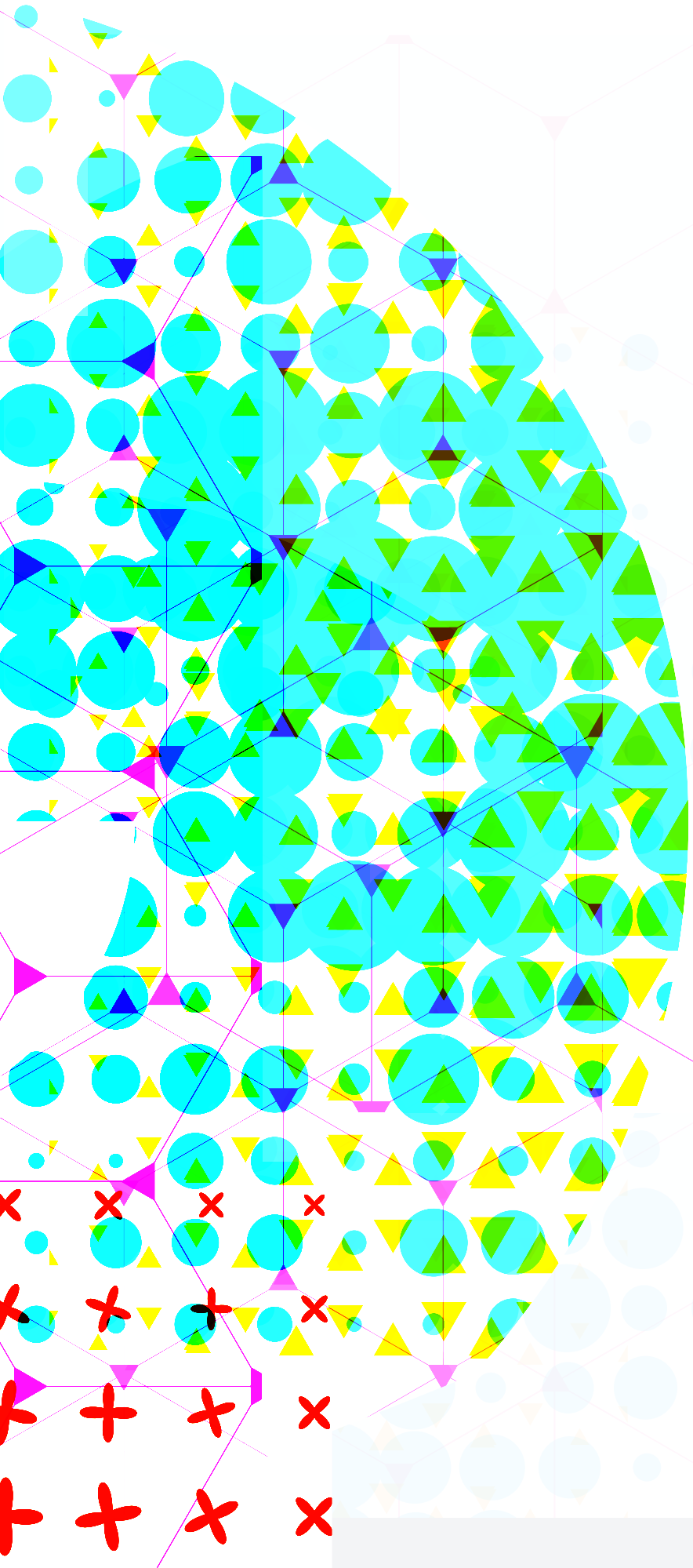
A scoping study:

Design's Role in the Satellite Applications & Transportation Systems Catapults



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Executive Summary

Introduction

In March 2010, Hermann Hauser published his report ***Current and Future Innovation Centres in the UK***. From this work, Innovate UK, the new name given to the Technology Strategy Board established seven Catapult Centres; also known as Technology Innovation Centres (TICS). With an investment of £200 million over the first four years, the aim of these TICS was to 'close the gap between universities and industry through a 'translational infrastructure' to provide a business focused capacity and capability that bridges research and technology commercialisation (Hauser, 2014:4)'.

This current report presents the results of a six-month scoping study exploring design's contribution to two of the Catapults: the Satellite Applications established in May 2013 and the Transport Systems set up in March 2013 . With both these Catapults currently using design practices to deliver and support innovation services, the funder of the research, the Knowledge Transfer Network (KTN), selected these two as the sites for the research in order to better understand design's role as part of the wider 'translational infrastructure'.

[1] (https://sa.catapult.org.uk/about-us/who-we-are/)
[2] (https://connect.innovateuk.org/documents/2157668/0/Five+Year+Delivery+Plan/17da4867-9309-455a-afa6-f92abfac357e)

Executive Summary cont...

Objectives

The following research objectives were identified to guide the work:

01 To understand the role of the Catapults as science and innovation services and design's role within this framework.

02 To identify and understand different types of design activities currently used within each of the two Catapults and how this assists in building knowledge within each of the organisations.

03 To understand how design is utilised within the two Catapults and how this determines the reach and service innovation capability of the Catapults.

04 To construct a framework to understand and articulate design's role and its potentiality within the two Catapults with the aim to open up discussion across the other Catapults.

Executive Summary cont...

Methodology

To frame the research I undertook a literature review of the following areas: Science and Technology Innovation, Service Innovation, Service Design and Design Research.

In addition, I undertook participant observations at three Cross Catapult Workshops, featuring not only the two selected Catapults but also representatives from other Catapult centres (Advanced Manufacturing, Future Cities and Digital) to capture discussions concerning the Catapults' engagement with themes identified by them as core in their sector's future, and to observe design's role in these contexts.

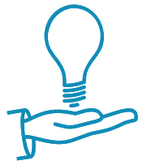
To explore my research agenda in more detail, I completed semi-structured interviews at the two participating Catapults; twelve interviews at the Satellite Applications Catapult with six at the Transport Systems Catapult. The unit of analysis was each Catapult's use of design and its embeddedness and reach within the organisations.

Outcomes

From the six-month scoping study the following outcomes have been produced:

Two case studies on the two Catapults, Satellite Applications and Transport Systems, demonstrating the different ways that design is used within both.

A presentation of the findings to the KTN at a Cross Catapult Workshop, including the positioning of the Catapults as KIBS and design's role in both service delivery and in science and technology innovation.



The framing of the Catapults as Knowledge Intensive Businesses Services (KIBS) with design's contribution in the co-creation of knowledge and innovation around service delivery.

An audit tool for mapping design activity within all the Catapults and design's reach within the organisation.

A summary presentation to Innovate UK.

Executive Summary cont...

Discussion

This research identified a number of areas relating to design's contribution to the Catapults as science and technology innovation services:

Context Specific

The utilisation of design within both the organisations is emerging, but is also significantly influenced by the industry sector it serves. Design activities (communication, facilitation - learning by doing) are diverse practices serving different purposes in each of the organisations.

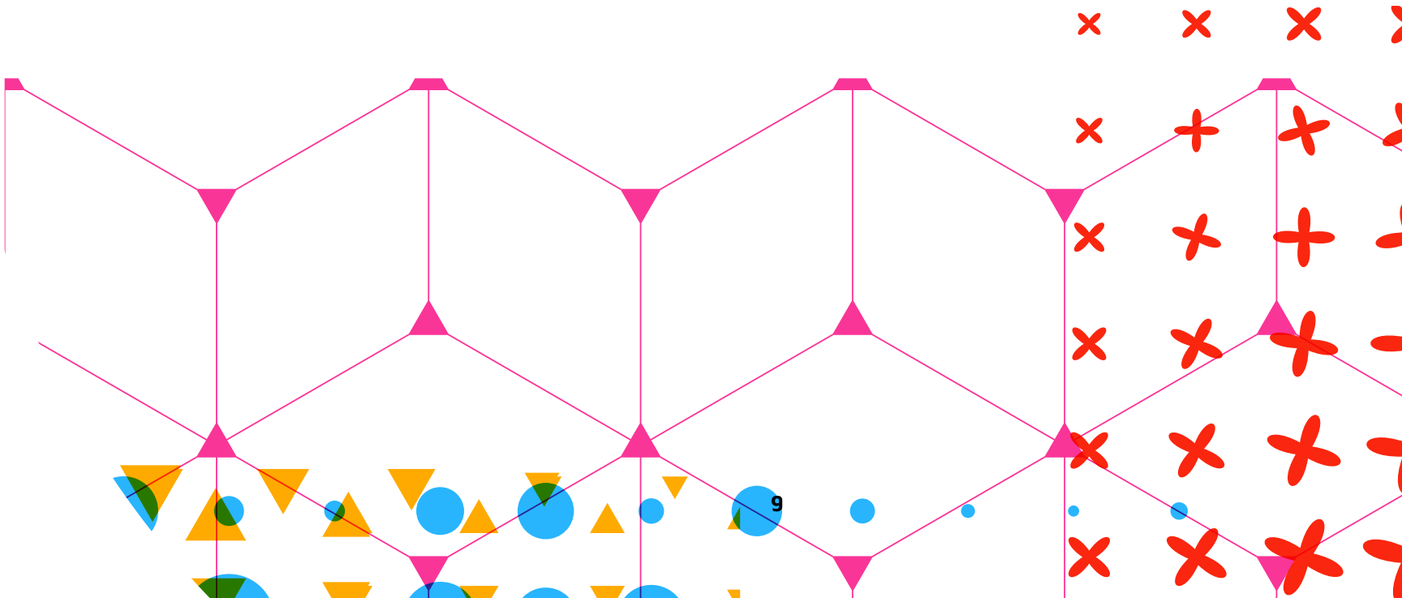
The range of design practices influences the level of understanding of design and its contribution within the Catapults.

Positioning Catapults as KIBS

As the two Catapults studied support different fields of science and technology innovation, it is difficult to articulate how design can be applied across these two different industry sectors. However, if the Catapults are framed as KIBS then design's contribution to these contexts becomes easier to conceptualise. As KIBS, the design methods and processes used by the two Catapults, to a greater or lesser degree, is to articulate, accumulate and disseminate complex knowledge both within the organisation and to existing and related industry sectors.

Design Activities and the Co-creation of knowledge

The design activities identified from both cases focus on co-creating knowledge, essential for KIBS. Design's role extends to converging both codified scientific and tacit knowledge through visualisation, playfulness, documentation, facilitation and fieldwork (learning by doing). Concomitant with this is the flow of knowledge beyond the organisation through the design activities.



Conclusion

This report presents design's contribution to the Satellite Applications and the Transport Systems Catapults. It conceptualises and opens up a discussion of design's role in science and technology innovation services. To better understand design practices as an enabler of technology within these context specific innovation environments, the Catapults have been framed as KIBS style organisations. The primary aim of KIBS is to provide highly collaborative value added activities that will support and enable different types of knowledge flows through an organisation, to external clients, the industry as a whole and to related sectors that wish to innovate. At the two Catapults I studied, the knowledge flows take place through a diverse range of design activities (journey maps, Lego play, personas) that initiate complex codified scientific and tacit knowledge to be disseminated, assimilated and translated.

This report identified the following key findings to articulate the role of design in these contexts:

– Design's role within the Catapults, and its capacity, is determined by how it is championed and understood and the industry sector context.

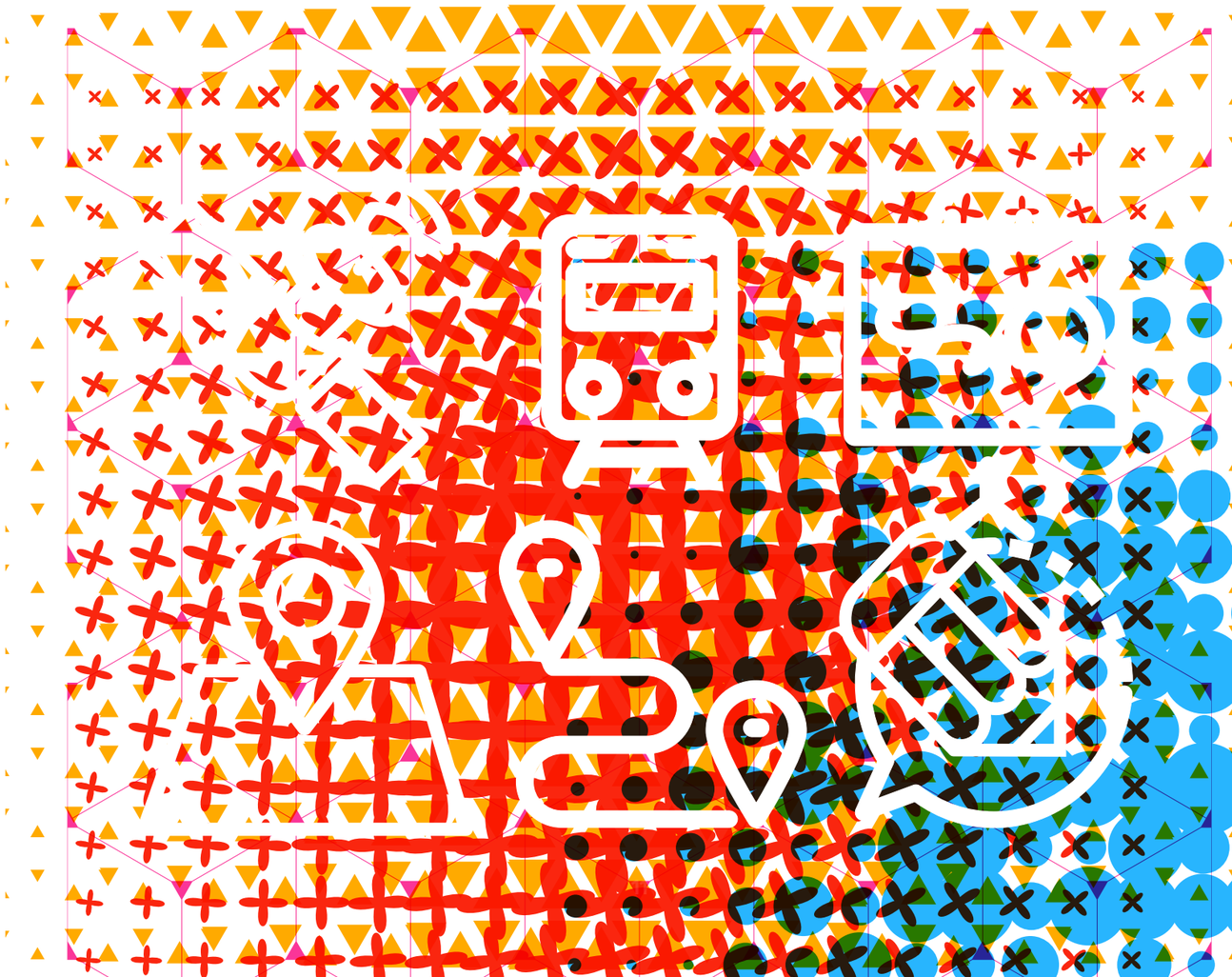
– Catapult activities are found to be 'translational infrastructures'; in order to innovate they need to look internally to their knowledge transformation processes and design enables this translation to happen.

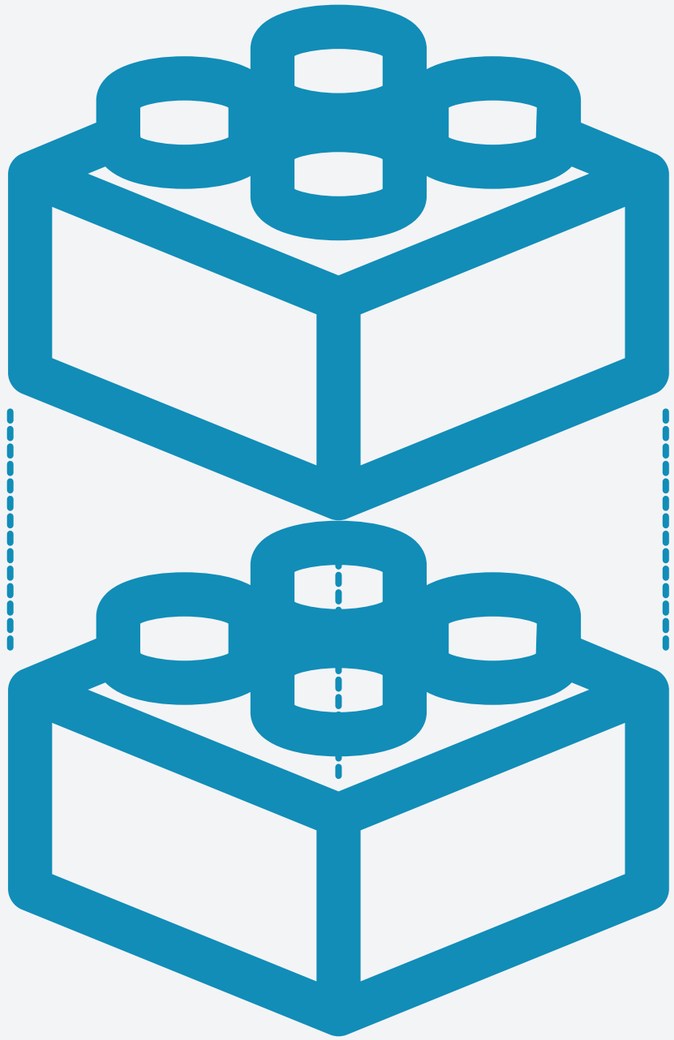
– The interaction between the Catapult and its client base needs to stimulate the diffusion of knowledge within the innovation system with design practices working at three levels. In the case studies, level one design activities focus on communication (visualisation, documentation) and consolidating design practices (standardisation of internal processes). At level two, playfulness, learning by doing (facilitation and fieldwork). Finally, level 3 design activities has reflexive learning (all of the above plus representation of strategy through design's facilitation).

This scoping study offers a first step to understand design's significant contribution to the Catapult's work. Most importantly, it shows that design, when adopted more fully (what I have described as level 3), aids the attainment of the organisation's strategic goals.

Future Research

Future studies could further focus on the relationship between the specific organisational culture of a Catapult, its adoption and engagement with design practices and the potential to increase the knowledge flows within the organisation, and in service delivery.





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Background and context

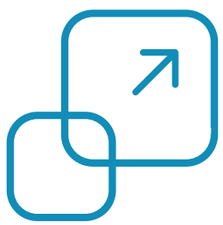
1.0

1.1 Introduction

Herman Hauser's seminal report in 2010 led to the funding of seven Catapults (Digital, Advance Manufacturing, Cell Therapy, Future Cities, Transport Systems, Satellite Applications and Renewable Energy). There are now eleven Catapults with more being added in the future. A recent review of their work and progress in connecting up with innovation communities (universities, Small to Medium Enterprises (SMEs) and industry) highlighted the Catapults' achievements and again emphasised the importance of Technology and Innovation Centres as 'translational infrastructure' to support innovation (Hauser, 2014:10) by:

Anchoring investment in the UK

Addressing natural and monopoly issues



Increasing the scale, speed and scope of commercialisation

Enhancing value through collaboration

Addressing societal challenges

Convening and collaborating

These six output categories raise questions about the methods and processes being used to support innovation as well as design's role in these mechanisms.

In the last decade there has been a sustained interest in design as a tool for innovation through design thinking, design management and strategic design (Commission of the European Communities, 2009), and how its use is underestimated in innovation based organisations. Earlier works relate this underrated acknowledgement of design in innovation to 'its imprecise boundaries, its broad nature and its overlap with other innovation activities particularly for statistical purposes' (Tether, 2005:2). For Acha (2008:4), there is still a 'lack of understanding of the role and nature of design, in comparison to the substantial work on characterising R&D, science, technology and even innovation itself'.

With the 2014 ***Review of the Catapults*** (Hauser, 2014) having outlined their ambition and future plans, it is timely to better understand how design is adopted in two of the Catapults as a starting point to engage in discussions of design's potential and wider adoption across these science and technology 'translational infrastructure' services. This research report has been funded by the Knowledge Transfer Network (KTN) to look at design's role in the Satellite Applications and Transport Systems Catapults. The research recognises the contextual specificity of each of the Catapult cases, but aims to provide a framework for the adoption of design within these diverse science and technology contexts to better enable innovation.

1.2
About This Report

This report aims to achieve four objectives:

Firstly, the study provides an overview of the types and range of design activities that the Satellite Applications and Transport Systems Catapults utilize.

In addition, the report conceptualises the Catapults, as KIBS, as a way of better understanding and articulating design's role within these highly 'translational infrastructures.'

Rather than comparing and contrasting the two cases, the aim is to conceptualise design's role within innovation services as a critical activity, one that generates knowledge and transmits it within and beyond the organisation.

Finally, the report aims to open up a discussion across all of the Catapults regarding design's role in science and technology innovation services.

Work undertaken

2.0

2.1 Methodology

This six-month scoping study funded by the KTN undertook two cases, the Satellite Applications and Transport Systems Catapults, as a way of better understanding design's contribution to science and technology innovation services. The analysis and the findings are grounded through the emergence of the data as each Catapult is contextually and organisationally specific and it is important not to position the work as comparative case studies, but as cases that offer insights into design's role.

The research objectives were informed through discussions with the KTN and observations taken at Cross Catapult Workshops:

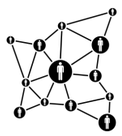
– To understand the role of the Catapults as science and technology innovation services and design's role within this context.

– To identify and understand the different types of design activities currently used within the two Catapults and how this assists in building knowledge within each of the organisations.

– To understand how design is framed and utilised within the two Catapults and how this determines the reach and service innovation capability of the Catapults.

– To construct a framework to understand and articulate design's role and its potentiality within the two Catapults with the aim to open up discussion across the other Catapults.

Concurrently a literature review was undertaken from the following inter-related disciplinary fields:



Service Innovation

Knowledge Intensive Business Services

Design Research

Visualisation and Cognition

Service Design

Participant observations were undertaken at three KTN Cross Catapult Workshops, held at the Future Cities Catapult, the KTN offices and the TSC in Milton Keynes. The workshops were started by the design team at the Satellite Applications Catapult and supported by the KTN for knowledge exchange across organisations. These workshops were used to observe the discussions on design activity between different Catapults and the barriers and opportunities for its up-take.

A research council workshop was also observed between the Satellite Applications and doctoral Students from the universities of Oxford, Edinburgh and Leeds. The aim of this workshop was to encourage doctoral students to think about how Earth observation satellite data could inform start-ups around challenges within the areas of fisheries, security, agricultural management and future cities.

A literature review informed semi-structured interviews on design's role within each of the Catapults. The interviews focused on how design is conceived and its practices assimilated within each of the organisations, and how these are supporting innovation. In addition, two projects from each organisation were used as a base line to capture and exemplify the range and utilisation of design activities in client projects. In both cases, interviews were undertaken with a range of people from across the organisation. In all, six interviews were undertaken with the Transport Systems Catapult and twelve with the Satellite Applications. Each interview took between one to one and a half hours.

Because each Catapult is context specific with its own industry characteristics, the two Catapults formed a unit of analysis not to contrast and compare but to demonstrate the diversity of design and the contribution to supporting innovation within the organisation and externally with clients.

Literature Undertaken

3.0

3.1 Introduction

This section provides an overview of the literature which informs the articulation of the research, objectives and questions. Taking as its starting point the role of the Catapults as providers of innovation services and 'translational infrastructures,' as described by Hauser (2010), the study takes an interdisciplinary lens to draw on Service Design, Visualisation and Cognition, Service Innovation and related literature from Management research. In this section, I summarise the key concepts that support the work and present the framework for conceptualising Design's role in the Catapults.

3.2 Design Research

The 'object of design' has changed, as design practice has evolved, to expand the boundaries of design from 'what is being designed, or "design as product", to embrace networks, services, organisational and societal issues' (Wetter Edman, 2011:19).

Design Thinking and methods converge 'designerly' ways of working, human centredness, visualisation and reflection-in-action (Schön, 1983) with Management Thinking (Wetter Edman 2011). Key features of Design Thinking are its ability to work on wicked problems, deal with uncertainties and ambiguities as an iterative process (44).

Design Thinking helps 'organisations to see new opportunities for innovation that are sparked by a deep understanding of peoples' needs' (Kumar, 2009:91). The author further states that the 'challenge for organisations is not only to adopt design methods into their innovation processes but also to merge effectively with existing processes of business modelling and technology development'. Furthermore, once established, Kumar (2009) notes the importance for organisations to practice 'design innovation collaboratively, reliably and repeatedly' (91).

However, when design is seen as a contributor to innovation it is presented as 'a driver, input or tool for innovation rather than the innovation itself' (Commission of the European Communities, 2009:13), resulting in its contribution to innovation being little understood and undervalued. The lack of acknowledgement of design's role stems partly from its very nature, which is messy and entangled with various dimensions that are affective, tacit, implicit and contextually specific and sit in opposition to economic, science and technology knowledge of quantitative, explicit and codified measurement' (Jensen ***et al,*** 2007).

3.3
Ways of Knowing

To understand the role of the design activities in the two Catapults, literature was examined on visualisation and cognition in management decision-making plus the value of experiential learning through Doing, Using and Interacting (DUI) (Jensen ***et al***, 2007).

Visualisation through the graphic representation of data, information and knowledge offers significant advantages when dealing with the demanding task of strategic planning (Eppler and Platts, 2009:43). The authors identify the 'cognitive benefits of visual representations including facilitating, elicitation and synthesis of information, enabling new perspectives to allow more effective recall and decision making; social benefits are also identified such as integrating different perspectives and achieving stronger communication'.

Serious play through Lego and the use of metaphorical imagery in workshops - verbal, visual and kinaesthetic - is a mode of representing knowledge (Bürgi, 2003: 74). This form of 'multimodal imagery challenges the abstraction of organisational life so often used in strategy making and instead offers a way of deepening understanding through metaphorical image making' (76).

There are two modes of knowing, one that is predicated on the Science Technology and Innovation (STI) model and the other which is an experienced-based mode of learning based on DUI (Jensen ***et al*** 2007:2). These two learning modes relate to different types of knowledge: the first that is tangible and codified that can be written down and the second which is tacit intangible and often localised (9). The authors show that using a mixed strategy of these two different ways of knowing enhances product innovation, Figure 01.

3.4
Services and Service Innovation

To understand the Catapults as services, the literature examined common features and definitions, and identified issues that make it difficult to identify and capture service innovation.

Historically, services have been conceptualized in opposition to goods, which means that they have been described for their non-material, intangible and indistinct nature when compared to manufactured goods (Shostack, 1977). More recent definitions see services as involving intangible qualities such as skills, information and knowledge, interactivity, connectivity and ongoing relationships. These are configured through interactions between the service provider and service receiver with effort required to make a service transaction meaningful (Segelström, 2013:19).

From a Service Design perspective, services are described as 'complex hybrid artefacts that are made up of things-places and systems of communication and interaction but also of human beings and their organisations (Meroni, Sangiorgi, 2011:1),' Figure 02.

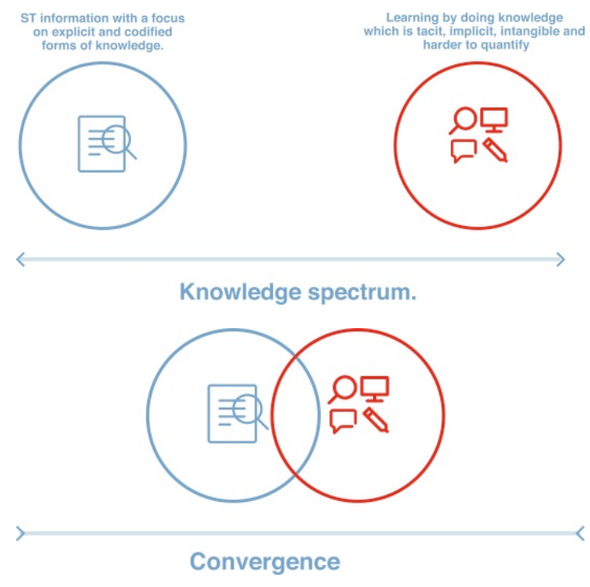
There has been an over emphasis on technology in service innovation and attention is now turning to non-technological elements of and approaches to service innovation (Buescher and Perogianni, 2007). Service Innovation is frequently connected to changes in non-technological innovation processes and related to organisational processes (3). Thus organisational innovation cannot be excluded from any investigation of innovation in services (Gallouj, 2002:143).

A feature of services is the production and consumption occurring simultaneously so the distinction is blurred between product and processes (Oslo Manual, 2005:53).

Because of the nebulous characteristic of the outputs, services are difficult to evaluate and because of a 'lack of stable reference points' it can be difficult to convince clients that the service is sufficiently new to justify the costs' (Gallouj, 2002:143).

Innovation activity in services tends to be an ongoing process, mainly 'consisting of incremental changes' (Oslo Manual 2005:38) and this complicates the identification of the innovation delivered. Often the innovation is difficult to capture as it includes invisible or hidden innovations that are not apparent by traditional indicators of innovation in the manufacturing sector (Morrar, 2014:6).

fig 01
The convergence of STI and the experiential learning with Doing, Using and Interacting knowledge that is required to enhance innovation.



3.5
Knowledge Intensive Business Services

To better understand the Catapults as services, the literature looked at Knowledge Intensive Businesses Services (KIBS) and their characteristics. This framing of Catapults as KIBS has helped conceptualise design's activities and roles within the two case studies.

By definition, KIBS are 'services that involve economic activities which are intended to result in the accumulation of a dissemination of knowledge' (Miles ***et al***, 1995:18). Other authors see KIBS as actors of knowledge transformation in regional and national innovation systems' (Muller, Zenker and Héraud, 2009).

As services, KIBS perform activities in close contact with the client and the more knowledge intensive and customised the service, the more the co-production depends critically on client participation and input (Bettencourt ***et al***, 2002:110). Clients are key to creating optimal knowledge based service encounters and, for this reason providers of KIBS should take steps to proactively manage their client's co-production behaviour (101).

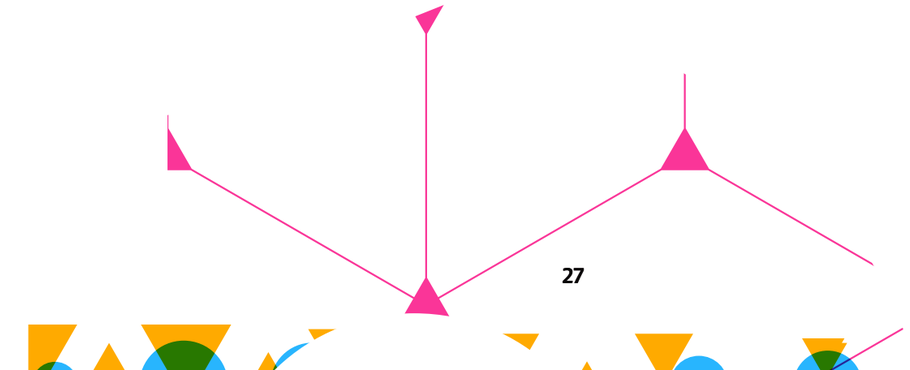
If knowledge is the core asset for KIBS' competitive position and delivering innovation, it raises the question on how this core asset emerges and how is it being generated? (Muller, Zenker and Héraud, 2009:1).

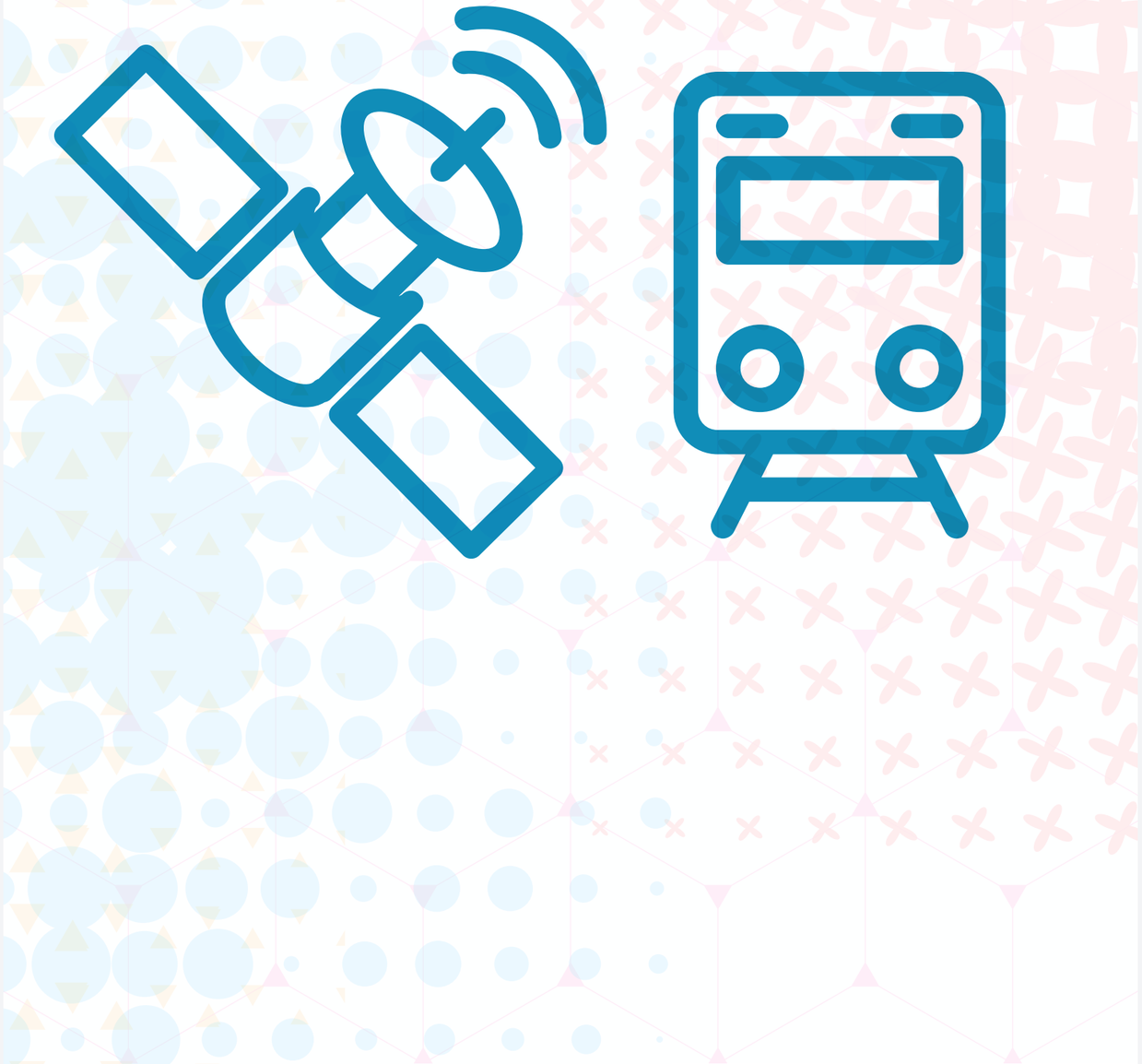
fig 02
A configuration of a service experience made up of interactions with many touchpoints, adapted from Polaine, Løvlie and Reason, 2013.

3.6
Research Questions

From the literature review research questions were formulated to guide the semi-structured interviews and the observations:

- As innovation services, what design practices are used within the two Catapults?
- How are these practices being adopted, disseminated and embedded within the organisations?
- How far is design's reach within the organisation?
- How can design's role in science and technology innovation be identified?
- What role is design playing in managing knowledge co-production behaviours?
- How is design supporting and developing emergent, multi-faceted and highly collaborative partnerships?
- How is design helping to innovate in service delivery?





Case Studies 4.0

4.1 Introduction

The following case study analysis is based on the data gathered from interviews and observations with the Satellite Applications and Transport Systems Catapults. The interviews are transcribed and analysed around the theoretical frame identified from the literature review. Referencing the ***Danish Design Ladder***[3] (2003) the analysis of design's role and reach within the Catapults has identified and categorised three levels of design activities. Particular attention is given to how design operates at each of the levels and how this contributes to different types of knowledge flows within and beyond the organisations.
The data has been mapped, Figures 11 and 16, and represents design's role as value added activities from a broad starting point and asks: 'How is it being done?', 'What is being done?', 'What are the knowledge flows?' and 'What is changing within the organisation?'

[3] http://www.seeplatform.eu/casestudies/Design%

Satellite Applications Catapult

4.2

4.2.1
Background

The Satellite Applications Catapults sees its role in improving the understanding of satellite technology across the UK economy from large corporations to single product early stage companies. It also aims to connect with companies that are unfamiliar with space technology by exploring opportunities and challenges and identifying where space technology may fit and assist. The sector is emerging and the challenge lies in getting the technology into the market and providing a monetary return.

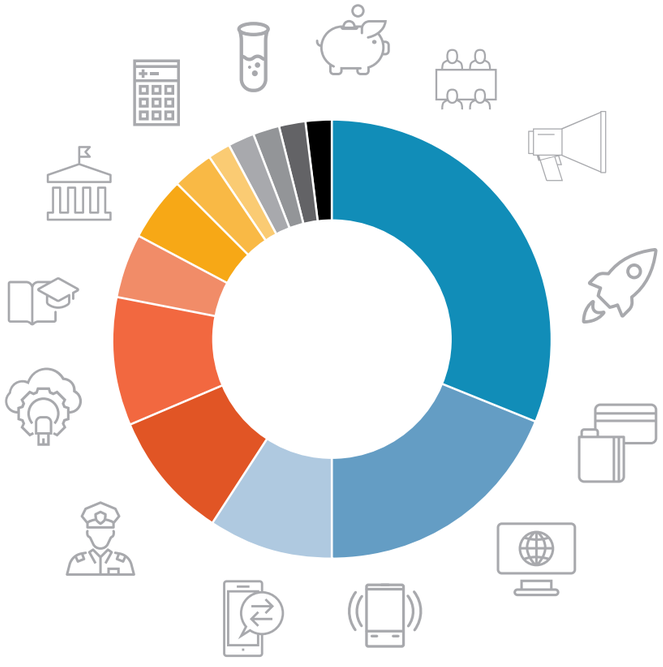
Figure 03 offers a conceptual configuration of different components (organisations, people, technology and place) needed to create a Satellite service. This environment for developing such services is agile, collaborative, flexible and intangible. From its inception, the Catapult applied the acronym PACE- Pioneering, Agile, Collaborative and Entrepreneurial to build an ethos and imbue projects with this thinking.

fig 03
A conceptual configuration of different stakeholders required in the delivery of a Satellite service.

Case study cont...
Satellite Applications Catapult

Communicating the potential of the space industry is critical and the organisation is intentionally interdisciplinary, so that there is specialist knowledge and experience from different sectors, not just engineers who are unfamiliar with non-space sectors, Figure 04. The space industry is also very specialized which can lead to insularity, so the Catapult is keen to engage the space industry with society in a language that can be more generally understood by external stakeholders such as investors and potential users.

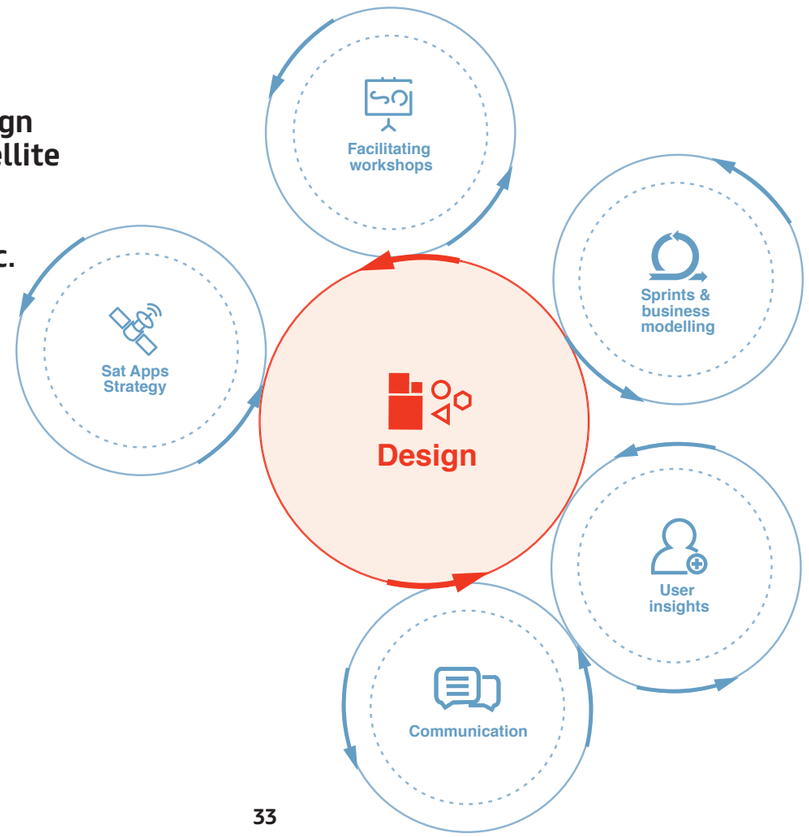
fig 04
The different skills and backgrounds of people working at the Satellite Applications Catapult.



4.2.2
Design Activities and Business Processes

Design activities in the organisation can be categorized into five key areas: communication, user insights, sprints and business modeling, facilitating workshops and Satellite Applications strategy formulation. These are all dynamically interlinked within the organisation and in the development of Satellite Application product services as illustrated in Figure 05.

fig 05
Five broad types of design activity used in the Satellite Applications Catapult. These activities are interlinked and dynamic.



Case study cont...
Satellite Applications Catapult

Throughout the design activities, within the Catapult there is an exchange of implicit and explicit tangible and intangible knowledge. These exchange take a number of forms but are seen to assist the Satellite Applications in the following ways:

Communicating Ideas

The designers can visualize well and are highly valued for producing beautiful slides that can strongly communicate ideas.

"Every time they create a visual for the Catapult to explain a very complex thing in a simple way they are creating value for us".
[Chief Financial & Operating Officer & Executive Director]

Constructing Understanding

The design and business 'sprints', assist companies in clarifying their thinking around satellite technology and help them reconfigure their businesses to reflect different users and communicate their value propositions more effectively to investors[4].

Knowledge Exchange

There is continuous learning and knowledge exchange between the internal business development and designers at the Catapult as represented in Figure 06. The designers are learning about the business model and for business development they appreciate a holistic view of the problem area. Increasingly the designers are interested in how an idea is developed into a business with clients and see this activity as integral to the design process.

[4] Innovate Vouchers to the value of £5000 enabled a SMEs to engage in a 3 day workshop / 'sprints' with the Catapult. These have now been stopped which has impacted on the Satellite Applications engagement with SMEs; they are currently reviewing different models of engagement to replace what was a very valuable scheme.

"Design is working with me to understand who are these people? Age, gender... it's trying to put me in their shoes to understand which way they approach the service. This then allows me to have a smaller group to identify with, and, in economic terms, I start to quantify the possible income. So it's really moving from one stage to another." [Business Analyst]

Value in the Process

Workshops run by the designers, are seen by senior management, to generate stronger ideas. The design process enables people to take ownership of a problem and collaborate towards a solution early on. Positive feedback is given at the end of the 'sprints' and workshops from participants and in some cases the organisations collaborating are keen to transfer the ways of working into their organisations.

"More importantly, and what hadn't been appreciated, is how much they enable groups of people to create ideas from nowhere, in a way that is stimulating. So they are enablers, they create lots of energy and they keep the process going, and the mechanisms they use (post-it notes) create an environment where people feel free to talk about ideas and for them to be captured. So design stimulates and captures ideas and also identifies problems and then finds solutions, designers do this in a way that is clever.
[Chief Financial & Operating Officer & Executive Director]

Design as a Bridge and Catalyst

Design is seen as a bridge builder and catalyst that enables the translation of technology into business opportunities in the form of new products and services, Figure 07.

"It encourages openness and free thinking throughout the whole process rather than starting with something that is a fixed view of what the outputs are going to be – by involving design, it challenges and tests your assumptions".
[CEO & Executive Director]

fig 06
The design team's work is interdisciplinary. In particular they work synergistically with the business development team.

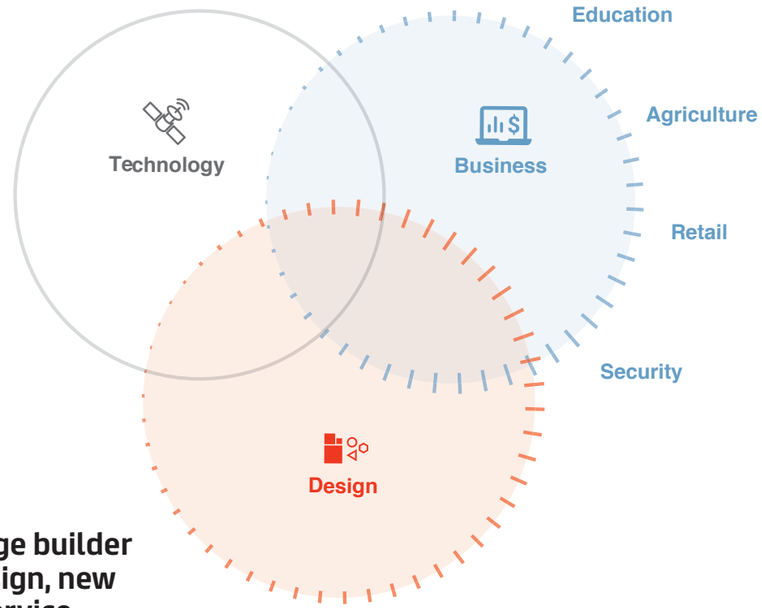
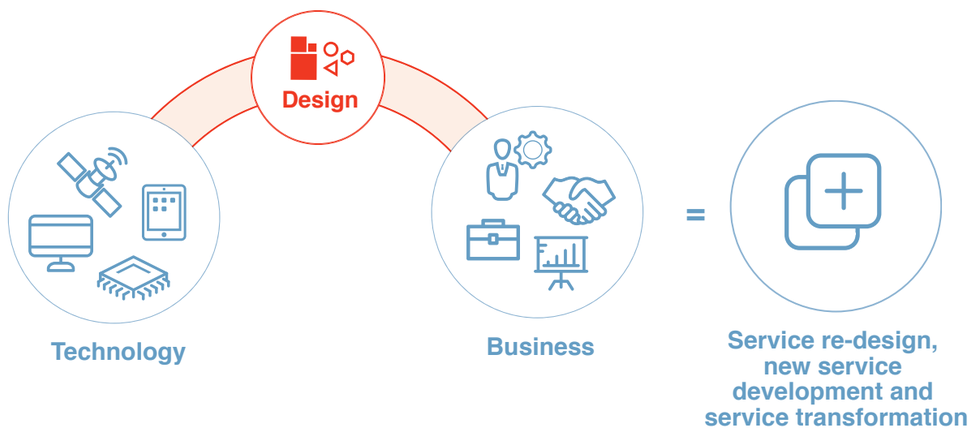


fig 07
Represents design as a bridge builder for delivering service re-design, new service development and service transformation within the Catapult.



Case study cont...
Satellite Applications Catapult

4.2.3
Design and Organisational Processes

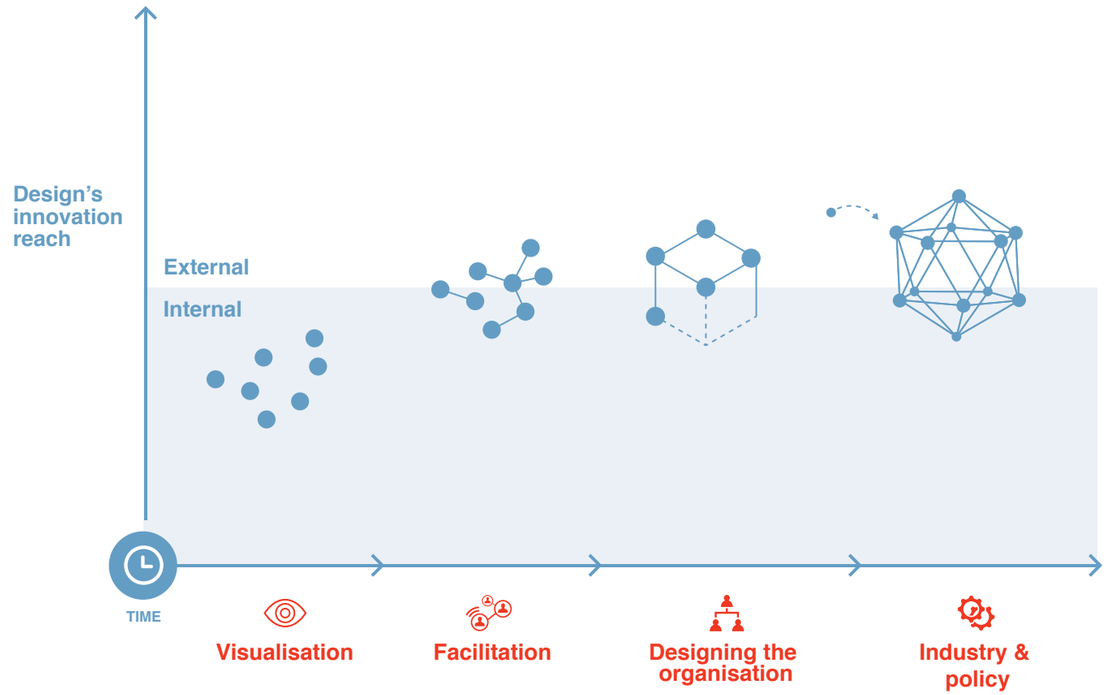
Design's focus is on the internal workings of the organisation as well as the outside interactions with clients. Early on, the lead designers saw the need to harmonize the organisation's internal tools to communicate projects and exchange ideas to create seamless exchanges throughout the organisation. This standardization of processes (sharing ideas, resourcing projects, workshops and creating a visual language) has speeded up the operations and enabled the organisation to become more agile with incremental, quick iterations of ideas through prototyping and feedback.

"Completely radically changing meetings. Instead of it being just the traditional space sector, we mix our design people with the numbers people or the business people. Nothing has changed the conversation more than putting in the design element."
[Chief Financial & Operating Officer & Executive Director]

Design plays a key role in developing world satellite application projects in countries such as Kenya and Brazil. Design ethnographic fieldwork has helped understand and overcome non-technological, cultural and user-centred barriers that often prevent the take up of satellite technology. Recent fieldwork in these countries, undertaken by the designers and the business analyst, exposed the complexities of introducing new technologies in these culturally specific environments.

The designers also treat the Catapult similarly to a design project by reflecting on how the organisation works as a service for the satellite industry. This approach has developed over time with the focus changing from individual projects to shaping organisational processes and the Catapult itself, Figure 08. The aim is to break down departmental silos and make the organisation more human centred with practices that reflect this. The focus for the designers is very much about processes, co-creating knowledge and how they work to create solutions.

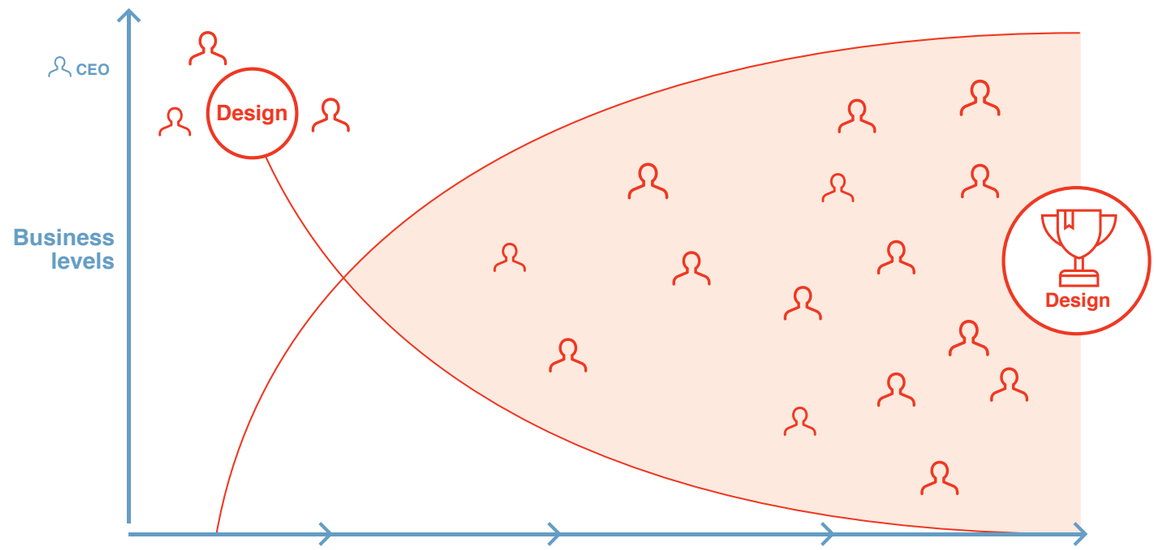
fig 08
Design's role has changed in its three years, from working on individual stand-alone projects to embedding design practices and shaping organisational processes.

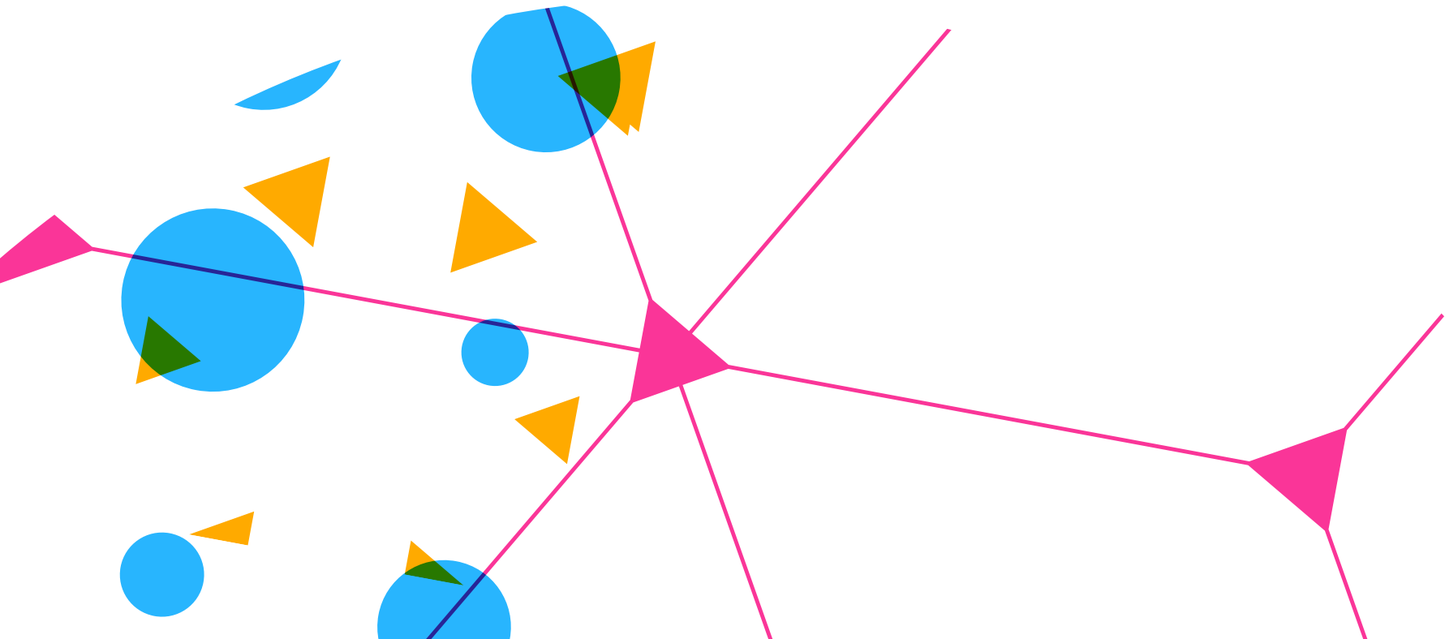


4.2.4
Design and Organisational Structure

Since the Catapult's establishment in 2013, a number of interrelated issues have influenced the emergence of design within the organisation. Early on it was recognized that the real economic value of space technology was not in the assets in the sky but what it could do for people on the ground. In addition, key people within the Catapult visited organisations such as the Stamford D-School (USA) and the Hasso Plattner Institute (Germany) that are powerful advocates of design. Figure 09 shows how early on, design received support from senior people within the Catapult. Over time, design's capacity has grown and spread throughout the organisation.

fig 09
Since its start, design has received a high level of support from within the organisation and this has helped increase capacity across the Catapult.



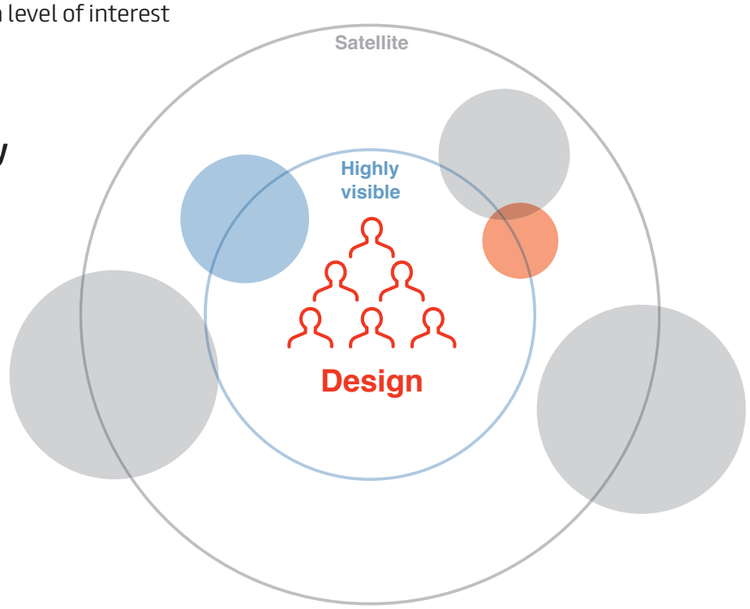


Case study cont...
Satellite Applications Catapult

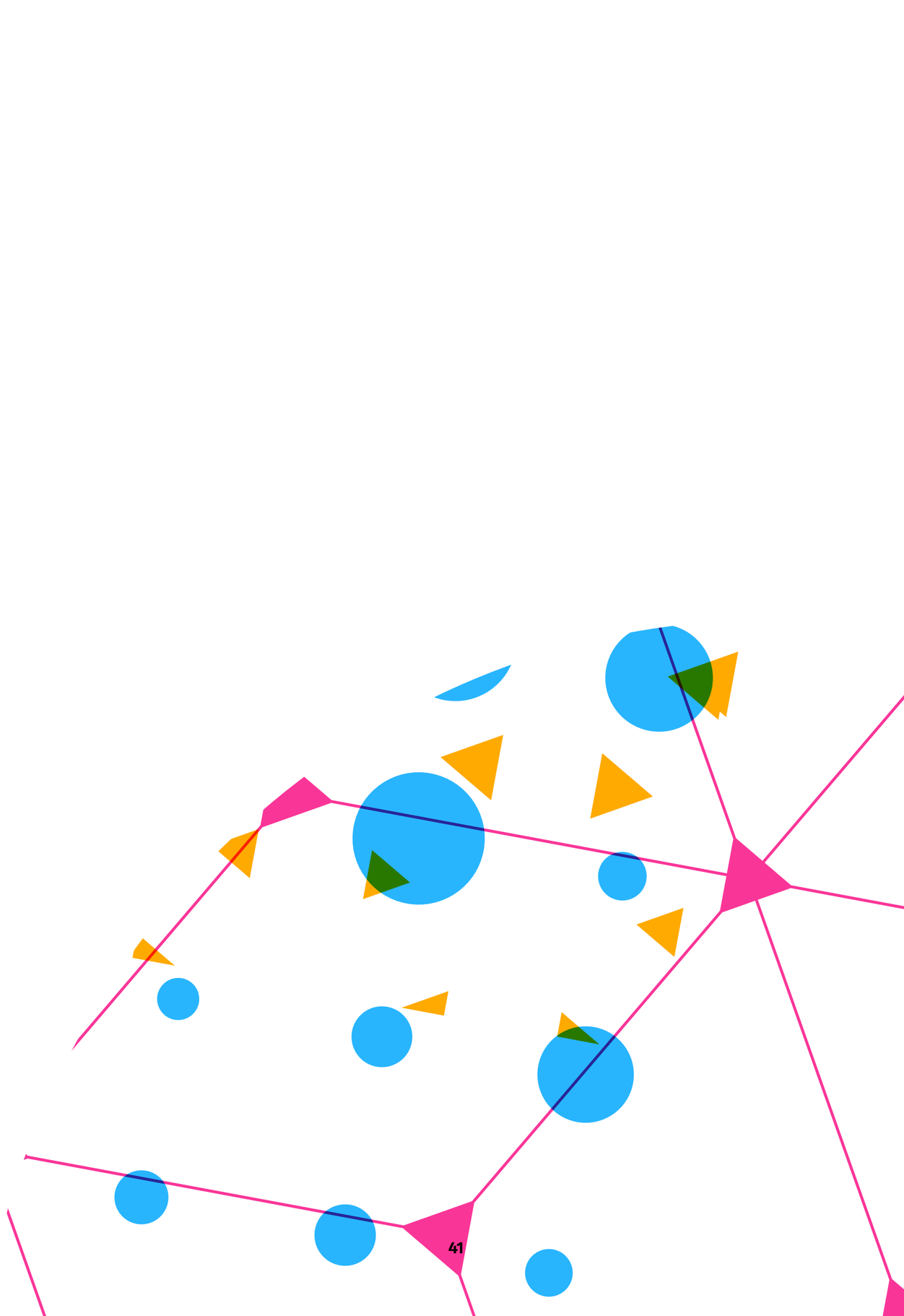
Initially design was not considered important and was viewed as an adjunct. The organisation understand its value, and then moved from employing one designer at its outset to having a team of five designers with a mix of skills and expertise such as graphic design and design thinking. The location of the design team in the organisation has also changed from a separate room, to one that is situated in a prominent position in a circular arrangement in the middle of the main open plan office, Figure 10. This circular desk area has all the physical evidence of a creative space with post-it notes, workshop materials and the team represented as Lego figures.

The design team are also involved in the five-year delivery plan which is updated annualy. They work very closely with the Head of Business Innovation who is on the executive management team at the top of the Catapult so there is a high level of interest in design within the organisation.

fig 10
Design is situated centrally in an open-plan office and plays an extensive role across the Catapult.



Design is centrally located within the organisation with a strong presence and visibility.



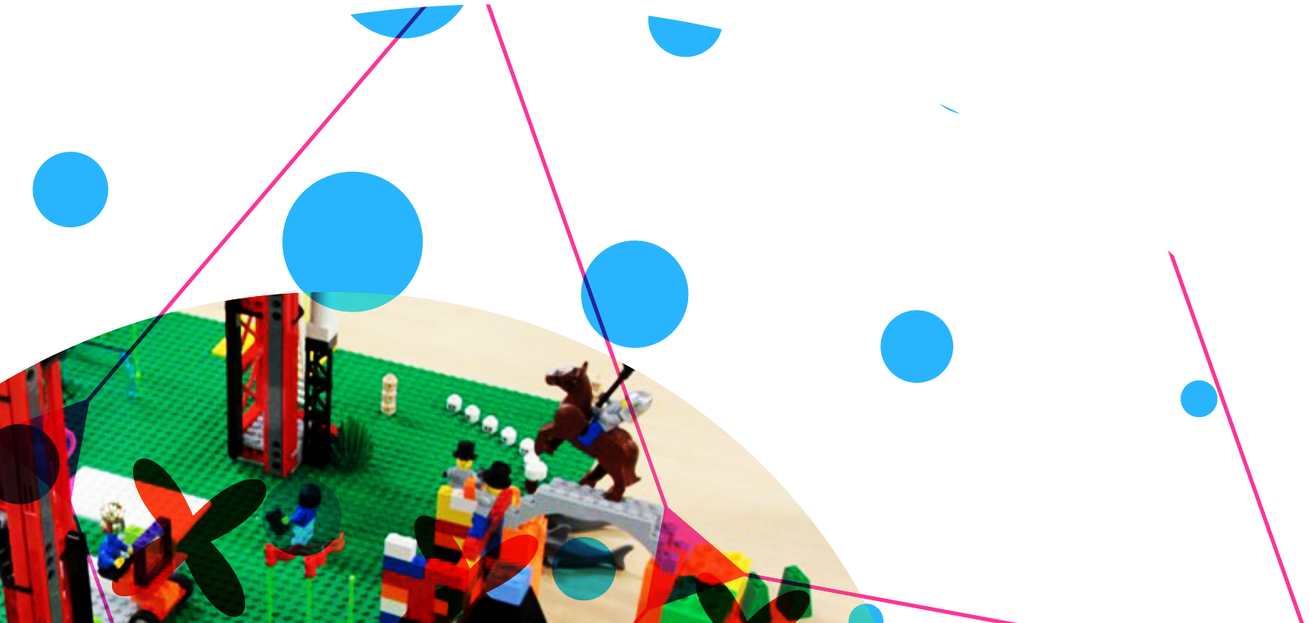
4.2.4
Design's Contribution: 3 Levels

My analysis of the data locates design practices on 3 levels. Mapped on the chart in Figure 11, you can see the multiplicity of the design activities.
The practices unlock intangible and tangible knowledge inside the Catapult and externally with clients. Throughout the three year life span of the Catapult, the range of design activities has increased, and the complexity grown, as it becomes more embedded at a strategic level.

Level 1
Design Activities

At level 1 design can be seen to focus on communication activities (infographics, powerpoint slides, brown bag events and design tools and processes) and reflective practices (standardization of innovation processes and documentation). The purpose of these is to consolidate a human centred design approach across the organisation, to make the Catapult more agile.

"I think it's even taken us a long time to realise we've got to embed it into everything; certainly for the first year or so, we probably just saw it as an adjunct 'oh well perhaps that needs some design' or 'can we do our power point slides better'".
Chief Financial & Operating Officer & Executive Director]



Level 2
Design Activities

The focus on level 2 activities can be categorized broadly as learning by doing through facilitation ('sprints' and co-design activities), playfulness (Lego, lab coats and furry cats) and fieldwork (undertaking design ethnographic work particularly in developing countries). This extends design practices and processes across the organisation, and externally with clients, and enables tacit and intangible knowledge flows. These activities further enhance social networks and ways of working and reinforce a human and business centred approach to the development of satellite technology.

"And what the design centred process revealed to me was a different way of doing it. And it's about winning hearts and minds earlier on and making that investment earlier on, just changing the way that you engage with your whole community, not only the people who are going to use it but the people who are specifying the system as well, and that sort of reduces the resistance all the way through. And then you don't actually need the same change management process or all these other things which are kind of the engineering way of dealing with it".
[CEO & Executive Director]

Level 3
Design Activities

At this higher organisational level, the designers assist the facilitation of strategy through visualisation and synthesising the Catapult projects through workshops and the development of 'threads and narratives' of related activities. This process helps in the identification of priority areas that may be market or technologically focused with common projects. The process helps the Catapult to think about how they plan their business and how to organise. By mapping out and visualising their strategy, the Catapult better understands its target, not in a prescriptive way but in ways that allows it to adapt and respond; thus design is seen to create the right level of structure and flexibility throughout the organisation.

"We have a strategy day coming up...this time we are doing it on the Catapult's impact and again we will be driven by their suggestions for our activities and how we capture the outputs from that day. So we do enable them to have a big influence on the business".
[Chief Financial & Operating Officer & Executive Director]

fig 11

Design activities take place at 3 levels. Each level shows design's role: How is it being done? What is being done? Knowledge flow and evidence.

Design's Role in the Satellite Applications Catapult

Knowledge Intensive Organizations as Service Intermediary in Innovation

Level 1

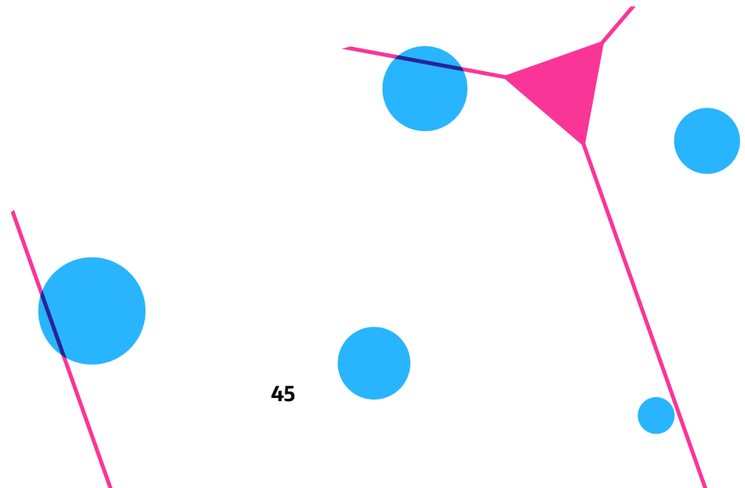
Design's role as value added activities	How How is it being done?	Activities What is being done?	Knowledge Tangible Knowledge Flows	Evidence What's changing within the organization?
Communication	Visualisation	Info-graphics	Communication material	Simplifying complexity - the strength of the visual
		Powerpoint	visualisation of complex data	Embedding presentation practices across the organisation
		Design tools & Processes	Use of the room & people using the white walls	Diffusion of creative practices - re-affirming processes
		Brown Bag events	Sharing practices and processes through projects	
		Case studies	Uniform documentation of processes & practices	Growing and consolidating knowledge internally & externally
	Documentation	Books	Design brief, stakeholder map	Rationalising and standardising design led innovation practices - internal and external facing
Reflective Practice	Standardisation	Processes - Sprints and outputs	Knowledge transfer internally and extermally	Changing view of design and its role

Level 2

Learning by doing	Facilitation	Sprints & co-design activities	Breaking down silos - Collaborative working	Adoption of practices and processes across the organisation	Everyone feels part of the process
	Playfulness	Lego, lab coats, furry cats	House app challenges	Enhancing social networks and ways of working	
	User fieldwork	Understanding different users	Seeing new opportunities for the technology in specific contexts Unlocking tacit knowledge	Human & business centred approach to satellite technology	

Level 3

Reflexive Learning All of the above	Strategy visualisation	Development of threads and inarratives	Assisting in decision making of projects and direction of the organization Synthesizing of strategic information Visualization and Images of strategy	Peoples' knowledge of their organisation, its direction and its goals increase



Case study cont...
Satellite Applications Catapult

4.2.6
Conclusion

The Satellite Applications sector is emerging with activities focused 'downstream' on developing digital services, which involve people, technology, artefacts and organisations to be configured in a human centred way, to generate economic and social value. To co-ordinate this complexity, there needs to be a high level of co-creation of knowledge between different stakeholders.

The designers use creative engagement activities to co-create knowledge flows across the organisation to embed and standardise processes and externally with clients to identify and generate potential solutions.

Through the alignment of different types of knowledge the design team are able to innovate around service delivery, Figure 12.

The design team work closely with the Business Analyst at the Catapult and the development of new services are conceptualized and integrated with the design of the business model. Both groups see this interactivity as an opportunity to learn and share knowledge.

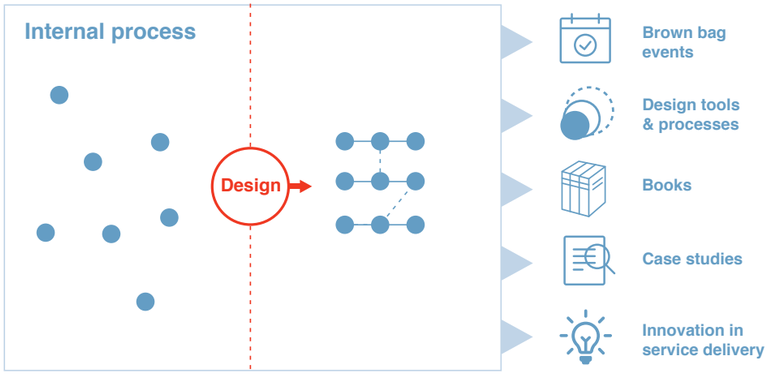
The level 2 activities involving fieldwork with clients means that the Catapult is a co-producer of innovation in Satellite Application services, through its service and business design methods and practices. Thus the organisation is involved both in the development of new services and in service transformation by extending these practices into client organisations.

The designers initially saw the standardisation of communication processes and practices as important requisites for making the Catapult more agile. The communication material and how the designers facilitate co-design activities are practices that are increasingly embedded within the organisation.

The capacity of design has grown and evolved over time. Since its start in 2013 its activities have shifted from communication design to a more dynamic set of practices, supporting the shaping of the Catapult and its formulation of priority areas at a strategic level.

fig 12

Knowledge is created and shared within the Satellite Applications Catapult through aligning its organisational processes to innovate in its service delivery with clients.



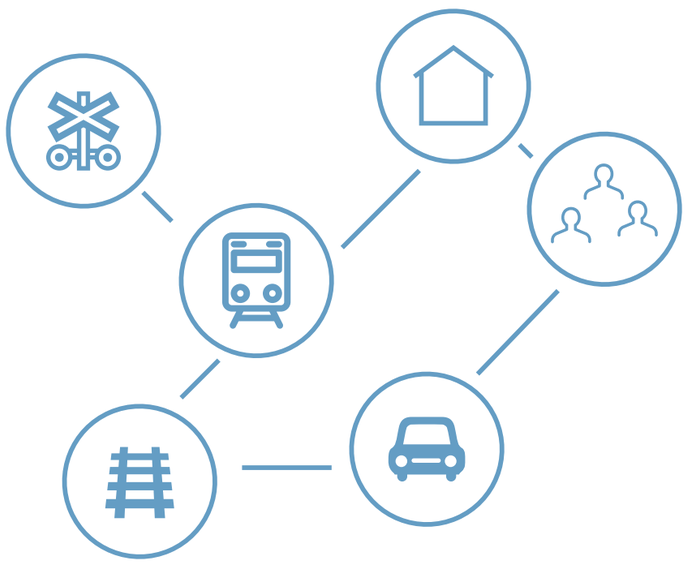
Transport Systems Catapult

4.3

4.3.1 Background

The Transport Systems Catapult (TSC) focuses on exploiting the economic impact and benefits of science and technology within the mobility sector, taking into its ambit different modes of transport. It concentrates on Intelligent Mobility (IM) and the digital transformation of transport, to develop the UK economy in this area. In particular, the TSC considers the movement of people and goods. Like all the Catapults, the organisation's aim is to bridge the gap between universities and potential industry sectors. Since the start of this research it should also be noted that design's role within the TSC has evolved and continues to develop.

fig 13
The transportation sector context is focused on engineering and building infrastructure.



4.3.2 Design Activities and Business Processes

Design's role within the transport sector is linked to its engineering origins. This means that design is commonly understood as design engineering and the development of infrastructure as shown in Figure 13.

"And again it's probably a language thing because we don't come from design….you know we come from quite a hard engineering world." [Chief Technology Officer]

The TSC recognises that the future of mobility concerns complex systems, centred on the integration of transportation and energy, and how cities are lived in. The TSC thus acknowledges that a human centred approach, that strives to understand behavior, and human factors within these systems, is critical to its success.

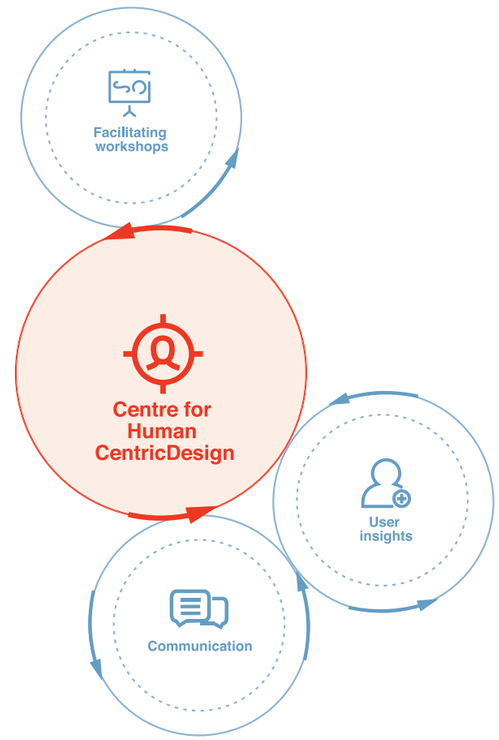
At the outset, the TSC identified ten key challenges, such as seamless travel, which led to the creation of five business units. These include: automated transport systems, virtual modelling and visualisation, customer experience, information exploitation and smart asset management.
The Principal Technologist within the Customer Experience unit has from 2013 promoted a learning by doing approach using a range of tools to facilitate workshops within the Catapult and with the industry. It was felt that this way of working needed to be demonstrated and adopted across the organisation.

The Customer Experience Business unit comprises five to six people with a Programme Director, two Project Managers, a Lead Technologist and Principal Technologist. At the time of the interview an additional team member had been seconded to the Government's Department of Transport. Within the TSC three areas of design activity were identified as shown in Figure 14.

The Principal Technologist is the person responsible for facilitating and delivering workshop activities throughout the TSC. With human centred design being identified as a key approach, it is not surprising that he has a background in psychology and human factors nor that this role is located in this unit.

The Principal Technologist works across the TSC. This engagement of facilitating workshops with the transportation sector applies 'designerly' techniques such as customer journey maps and personas that are considered fundamental in identifying the right questions and problems within the area of mobility. The Principal Technologist considers that other disciplines within transportation are overly focused on the technology and finding a problem, rather than understanding and defining a challenge in the first instance.

fig 14
Three main areas of design activity are used at the Catapult. These different activities are interlinked and dynamic.



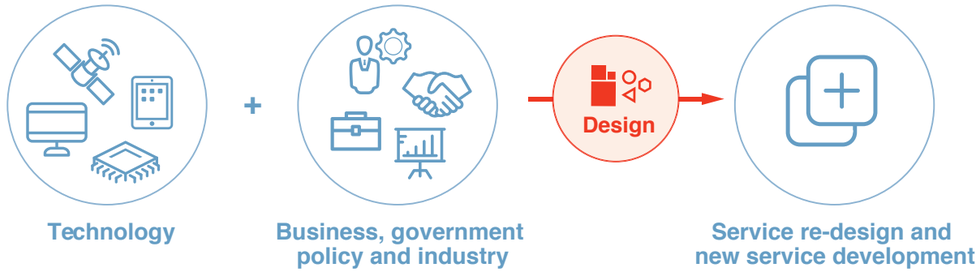
4.3.3
Design and Organisational Processes

At the TSC the Customer Experience unit do not have a particular set of workshop activities but instead try and use different conceptual frameworks for facilitation depending on the types of participants and the problems they are exploring. For example, the Catapult uses the problem solving methodology known as TRIZ[5] and the innovative 'How Might We' language of Proctor and Gamble. Such tools are interspersed with the TSC's specific problem statement approaches and tools. For example, to locate touchpoints with an operator the customer journey map may be applied. In addition, personas are developed to identify enablers and barriers to a particular context. Whilst there are no standardized practices there exists an appreciation of a human centred design approach, as already stated.

In the workshops different stakeholders from business, policy and technology come together with design providing the ingredients to act as a catalyst for the knowledge exchange. Design's role in this process is more bounded and viewed as one of a number of key assets within the Catapult Figure 15.

[5] A problem solving methodology developed in Russia in 1946 this approach draws on past knowledge and experience to expose patterns of a systems evolution. It includes a set of tools, a knowledge base to generate innovative solutions for problem solving.

fig 15
Design and Organisational Process



4.3.4
Design and Organisational Structure

Since the start of this research and the interviews in April 2016, a human centred design approach has been acknowledged in the Catapult's 2016 Strategy (TSC techstrategy.co.uk) framework. This identifies and establishes within the Catapult the Centre for Human Centric Design as one of six assets to support IM. The development of this strategy was not undertaken through a design process but seen more as a collection of the requirements of what is needed to develop IM products and services.

The information that comprises this strategy is communicated to the industry via a brochure and an online repository supported by Sharp Cloud (an online tool and portal for data sharing and storytelling) to provide a detailed breakdown of IM, with the IM Challenges and roadmaps and the UK capabilities as two parts of the strategy framework. The online portal offers a way of sharing knowledge around IM with external stakeholders and offers a place to locate relevant information relating to IM.

Within this Strategy framework, the Catapult has developed a set of internal assets to create the IM Integrated Test Environment, which includes the Centre for Human-Centric Design. The aim of this is to enhance and enable IM technology innovation from a user centred perspective by situating them at the centre of the design and development process.

The IM roadmaps consists of twelve challenge areas, informed through the Traveller Needs Study that used a systems approach to generate data through market research, expert interviews, expert panel and desktop research. These roadmaps reveal the underlying capabilities that are required to support the markets for IM. The twelve roadmap challenges were explored with industry and academia through workshop based processes with facilitation using pictoral representation and post-it notes to identify how you move from a policy through to a capability assessment through to a IM product or service in one of the challenge areas.

4.3.5
Design's Contribution: 3 levels

Similarly to the Satellite Applications Catapult, as in section 4.2.5, there are different levels of design activity within the TSC shown in Figure 16. Mapped onto the chart the greatest concentration of 'designerly' ways of working occur at level 2 where workshops and learning by doing are used to engage the transportation industry in activities that range from infrastructural issues through to policy. Here the activities draw together stakeholders from government, transport operators and infrastructure providers to facilitate dialogue using a human centred approach to explore transportation challenges.

Level 1
Design Activities

At level 1 communication and visualisation materials are produced in the form of info-graphics, reports and powerpoints for internal dissemination as well as for external use in the industry sector. This material is not co-ordinated through a design team.

The use of the Sharp Cloud online repository offers a place for the TSC to communicate the strategic area of IM and for the industry sector to engage in the roadmaps and Challenges and the asset requirements for developing IM products and services.

"We are then using something called Sharp Cloud, an online repository, which is a method of communicating stories which sounds like it has a design element."
[Chief Technology Officer]

Level 2
Design Activities

Evidence of level 2 design activities is demonstrated through workshops to explore future scenarios in areas such as station innovation. Materials such as Lego are used to stimulate the thinking of the participants, to co-create knowledge and to facilitate collaboration around a particular challenge to build ideas. Because of the success of these workshops, recognised in part through participant feedback, the use of these approaches are beginning to be used as standard practices within the organisation.

The following quote reveals the importance of this approach:

"Stations Innovations Workshop for instance, utilised serious play so the Lego approach, although at first it looks like a bit of fun, which it is to some degree, it's identifying proper engineering requirements and then how do you actualise it, how do you visualise it by the nature of using Lego? And then how do you draw all these things together into a larger piece?"
[Lead Technologist]

In a further interview with the Chief Technology Officer the following quote endorses this thinking:

"OK, so when a workshop is run with multiple partners around information systems of the future within, I don't know, Transport Interchanges, he [the Principal Technologist] is actually facilitating possibilities with perhaps disparate partners who haven't actually had that sort of collaborative envisioning before?"

Business development methods and expertise are used in the workshops in conjuction with human centred design activities to encourage the participants to share information and free up their thinking. These ideas are then taken out into the field to interview different user groups (station managers and rail signal controllers) to gather feedback.

Level 3
Design Activities

The Centre for Human-Centric Design is a key asset in IM, however, although promoting a human centred approach to the transportation sector, this asset is not used internally to shape the strategic vision of the TSC itself as a level 3 activity.

As the Chief Technology Officer commented:

'I think design as a concept is not well understood. So I think, again it depends on what you call design...I maybe wouldn't associate what we are doing through the Technology Strategy as design but we are, through that, really designing what we do as an organisation, so there's an aspect of design."

fig 16

**Design Activities take place at 3 levels. Each level shows design's role: How is it being done?
What is being done? Knowledge flow and evidence.**

Design's Role in the Transport Systems Catapult as a KIBS

Knowledge Intensive Organisation (Service Intermediary in Innovation)

Level 1

Design's role in organisational knowledge learning	How How is it being done?	Activities What is being done?	Knowledge Tangible Knowledge Flows	Evidence What's changing inside & outside the organization?
Communication	Visualisation	Info-graphics	Brochures	
		Powerpoint	Reviews, Government Policy, Industry engagement	Sharing information and processes
		Design tools & processes	Reports	Acceptance by other transport operators of the value of such tools
		Photographs	Industry engagement	Stakeholders external to the Catapult adopting new ways of working
		Case studies	Government Policy. Industry engagement.	Growing and coordinating knowledge
	Sharp cloud	Online tool	Exchange stakeholder engagement	Acting as a conduit for industry
		Whiteboards		
Reflective Practice	Standardisation	Tools, use cases, data sets	Ways of sharing knowledge	

Level 2

Learning by doing	Facilitation	Workshops	Unlocking tacit knowledge, breaking down silos, knowledge sharing	Moving from Engineering Design to Design thinking
	Playfulness	Lego	Making people more comfortable	Free and open discussions, new Relationships
		User scenarios	Putting yourselves in the shoes of someone else	Changing perspectives externally on how to frame problems
		Testing ideas		

Level 3

All of the above	Centre for Human-Centric Design	High level brochure and website	Mainly front – end thinking enabling the transport industry to knowledge audit its needs around an issue	Presenting the Centre for Human-Centric Design as a key asset to the TSC
		Online interactive repository of tools to locate knowledge		Acting as a conduit for industry

4.3.6
Conclusion

The transport sector has established links with the design and development of engineering infrastructure. Although the Catapult clearly positions itself as seeing mobility as a service, the industry still naturally looks to engineering practices and processes.

Although the Centre for Human-Centric Design is one of five key assets that make up the IM Integrated Test Environment, design's role within the Catapult is more bounded to a particular set of activities rather than embedded across the organisation.

The human centred design activities and the serious play undertaken in the workshops through Lego is valued for eliciting more open discussions and free thinking; the ideas are also judged by the Customer Experience Business team to be of better quality. Because of their success these practices are beginning to be adopted across the Catapult and also externally by the transport sector. In addition, the involvement with user groups such as the Royal National Institute for the Blind (RNIB) in workshops with operators and infrastructure experts is raising awareness in the mobility sector for a more human-centred perspective.

Discussion

5.0

In this section I refer back to the original research objectives to understand the role of Catapults as science and innovation services and design's role within them. The following has been identified:

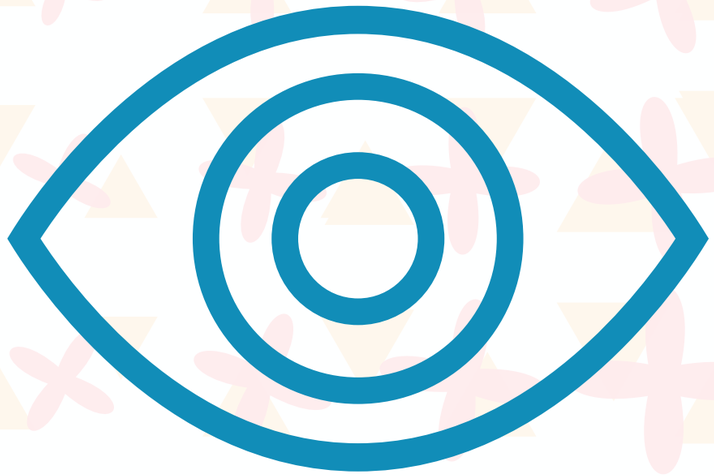
Positioning Catapults as KIBS(dealing with different technology sectors) enables design's role to be better understood as a key business and organisational asset that enables the translational role of the Catapults to be realised through a set of design practices.

Catapults' fit the characteristics of being service organisations that act as Knowledge Intensive Business Services, facilitating innovation across multiple actors. Design's role in this environment is therefore to enable, through a wide range of 'designerly' practices, the convergence of both explicit and tacit knowledge flows inside the Catapult and externally with clients where they serve as co-creators of knowledge based solutions.

3 different levels of design activity emerge over time within the Catapults. Level 1 deals with consolidating communication practices through visualisation of complex information, methods and tools so organisational processes can be easily digestible; these activities can also be co-ordinated to develop and support a more agile way of working. Level 2 activities facilitate more dynamic learning via the exchange of tacit knowledge by learning by doing, playfulness and fieldwork. Concurrently the design activities build capacity and capability across the organisation and embed practices through highly interdisciplinary encounters. At level 3, design has shifted to a strategic level to be a key component of devising the Catapult's direction and goals. Its techniques are used to facilitate and shape the thinking for the Catapult's strategy.

I established that design's contribution to service innovation within the Catapults can be difficult to identify. However, if one considers innovation as including organisational processes to assist in the adoption, assimilation and routinisation of methods and processes to co-create knowledge, design's contribution can be seen in innovating around service delivery, in new service development with clients, and ultimately, in transformation across the organisation and beyond in the industry.

As evidenced, the industry context influences design's role within the organisation. In the Satellite Applications Catapult, the industry sector is rapidly developing and agile ways of working are intrinsic. The approaches adopted by the designers share many similarities with service design, used in the development of new digital products and services. These shared methods are being adopted, assimilated and embedded across the Satellite Applications Catapult to support its service delivery to its clients. In contrast, the transportation sector is engineering led. Thus design's role in the TSC is focused on building, as one of a number of key organisational assets, its Centre for Human-Centric Design.



Conclusion

6.0

This short research project has highlighted design's role in two of the eleven Catapults. By framing the Catapults as KIBS, design activities can be seen as enabling organisational learning at the very least at level two, which involves learning by doing. Considering the results for the future, I recommend as a first step, design activities need to be focused on their contribution to service delivery between the client and the Catapult. To assist this knowledge exchange attention needs to be given to how design activities are coordinated, assimilated and embedded across the organisation in order to ensure that a human centred approach can be readily adopted and understood between different stakeholders inside and outside the organisation.

The aim of this analysis of the two Catapults was not to compare and contrast but to provide a framework to open up discussion around design's role in science and technology services. More importantly and as I have shown, the mapping template Figure 17 should assist in identifying different design activities within an organization and their contribution to knowledge flows and reach within a Catapult, thus enabling the organisation to deploy design strategically.

Building on this research, future work should look to identifying different levels of design activity in other Catapults and its contribution to the internal and external co-creation of knowledge. Where there is an absence of design activities within the Catapults, there is also an opportunity to use the framework tool to open up discussion to explore how 'designerly' and human centred practices may assist in engaging with clients and support the Catapults in their service delivery.

Acknowledgements

7.0

This research and publication would not have been possible without the funding of the KTN. In particular I would like to thank Beatrice Rogers for planting the seeds for the research and also for Edward Hobson for providing ongoing support and allowing me to participate and observe the Cross Catapult Workshops.

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fig 17

A blank mapping template to explore design activity across other Catapults

Designer's role

How

Communication	Visualisation	Testing ideas	Facilitation	Playfulness
All of the above	Centre for Human-Centric Design	Standardisation	Documentation	
Learning by doing	Strategy visualisation	Systemising internal processes	User fieldwork	

Activities

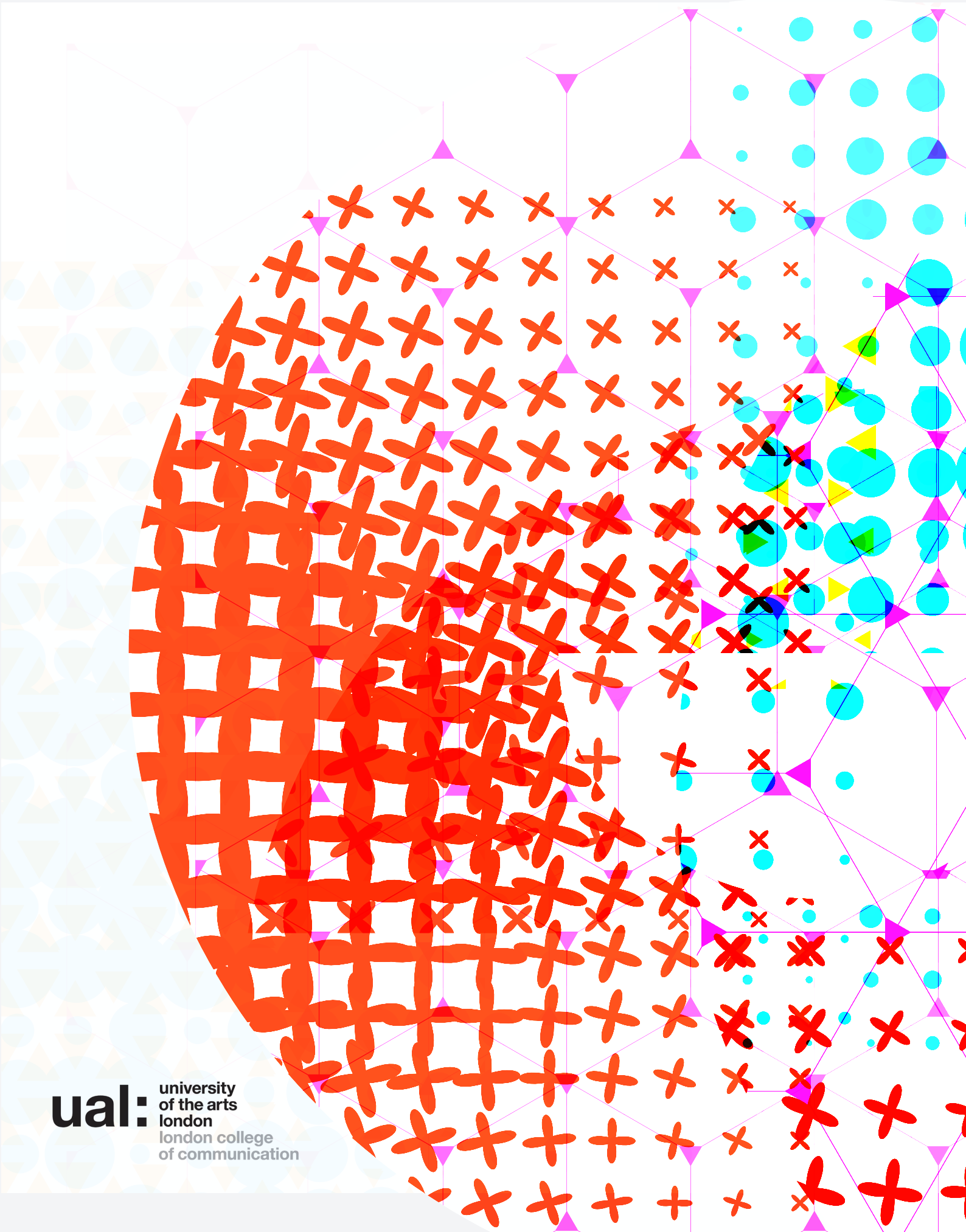
Info-graphics	Lego, lab coats, furry cats.	Powerpoint	Design tools & processes	Brown Bag events	Online interactive repository of tools to locate knowledge.
Workshops	Books	Understanding different users	Case studies	Lego	Processes - Sprints and outputs.
High level brochure and website	User scenarios	Online tool	Sprints & co-design activities	Development of threads and Inarratives.	
Tools, use cases, data sets.	Whiteboards	Information	Photographs		

Level 1

Design's role in organisational knowledge learning	How How is it being done?	Activities What is being done?	Knowledge Tangible Knowledge Flows	Evidence What's changing inside & outside the organization?

Level 2

Level 3



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london college of communication