initial concept, the design direction with the creation of logotype variations, and brand language and guidelines essential to communicate the partner's value were made suitable for the company and its stakeholders. The evolving fifth case study drew its inspiration from in-depth research and conversations with the partner, the creative orientation and first design route that can be useful work in progress for the charity's umbrella brand.

The differentiation within individual design thinking processes was as a consequence of the uniqueness of each organisation's needs and the subsequent identification of solutions. Design thinking is found to be a valuable approach for the space tech sector due to its adaptability and ability to accommodate a range of contexts.



**Figure 16.** Interview keyword metadata.

In light of both primary and secondary research (emerging themes in design, economy, innovation and technology, Figure 1), the word map in Figure 16 points to the number of key areas that account for the aim of this research and the overlaps therein. Through this approach, extensive interviews with diverse professionals from all five partner organisations helped evaluate the research. A list of actors involved in the analytical framework can be found in the Appendix.

The combination of research methods, including interviews, feedback and FGDs, as well as the various visual prototypes, an intelligent and flexible design thinking process was developed that created an environment that cultivated long-term growth in businesses. This demonstrates that an applied design thinking model can help organisations become more resilient.

Therefore, visual design can represent innovation culture through a tailored design thinking model in the field of satellite and space technologies. In the context of the UK Government's Industrial Strategy (BEIS, 2017), visual outputs help build a business case to enter new markets and advance communication with prospective funders and new audiences, and to establish a professional presentation. These contrasting projects apply the same design thinking model, tailored to each context, resulting in a complex yet accommodating structure. This process is divided into five stages:

KNOWING, PACE, CRESCENDO, REFLECT and RECOVER and inform, generate and provide novel approaches and to solve problems strategically, creating opportunities conducive to innovation, and helping ensure the longer-term sustainability of organisation. Primary data corrolates with secondary research which aligns with the overarching aim of the research and informd a final model that is valuable to space tech organisations.

Limitations to the study include pressure from partners, when something needed to be ready quickly for a launch or when a partner preferred a certain colour to be translated into the brand. With good communication and integration through FGDs with co-design activities, the partners were involved in decision making and problem solving.

The partners' images have been transformed as a result of applied design thinking. The enhanced brand value indicates the contribution that visual design has in communicating space tech organisations' innovation.

## Acknowledgment

## References

AHRC. (2013). *The Value of Design*. Available at https://www.youtube.com/watch?v=nNy1wxnFq8Y, Retrieved on 29/09/2018.

Asteroid mining CEO. (2019). *Feedback form for J. Adler*. 1 April.

Bason, C. (2015). *Why the world's leading organisations are looking to design*. Available at http://www.designforeurope.eu/news-opinion/why-world-s-leading-organisations-are-looking-design, Retrieved on 30/05/2018.

BEIS. (2017). *Industrial Strategy: Building Britain for the future*. London. Available at https://doi.org/10.1049/ir:19930092, Retrieved on 29/09/2018.

Bierut, M. (2018). *Now you see it and other essays on design*. New York, NY: Princeton Architectural Press, 20-21.

Borja de Mozota, B. (2006). *The four powers of design: A value model in design management*. Design Management Institute. Design Management Review, 17(2).

Catapult. (2018). *Intelligent Transport Programme*. Available at https://sa.catapult.org.uk/our-focus/intelligent-transport, Retrieved on 10/05/2018.

Chun Tie, Y., Birks, M., & Francis, K. (2019). *Grounded theory research: A design framework for novice researchers*. SAGE Open Medicine, 7.

Cooper, R., Hernandez, R., Murphy, E. & Tether, B. (2016). *Design Value: The Role of Design in Innovation*. Lancaster University, Lancaster.

Copernicus Masters. (2016). *Envirosar© - Managing Wildfire Disturbance In Moorlands And Heathlands*. Available at https://copernicus-masters.com/winner/envirosar-managing-wildfire-disturbance-moorlands-heathlands, Retrieved on 24/06/2020.

Crotty, M. (1998). *The foundations of social research: meaning and perspective in the research process*. London: Sage Publications, 2-9.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row, New York, 51, 131, 216-217.

De Bono, E. (2000). *The De Bono Code Book*. Viking, London, 52, 76.

Design Council. (2017). *Designing a future economy: developing design skills for productivity and innovation*. Design Council, 6-13.

Design Council. (2019). *The Design Process: What is the Double Diamond?* Available at https://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond, Retrieved on 21/06/2019.

Discover Magazine. (2015). *How Google Earth Has Revolutionized Archaeology*. Available at https://www.discovermagazine.com/the-sciences/how-google-earth-has-revolutionized-archaeology, Retrieved on 24/06/2020.

EnviroSAR. (2020). *Home*. Available at http://www.envirosar.com, Retrieved on 24/06/2020.

Frayling, C. (1994). *Research in art and design*. Royal College of Art Research Papers, 1(1), 1993/4.

Gorb, P. & Dumas, A. (1987). *Silent Design*. Design Studies, 8(3), 150-156.

GOV.UK. (2017). *Red Ninja's smart tech clears the road for ambulance crews*. Available at https://www.gov.uk/government/case-studies/red-ninjas-smart-tech-clears-the-road-for-ambulance-crews, Retrieved on 03/03/2020.

Grossman, D. (2020). *How The UK Is Quietly Disrupting The Space Industry*. Available at https://www.inverse.com/innovation/uk-disrupting-the-space-agency, Retrieved on 18/12/2020.

Heaton, J. (2004). *Reworking qualitative data*. Sage, 58.

Hernandez, R., Cooper, R., Tether, B. & Murphy, E. (2017). *Design, the language of innovation*. (26), 1-14.

IntechOpen. (2020). *Mars Exploration – A Story Fifty Years Long*. Available at https://www.intechopen.com/books/mars-exploration-a-step-forward/introductory-chapter-mars-exploration-a-story-fifty-years-long, Retrieved on 22/09/2020.

Intelligent transport CEO. (2019). *Feedback form for J. Adler*. 9 May.

Issuu. (2019). *ManSEDS Sponsorship Proposal 2018-19*. Available at https://issuu.com/manseds/docs/manseds_sponsorship_proposal, Retrieved on 22/12/2019.

Jamasmie, C. (2017). *Luxembourg shoots for the stars with fresh space mining deal*. MINING.COM. Available at https://www.mining.com/luxembourg-shoots-stars-fresh-space-mining-deal, Retrieved on 18/06/2019.

Krippendorff, K. (2006). *The semantic turn: a new foundation for design*. Boca Raton, CRC/Taylor & Francis, iii-iv, 27-29.

Lewis, J. (1992). *Extraction of volatiles and metals from extraterrestrial materials*. Lunar and Planetary Laboratory, The University of Arizona, 5.

Manseds. (2019). *About*. Available at http://manseds.co.uk, Retrieved on 19/12/2019.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis: An expanded sourcebook*, (2). Sage, 27, 57, 71, 92, 96, 103, 133, 162, 211, 227, 236, 268.

Mills, A., Durepos, G. & Wiebe, E. eds. (2009). *Encyclopedia of case study research: L-Z; index*, 1. Sage.

Noble, I. & Bestley, R. (2011). *Visual Research: an introduction to research methodologies in graphic design*, (2). AVA Academia, Lausanne, Worthing, 23-76.

Nyrnes, A. (2006). *Lighting from the side: rhetoric and artistic research*. Bergen National Academy of the Arts, Bergen.

Parmar, R., Mackenzie, I., Cohn, D. & Gann, D. (2014). *The new patterns of innovation*. Harvard Business Review, 92(1), 2.

Pettigrew, A. (1997). *What is a processual analysis?* Scandinavian journal of management, 13(4), 337-348.

Remote sensing CEO. (2020). *Feedback form for J. Adler*. 10 March.

Sagmeister, S. (2008). *Things I have learned in my life so far*. Abrams, New York.

Salmons, J. (2016). *Choosing methodologies and methods for online studies. Doing qualitative research online*. SAGE, 17-39.

Satellite Applications Catapult. (2018). *Research Into The Value Of Satellite-Derived Earth Observation Capabilities To UK Government – Satellite Applications Catapult*. Available at https://sa.catapult.org.uk/news/research-into-the-value-of-satellite-derived-earth-observation-capabilities-to-uk-government, Retrieved on 24/06/2020.

Schroeder, J. E. & Salzer-Mörling, M., 2006. *Brand Culture*. Routledge, Abingdon, 145.

Silverman, D., 2017. *Doing qualitative research*. Sage, (5), 263, 283, 297, 475.

Space engineering President. (2019). *Feedback form for J. Adler*. 14 August.

Space Growth Partnership. (2018). *Prosperity from Space*. Available at https://www.ukspace.org/wp-content/uploads/2019/05/Prosperity-from-Space-strategy_2May2018.pdf, Retrieved on 31/07/2020.

Stanford d.school. (2019). *Design Thinking Bootcamp*. Stanford d.school. Available at https://dschool.stanford.edu/executive-education/dbootcamp, Retrieved on 14/12/2019.

Sukumaran, P. (2016). *Mining Asteroid Resources*. Journal of the Geological Society of India, 88(1), 125.

The University of Manchester. (2018). *University Start-Up Company To Expand Its Peat And Heathland Wildfire Research Efforts*. Available at https://www.manchester.ac.uk/discover/news/university-start-up-company-to-expand-its-peat-and-heathland-wildfire-research-efforts, Retrieved on 24/06/2020.

Transformation North West Cohort – Adler, J., Blackwell, B., Costabile, I., Kallegias, A., Kowalska, P., Latham, G., Omar, L., Partha, C., Pialorsi, V., Robins, J., Street, J. & Wareing, L. (2018). *Driving Industrial Strategy for North West Growth – the Role of the Creative Industries*, 22-27.

Tufte, E. (1990). *Envisioning information*. Cheshire, CT: Graphics Press, 38-65.

UX Designer (2020). *Interview with J. Adler & B. Lee*. 13 February, London.

Verganti, R. (2009). *Design driven innovation: changing the rules of competition by radically innovating what things mean*. Harvard Business Press, 5, 11-12, 24-29.

Waters, M. (2019). *Constructing A Life On Mars*. Available at https://www.calom.space, Retrieved on 19/10/2020.

Yin, R. (2014). *Case study research and applications: Design and methods*. Sage Publications, (5), 17.

# Appendix

**Table.** Analytical framework: design thinking activity map.

| | | knowing | pace | crescendo | reflect | recover |
|---|---|---|---|---|---|---|
| **input** | INTELLIGENT TRANSPORT | wants, needs; sensor technology; small intervention; skills | different modes of transport; names; decision matrices | interpretation; translation; amendment | assessment | semi-structured interview schedule; feedback form |
| | ASTEROID MINING | what it is; targeting the off-Earth commercial market | design critique | design by metaphor | scenario | corporate identity valuable to developing the business |
| | SPACE ENGINEERING | student society that is working to explore and develop space with four sub-divisions: lunar and Mars rovers, rocketry, space balloon and cansat | co-design workshop; sketching; look and feel | translated into a visual system | understand innovation | funders encouraged to lend to higher risk organisations, that create new products |
| | REMOTE SENSING | mapping wildfire patterns via satellite earth observation data | empathic modelling; layout system; legibility and accessibility; perspective of satellites, radar pulses, visual translation of flames as inspiration | suitable logotype for organisation and its sub-departments | story board | communication tool to customers and funders; professional presentation helps develop the business and takes the design forward into e.g. a geoportal service online |
| | SPACE SETTLEMENT | young people can take charge of their future skills through the scenario of life on Mars | FGDs; mindmapping | participatory workshop model | empathic modelling mock-ups | |
| **actors** | INTELLIGENT TRANSPORT | designer, digital lead, CEO | animator | digital lead | digital lead | CEO |
| | ASTEROID MINING | engineer, scientist, astrogeologist, investment analyst | CEO | engineer, scientist, astrogeologist, investment analyst | CEO | CEO, designer |
| | SPACE ENGINEERING | project planner, aerospace engineers, outreach officer, treasurer | president, department heads | president | president, department heads | president |
| | REMOTE SENSING | researcher, technical lead geologist | | CEO | CEO | researcher, technical lead geologist |
| | SPACE SETTLEMENT | CEO | CEO, immersive technology developers, 3D printing prototypers | CEO | CEO | |
| **activities** | INTELLIGENT TRANSPORT | FGDs; collaboration across different fields of expertise; reframing | naming process; brain writing; creative orientation – ideas for colours, form, font, illustration style | creation of logotype; visual design elements | lo-fi prototypes of design applications | business case; enter new market |
| | ASTEROID MINING | mapping; contextual observation | initial concept of prospective imagery, fonts, layout and colours | brand language contrasting to existing logotype | linking to the organisation's innovation by building confidence in its propositions | attract investors; promoting optimal market position; assist internal structure |
| | SPACE ENGINEERING | card sorting; group passing | inspirational words to describe values decoded into images; recognisable graphics | logo icons; brand applications | layered, reiterating elements | set itself apart from other branches and its parent organisation nationally and internationally |
| | REMOTE SENSING | mindmapping; competitor analysis; insight into prospective clients | open coding; inspiration translated into colour palette, typography, patterns etc. | room for interpretation; visual and functional elements of the brand | flexible structures to be adapted to a wide range of applications | reach new audiences, initiate enthusiasm for this start-up in the space industry; cross-industry collaboration is stimulating innovation |
| | SPACE SETTLEMENT | workshop observation; FGDs, interview | illustration, character inspiration, colour and form study | workshops | lo-fi prototypes: illustration and layout | |
| **outputs** | INTELLIGENT TRANSPORT | insight – satellite technologies for everyday traffic; structured online interview | brand name; creative orientation presentation | design route; brand | brand guidelines; business model canvas | explainer video; feedback; interview |
| | ASTEROID MINING | persona; seeking investors for satellite launch; detailed predictions in terms of fuel and fire risk, visibility, safety and curiosity in brand presentation | creative orientation | design strategy; professional identity; investment brochure ready for publication | visual portfolio; mockup | practical application yet challenging the norm; audience accepting Space Mining concept; increased trust and profit |
| | SPACE ENGINEERING | thematic analysis; expertise, understanding its ambitions and preferences | mood board; integrating the organisation's interests and activities | rebrand | high-fidelity prototype brand guidelines | kit to attract more sponsors, partners and potential colleagues; name = identity |
| | REMOTE SENSING | profile | ideation sketching; creative orientation; rhythmic phrases | design route; logotype; fav icon | detailed brand guidelines combining found visual elements with future assignments across physical and digital spaces | raised image; social media to captivate viewers; growing business not limited to wildfires alone, expand its offer further afield |
| | SPACE SETTLEMENT | research insight from interview and FGDs | creative orientation | first draft of design route | brand application (flyer) | |