THE VALUE OF DESIGN RESEARCH

11TH EUROPEAN ACADEMY OF DESIGN CONFERENCE

APRIL 22-24 2015

PARIS DESCARTES UNIVERSITY
INSTITUTE OF PSYCHOLOGY

BOULOGNE BILLANCOURT
FRANCE

CONFERENCE ORGANIZERS:

PARIS DESCARTES UNIVERSITY
PARIS SORBONNE UNIVERSITY
PARIS COLLEGE OF ART
ISTEC PARIS

Designing from the Unfamiliar: How Designing for Space and Extreme Environments can Generate Spin-off and Innovate Product Strategies

FAIRBURN, Sue IDEAS Research Institute, Robert Gordon University s.fairburn@rgu.ac.uk

DOMINONI, Annalisa Design Department, Politecnico di Milano Annalisa.dominoni@polimi.it

ABSTRACT

We moderate our world and our interactions with objects and others through our behaviours, habitats, clothing and gadgetry. Designers seek new ways to innovate products but there is a limit to our experiences and observations of the everyday and there is opportunity in finding ways to aid our imaginations.

This paper proposes that experience gained designing for Space and extreme environments could enrich design research through the application of unfamiliar design scenarios. The proposal is based on first-hand research by the authors who work in the area of space architecture. Using the experience of design for Space to inform methodologies for design on Earth may generate a paradox, as clearly microgravity isn't a condition on Earth, but therein lies the opportunity to find analogous ways to create this state, and other states, to generate new conditions, in turn leading to design innovation.

What is an extreme environment? Outer Space has always been an environment considered too cruel and hostile for life to exist. Earth presents a more familiar environment that supports life and that enables us to explore and exist. But, what if everything we know about forces and mechanisms changed? How would we perceive the interface between the body and the material world? How would we interact with the environment if tested under extremes? And, how can those extremes inspire design for everyday terrestrial living conditions?

Designing for environmental extremes is a perspective, a transformative lens, for applying lessons learned from extreme scenarios to assist us in methodologically imagining not only new things, but also a wider range of possibilities.

Keywords: Extreme Environments, Design for Space, Design Innovation, Creativity Tool, Design Methodology.

1 INTRODUCTION

Design makes ideas tangible. In the context of consumer products and services, it responds to problems, it anticipates our needs, and sometimes it offers delight. Designers are constantly seeking ways to better understand users; their needs and their behaviours in daily life society, thus understanding the user is considered central to the design process and user research informs the specifications for most new products and services. The default practice for many designers is first based in user studies then design, but Chow and Jonas (2010) argue that the focus on the user has 'overshadowed the projective competence' of design and thus limited our ability to imagine the new. Reconsidering the design process, between user study and design, can open up possibilities.

Designers seek ways to innovate, but there is a limit to our experiences and observations of the everyday and there is opportunity in finding ways to aid our imagination. As an alternative to user-based and participatory design approaches we propose unfamiliar design scenarios as a means to achieve design innovation. In this sense, the unfamiliar is sought as a way to shift our perspective and assist in issue exploration and idea generation. The Oxford Dictionary defines familiar as that which is often encountered, or experienced, as in "the situation was all too familiar" so how might designers work with that which they rarely encounter, or the unfamiliar? Dunne and Raby use the concept of speculation to generate ideas through a range of methodologies, such as fictional worlds and thought experiments. They describe speculation as based in imagination, other worlds and alternatives, and in the fields of imagination they describe their specific interest as "the design imagination." (2013 p 70)

In this paper, we discuss how extreme scenarios based in design for Space can inform design methodologies as a creativity tool, for generating new artefacts and systems, for the familiar environments we inhabit. In doing so, we do not diminish the relevance of existing design methodologies, instead we propose to complement them by shifting perspectives through research scenarios based in factual extreme environments, specifically through space.

Though unfamiliar to most, Space is perhaps the most extreme environmental scenario. With over 50 years of human spaceflight we have amassed a substantial understanding of how to survive the journey and the implications of living and conducting research in an artificial environment for prolonged periods of time. Space, as the unfamiliar or the unusual, presents us with a range of environmental and even contextual conditions wholly different from those on earth. Some of the most unfamiliar aspects of the environment include; weightlessness, isolation, infinite space and natural resources, the absence of atmosphere, temperature extremes, magnetic field, and a comprehensive overview of the Earth (Connors et al, 1999). Harris (1995), who also wrote extensively about the unusual orbital environment, further proposed that current research in evolution supports that harsh environments, such as Space, often result in innovation among a species. As we transition from surviving in Space to living in Space, we demonstrate our capacity to anticipate and mitigate the design challenges.

From the human perspective, the most relevant and challenging aspect is microgravity and it is this environmental condition that informs the author's experience and serves as the basis for their joint intentions in this paper. Independently, both authors have worked in design for space, including the design of; Space habitats and devices, crew wardrobes, and crew quarters for the International Space Station (ISS). It was on meeting and sharing their perspectives that they realised they had similar intuition and awareness arising from the challenges and expansions of designing for an unfamiliar environment.

Recognising that some may not be familiar with the environment of Space, the authors begin by offering an overview of microgravity and then discuss the approach of using unfamiliar design scenarios as a design methodology. They share first-hand case studies that position Space as a transformative lens for applying experience from extreme scenarios to everyday contexts. Lastly, they reflect on how experience in Space can translate onto experience on earth, an apparent paradox since obviously microgravity doesn't exist on Earth, but that by finding analogous ways to create the state of consciousness that microgravity

11TH EUROPEAN ACADEMY OF DESIGN CONFERENCE

APRIL 22-24 2015

PARIS DESCARTES UNIVERSITY
INSTITUTE OF PSYCHOLOGY

BOULOGNE BILLANCOURT
FRANCE

CONFERENCE ORGANIZERS:

PARIS DESCARTES UNIVERSITY
PARIS SORBONNE UNIVERSITY
PARIS COLLEGE OF ART
ISTEC PARIS

provides can yield new effects on the human being, and in turn new conditions for design. Thus, design in this way becomes a 'science mediator' for translating unfamiliar scenarios.

2 SPACE AS AN EXTREME ENVIRONMENT

The principal differences between living and working on Earth and in Space involves the effects of microgravity, which exerts multiple effects internal and external to the body. Physiological effects are numerous and include: the posture assumed by the body; the movements necessary to go from one point to another; the ability to maintain one's balance and sense of direction; the perception of space, of volumes, and of colours; and, consequently operating efficiency and the performance of various human activities.

Microgravity is considered the greatest limitation and the most difficult problem to solve in Space, at least for the time being, because of the harmful affects on the nervous system, the cardiovascular system, and the muscular and skeletal system in particular. Microgravity also causes variations in the dimensions and the morphology of the human body: the circumference of the legs decreases and body fluids flow from the lower part of the body to the upper part, causing the typical "puffy face", and if relaxed, the static body assumes a stooping position with the angle of the elbows and knees at about 130 degrees, the pelvic angle changes, the curve of the lumbar and thoracic sections of the spinal column straighten causing an elongation of the body by more than 10 centimetres. Thus, the transformative environment imposes a complete change in the morphology of the human body and a substantial change in posture and dimensions, known as Neutral Body Position (NBP), as seen in Figure 1.

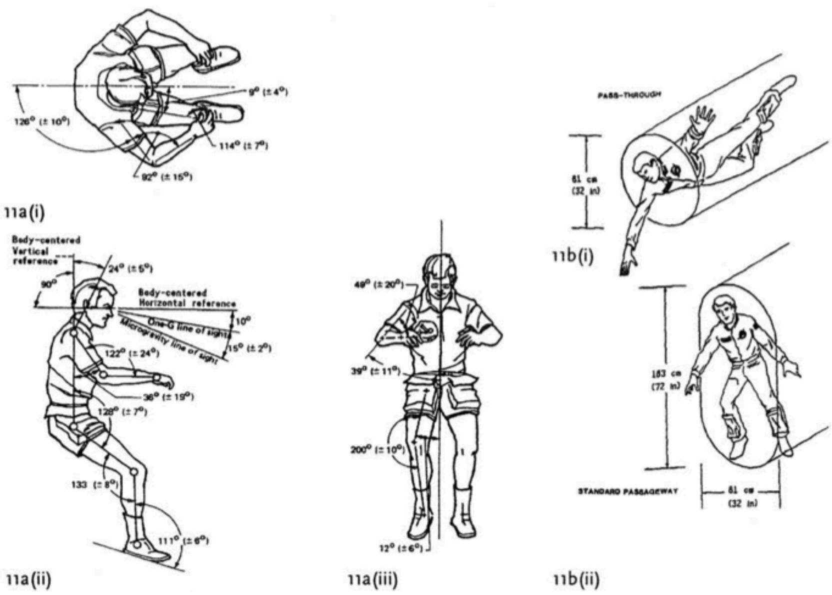

Figure 1. Illustration of a crewmember in Neutral Body Position (MBP) and envelopes for translation/ passageways (Image source: NASA).

11TH EUROPEAN ACADEMY OF DESIGN CONFERENCE

APRIL 22-24 2015

PARIS DESCARTES UNIVERSITY
INSTITUTE OF PSYCHOLOGY

BOULOGNE BILLANCOURT
FRANCE

CONFERENCE ORGANIZERS:

PARIS DESCARTES UNIVERSITY
PARIS SORBONNE UNIVERSITY
PARIS COLLEGE OF ART
ISTEC PARIS

This new "neutral posture" is similar to the one assumed by the body underwater and seems to result principally from a new equilibrium of the muscular forces in relation to the tension of the tissues acting on the various joints. How does this shift inform constraints for the designer, what design methodologies emerge, and how do we understand this from a design research perspective?

Translated into design conditions, the first and most obvious impact is that microgravity enables you to use space and interact three dimensionally requiring us to reconsider our axis of movement (Figure 2). We are no longer bound to the horizontal surface, and no longer need chairs, tables, beds, and instead, and instead, we find ourselves in need of an interface with which to attach, and secure objects and ourselves. Suddenly you design for an environment where you can leave everything you learned aside, it has no impact anymore, it doesn't make sense anymore, and that is the point where you start really re-thinking the possibilities for artefact, systems and interfaces.

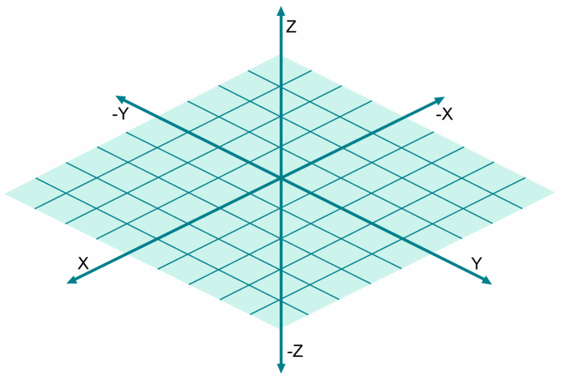

Figure 2. Reconsidering the axis of movement from a graphical representation.

Not only does microgravity have a determining influence on a human being but also on the force-weight of objects, increasing the difficulty in their control and use. In fact, there is always a minimum residual speed, perhaps because of re-circulating air, that causes the object to move slowly and inexorably on its own account. This in itself is the basis for significant design adaptations specific to the micro-gravity environment and further adds to the unfamiliarity of the design specifications which microgravity imposes.

Designing for the extreme environment of space, of microgravity, you have the chance to leave out all the given facts and reconsider these interfaces – and at the same time you get closer to the human body because you have to think about the human body, how we interact, how we behave in an environment, and how we perceive a space. These are all things that place us in a scenario where we have to relearn, rethink, and the result is new perspective on conditions we take for granted.

3 DESIGNING DESIGN SCENARIOS

Designing for Space, and specifically microgravity conditions, extends the area of design research outside of the common rules and consolidate methodologies that we use to consider and apply in a design process. Looking through the transformative lens of Space, the designer is freed from the conventional references and potentially advantaged by different points of view and new scenarios. Wolfgang Jonas writes about how design and science can approach each other, particularly with regard to knowledge generation, wherein he recognises the role of scenarios as a guiding idea within a design process. Jonas (2001) sees a scenario '*as a design in itself'* and highlights their generative potential. Thus, conceiving and working from scenarios invites us to answer the question - '*What if*?' - and this in turn invites us to shift our perspectives and further stretch our imaginations.

What if everything you knew about forces and mechanisms changed? What if you had an additional axis of movement (Z-axis) to consider (Figure 2)? The ability to foresee how to live and move in unfamiliar settings such as in microgravity conditions – with shifting environmental stimuli, with physical and perceptive body alterations and objects which start to float around if not supported, with altered translation - is a useful exercise of thinking "outside the box": a method that helps designers to change the mental map created with the passing years and the experience acquired, able to reduce the creative potential and inhibit their observation of the world/box in which we all are surrounded.

Within this new approach we are invited to reconsider our normative relationship with our immediate environment. Two first-hand case studies follow; the first references "immersive kinaesthetic exercises" as an empirical aid to gain awareness and insights and to generate scenarios and questions to directly inform a design process (Fairburn and Walker 2001). The second case study positions itself as 'design of use and gesture" methodology, an approach based on the forecast use and on the simulation of the results (A. Dominoni 2002). Both case studies reference simulation, or the creation of analogous situations as an aspect of design research scenarios, to explore our understanding of body mobility, position and object/environment interface, and to inform design methodologies. Equally interesting is their potential for offering an unfamiliar scenario as a transformative lens to aid awareness and imagination and to innovate terrestrial product strategies.

3.1 CASE STUDY 1.0 – DESIGNING KINAESTHETIC AWARENESS

If the architecture of motion is explored as scenarios of movement and stasis, very perceptible in Space, how are the considerations transferred to terrestrial design. As terrestrial creatures, we are continually exposed to the gravitational field of the Earth. The reduced gravity in Space is a circumstance that brings both opportunities and restrictions. On Earth, we learn to anticipate the effects of gravity and adjust accordingly - its absence must lead therefore to re-learning, re-adjustment, and re-orientation.

Though the environment is hostile, Space as a medium, is "easy" - it requires minimal energy to initiate movement in space. A crewmember can push off by just blowing a puff of air against a surface. While this 'magical' quality of weightlessness inspires a range of recreational pursuits possible only in a large-scale weightless environment, maintaining a position in a weightless environment can be difficult and Crewmembers use interfaces while sleeping and resting and when moving about. Further, the equipment on the ISS must also provide the means to keep articles and objects from floating about and becoming hazards.

11TH EUROPEAN ACADEMY OF DESIGN CONFERENCE

APRIL 22-24 2015

PARIS DESCARTES UNIVERSITY
INSTITUTE OF PSYCHOLOGY

BOULOGNE BILLANCOURT
FRANCE

CONFERENCE ORGANIZERS:

PARIS DESCARTES UNIVERSITY
PARIS SORBONNE UNIVERSITY
PARIS COLLEGE OF ART
ISTEC PARIS

In the first case study, the author, a registered SCUBA diver with years of open-water and simulated (hyperbaric chamber) diving experience, sought to perceive body mobility and body-object interface in an unfamiliar way (Fairburn and Walker, 2001). A series of experiential exercises were developed involving underwater, simulated-weightlessness sessions, carried out in a diving tank using SCUBA to permit longer period of activity and observation. The goal of the exercises was to experience the challenges of microgravity when orienting the body and the position of other bodies and objects. A series of forms were constructed from various materials (rubber, textile, wire, wood) and then immersed in the diving tank, with the designer, to observe underwater and explore through interactions in the simulated-weightless environment. Awareness of body position, body–environment, and body-object interaction were documented through photography and journaling, to generate both an inner-awareness or kinaesthetic imprinting, and an external awareness, and ultimately to inform the constraints for creating an array of body-positioning products for ISS (Figure 3).

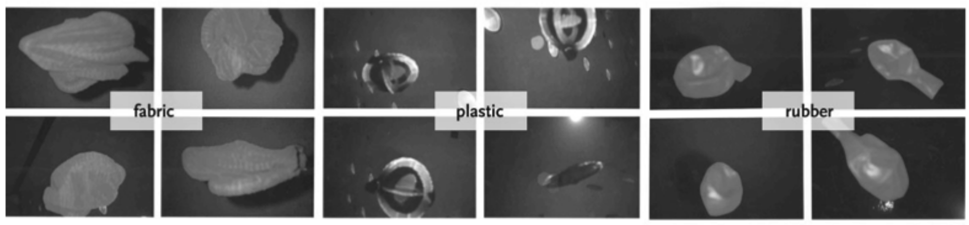

Figure 3. Body/Objects underwater exercises to inform design for living in space concepts (Image source: Fairburn and Walker, 2001).

The main insight generated by the immersive exercises was that in microgravity the natural state is motion and there is an absence of rest, whereas in a gravity-rich environment the natural state is rest. While, the insights arising from the original experience informed an innovative design for positioning devices for ISS crew quarters (Fairburn, 2009), what followed was a persistent curiosity as to how the observations and insights could inform design in a terrestrial environment, and there-in, the opportunities for innovations across a range of design areas (e.g. interaction design, transportation, way-finding, furniture, fashion, etc.) and everyday terrestrial settings (e.g. domestic, office, hospital, public transport, etc). The challenge arising from the first case study is in how to conceive of immersive scenarios, such as that afforded by the kinaesthetic experience, that aid our sensory capacity and enable new strategies for exploring issues, developing constraints and generating ideas.

3.2 CASE STUDY 2.0 – DESIGN OF USE AND GESTURE

Acknowledging that Space is not possible for a designer to experience in person, the “design of use and gesture” methodology is based on the forecast use and on the simulation of the results. The task focussed on facilitating human movements and activities to foresee new ways of using tools and new gestures in relation to the extraordinary conditions of the environment (A. Dominoni 2002). Designing for microgravity conditions requires the capacity to foresee the way an object will be used, to be able to imagine, for example, the actions and the movements of the Space crew in relationship with the new microgravity body position, and to foresee the physiological, perceptive, ergonomic, psychological and motor requirements that arise in these conditions completely new and unknown to the human being.

The 'design of use and gesture' methodology was applied to the development of a system of portable tool-holders called "Portable Caddy", designed by the author A. Dominoni. The device can be carried or worn by the crew members for use as an aid in the ordinary maintenance onboard the Columbus European Laboratory of the International Space Station (ISS). The design is based on the possibility of simulating on Earth the operator's movements by means of advance verification of the body's possible uses and gestures in relation to the objects and the Space environment. Design in compliance with use and gestures – that is the analysis of the movements most suitable for using the containers and the tools, and recomposed into precise sequences of gestures – was carried out inter-linking it with the parallel development of the morphologic and functional characteristics of the tool-holder system (Figure 4).

Figure 4. A sequence of movements performed by astronaut Roberto Vittori during GOAL experiment, ENEIDE Mission (Image source, Dominoni 2005).

To plan the gesture of "how" to use the containers and the tools – that is, how to recognize the tool required for a particular operation, how to take it out of the container, how to anchor it to the body and to the structure of the Space habitation module in a situation of microgravity, how to put it back into the container etc. – and to design the shape of the objects themselves – relative to the physiological, perceptive, ergonomic, psychological and motor aspects of the operator, but also to the structural, material, mechanical and functional aspects of the instruments on board – are actions that interpret a unique design process where theory and practice overlap, and in which the value relative to the use of an object is strictly connected to the intrinsic value of the object itself.

To have recourse to consolidate practice is desirable both for the designer, who can operate in a familiar field, according to predetermined and consequently easier to manage conventions, and for users, who have the advantage of greater confidence in and control of actions, which are the same as, or similar to familiar gestures.

4 FUTURE SCOPE: AS EMERGENT DESIGN METHODOLOGY

We introduce here, in this emerging area or research, a design methodology of kinaesthesia, of use and gesture, because we believe that the level of consciousness coming from the awareness of body, object and environment, of each gesture and movement necessary to perform a task, can help the designer and the "performer" to analyse in depth the need and the most hidden behaviours of people.

The transversal reference to the background of the choreographic ideology – which is to say the structuralist intention on the basis of which every actions can be separated into a series of single movements and reconstructed as a sequence of movements – may be useful when illustrating the methodology that the designer should apply when "designing for use and gesture". Like a director who must conjugate the engineering of screenplay narrative and the figurative nature of the story board – tracing the thread through the identification of the nodal points essential to film editing, and include and determine the geometry of actor and extra movements, as well as camera movements, connecting all with sound track rhythms – so the designer of structures and equipment for living and working in Space expresses, through a "program of use" or a "program of gestures", a predefined sequence of actions that enable operators – in this case astronauts – to reconstruct designed movements for use of new products and therefore to reproduce them.

Going back to the choreographic ideology, the designer must not only foresee the series of actions involved in the use of the object, but must enhance, at the planning stage, both the gestures and the movements that accompany the object, and the object itself, like in a dance, must take on the role of the artifice of a series of gestures, a program of ritualistic movements.

We offer scenarios that may be of use to enrich design processes for non-extreme environments. Working and observing astronauts who live in microgravity conditions we have been "forced" to slow down the rhythms to which we are accustomed on earth during the design process. Could "slowness" become a new and important approach in the design process to innovate? In this context, the design becomes a "slow mediator" able to read usages, gestures and behaviours of the people and translate them into new useful products to increase the wellbeing and answer to the need of the humans by observing the experience of living and working in Space or on Earth, and also, by transferring the results from one field to another and vice versa. There are also the physical fictions of Dunne and Raby (2013, p. 88) whose driver is speculation, not to predict the future but to 'unsettle the present' and ultimately to achieve new perspectives. Could a constructed design scenario, for example an immersive experience in an unfamiliar environment, induce a state that shifts our perspectives and in turn generates new conditions for design?

5 CONCLUSIONS

The case studies presented push us to reflect on how our normative understanding of our familiar world impacts on our practice. They invite us to consider how unfamiliar environmental alterations can become design scenarios to facilitate creativity and innovation.

11TH EUROPEAN ACADEMY OF DESIGN CONFERENCE

APRIL 22-24 2015

PARIS DESCARTES UNIVERSITY
INSTITUTE OF PSYCHOLOGY

BOULOGNE BILLANCOURT
FRANCE

CONFERENCE ORGANIZERS:

PARIS DESCARTES UNIVERSITY
PARIS SORBONNE UNIVERSITY
PARIS COLLEGE OF ART
ISTEC PARIS

The impact of this proposed research approach is intended to offer first reflections on kinaesthetic design methodologies as a "slow mediator" able to translate, in terms of usage, needs and behaviours, the technologic and scientific innovations to inform new conditions for design. The authors propose that extreme environments, while unfamiliar, may be mediated by enriching our arsenal of design methodologies, and that conceiving such unfamiliar design scenarios and reconsidering our normative relationships with our everyday environment can renew design for non-extreme environments.

6 REFERENCES

Chow, R, and Jonas, W. (2010) Case Transfer: A Design Approach by Artifacts and Projection, *Design Issues*. 28 (4), 9-19.

Oxford Dictionary, http://www.oxforddictionaries.com/definition/english/familiar [Accessed 28 February 2015].

Dunne, A. and F. Raby, (2013) *Speculative Everything, Design Fiction and Social Dreaming.* MIT Press, Cambridge Massachusetts, London, England.

Connors, M.M., Harrison, A.A., Akins, F.R.,(1985) *Living Aloft, Extended Requirements for Human Spaceflight.* NASA, Washington, D.C.

Jonas, W. (2001) A Scenario for Design, *Design Issues*. 17 (2), 64-80.

Harris, P. R. (1995) The Impact of Culture on Human and Space Development – New Millennial Challenge. *Acta Astronautica. 34 (7), 399-408.*

NASA-STD-3000 285*, Volume 1 Man-Systems Integration Standards,* http://msis.jsc.nasa.gov/sections/section03.htm [accessed 4 Nov 2014].

Fairburn, S and Walker, S. (2001) 'Sleeping With the Stars' – The Design of a Personal Crew Quarter for the International Space Station, SAE Technical Paper 2001-01-2169.

Fairburn, S (2009). Retrofitting the International Space Station. In Howe, A.S and Sherwood, B. (eds.) *Out of this World: The New Field of Space Architecture.* Reston, Virginia: American Institute of Aeronautics and Astronautics.

Dominoni, A. (2002) *Industrial Design for Space* (or Disegno industriale per la progettazione spaziale) Silvana Editoriale, Project Research Series, Cinisello Balsamo, Milano.

Dominoni, A. (2010) Cosmic Space as a Key for Creative Design. How Industrial Design in Cosmic Space is Useful to Exemplify an Innovative Methodology for Design Process in Education. *Research in Education. Experiences in Research in Education Session, INTED 2010 Proceedings*. International Technology, Education and Development Conference Valencia, Spain, 8-10 March 2010. Published by Association of Technology, Education and Development (IATED).