Designing disruption

Dr James Moultrie
Design Management Group
Overview

• Design Management Group
• Current work: Euro-Design - Measuring the value of design
• Future plans: Designing disruption
The Design Management Group activities are focused on understanding and improving the ways in which design and new product development are managed.

The Design Management Group is interested in how design can be effectively managed to create sustainable, desirable, usable and producible new products and services. Central to this aim is the role of design as an integrator between technology and users. We are also active in understanding, valuing and promoting the importance of design at firm and national levels.
<table>
<thead>
<tr>
<th>Current</th>
<th>Key collaborators</th>
</tr>
</thead>
</table>
| Measuring the value of design                                                                     | Dr Finbarr Livesey  
Lecturer in Policy                                                                 |
| Design leadership                                                                                 | Prof John Clarkson  
Head, Engineering Design Centre, University of Cambridge                           |
| Co-design of services                                                                             | Dr Nathan Crilly  
Engineering Design Centre, University of Cambridge                                       |
| User involvement in NPD                                                                           | Dr Anja Maier  
Assoc Prof, Technical University of Denmark                                                 |
| Design of healthcare technology for low income countries                                          | Claudia Eckert  
Senior Lecturer, Open University                                                     |
| Design leadership                                                                                 |                                                                                     |
| Co-design of services                                                                             |                                                                                     |
| User involvement in NPD                                                                           |                                                                                     |
| Design of healthcare technology for low income countries                                          |                                                                                     |
| How design influences behaviour                                                                  |                                                                                     |
| Designer intent and meaning                                                                       |                                                                                     |
| App design for healthcare                                                                        |                                                                                     |

| Left in 2013                                                                                      |                                                                                     |
| Sustainable design toolkit                                                                       |                                                                                     |
| Design in science                                                                                |                                                                                     |
| Early stage medical device feasibility                                                           |                                                                                     |
| Design knowledge transfer                                                                        |                                                                                     |

| Left in 2012                                                                                      |                                                                                     |
| Top management involvement in NPD                                                                |                                                                                     |
| Design in science                                                                                |                                                                                     |
| Sustainable design of medical devices                                                            |                                                                                     |

| Left in 2011                                                                                      |                                                                                     |
| Design trends theory and practice                                                                |                                                                                     |

| Left in 2009                                                                                      |                                                                                     |
| Strategic role of design                                                                         |                                                                                     |

| Left in 2009                                                                                      |                                                                                     |
Krista Keranen: CoCo - from co-creation to co-production
PhD Candidate
Wei Liu: Customer involvement in new product development

PhD Candidate
Some recent publications …

€Design | Measuring Design Value
Design > R&D

Design = R&D

R&D > Design

Total design investment as % turnover

R&D Investment as % turnover
Design falls between organisational boundaries

R&D

- Basic and applied research
  - Experimental development
    - Technical design in the creation of new products and services
    - User focused design in the creation of new products and services
  - Other activities
  - Performance/Functionality
  - Experience (social and emotional)

MARKETING

- Commercialisation of products and services
  - Design in the promotion, communication and branding of new products and services and the creation of corporate identity
  - Other activities

DESIGN

Why measure design?

• The Commission has identified design as a potential policy instrument, among other instruments, to fulfill Europe 2020.

“design is of particular importance and is recognized as a key discipline and activity to bring ideas to the market transforming them into user friendly and appealing products”

Europe 2020 Flagship Initiative Innovation Union p.22

• This policy instrument needs to be measured.
• €design is a policy driven exercise.
Defining ‘design’ ...

**FUNCTIONAL Utilities**

**EMOTIONAL Utilities**

**SOCIAL Utilities**

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**Perceived Utilities (B)**

**Price (P)**

**Consumer’s surplus (B-P)**

**Economic Profit (P-C)**

**Economic Cost (C)**

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One unit

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UNIVERSITY OF CAMBRIDGE
Design is [to focus on] the integration of functional, emotional and social utilities of new or improved products (goods and services), processes and marketing methods.
Technology push: Design is a styling “add-on” taking place in the latter stages of development.

Frascati Manual
Standard practice for surveys on research and experimental development” OECD (2002). Creative work undertaken ... to increase the stock of knowledge, ... and the use of this stock of knowledge to devise new applications.

Oslo Manual

Research
Creative work undertaken on a systematic basis in order to increase the stock of knowledge

Development
Use of stock of knowledge to devise new applications

Innovation
Implementation of a new or significantly improved product (good or service), process, marketing method, or a new organisational method
Design according to Frascati & Oslo

Δ Functional utilities

R&D

Δ Emotional & social utilities

Design?

MARKETING
Design not well treated in CIS

- Two aspects of design:
  - Product/process development:
    - Incidence of activities to design (Yes or NO)
    - Design definition: to improve or change the shape or appearance of new or significantly improved goods or services
  - Marketing innovations: significant changes in the aesthetic packaging or design

- CIS exclude:
  - Design as an essential part in the feedback loops between producer/developer and user
  - Design is reduced to an add-on
  - Design is treated as an separate item instead of an aspect of strategy
### Question 4:
During the 3 year period 1 January 2006 - 31 December 2008, did this business engage in the following innovation related activities?

**f. All forms of Design**
Engagement in design activities for the development or implementation of new or improved goods, services and processes. Design activities in the R&D phase of product development should be excluded.

- Include: design for creating and promoting products/services/processes
- Exclude: design in the R&D phase. This is difficult to understand, but true to Frascati!

### Question 5:
For each of the main innovation related activities in question 4, please ESTIMATE the amount of expenditure for the year 2008.

- **d. Acquisition of external knowledge**
- **e. Training for innovative activities**
- **f. All forms of design**
- **g. Market introduction of innovations**

<table>
<thead>
<tr>
<th>Expenditure</th>
<th>1360</th>
<th>1440</th>
<th>1450</th>
<th>1460</th>
<th>1470</th>
</tr>
</thead>
</table>
Improving the treatment of design in CIS

- CIS would benefit of a characterization of introduced innovation with respect to:
  - functional attributes (e.g. performance)
  - intangible attributes (e.g. aesthetics)
- It is difficult to ask about design as a separate item: it is an integral part of innovative activities
  - Expenditures as part of total innovative activity
  - Focus on design within innovation
  - Effort or resources as part of total innovative activity
- Measurement of a firm’s strategy regarding focus on innovations attributes
△ Functional utilities

△ Emotional & social utilities

Superior margins?

Average margins

Low margins
Technology driven industries

△ Functional utilities

Superior margins?

Average margins

Low margins

△ Emotional & social utilities

Pharma
Aero Engines
Hybrid industries

Δ Functional utilities

Δ Emotional & social utilities

Superior margins?

Average margins

Low margins

e.g. Consumer electronics
Design intensive industries...

\[ \triangle \text{Functional utilities} \]

\[ \triangle \text{Emotional & social utilities} \]

- Superior margins?
- Low margins
- Average margins

E.g. Fashion, furniture etc
Evolution of industries over time ...
Conceptual/analytical framework

Social and emotional utilities

Functional utilities

Non ‘product’ based utilities (delivery, efficiency, low cost)

Measures of financial or commercial success

Ability to price at a premium

Performance in relation to main competitors in the firm’s market

Moderating influence of sector?
Cognitive testing

- Can data be provided?
- Is the question clear?
- How difficult is it to answer?
- Are questions understood consistently in different countries?
- Which question generates the most accurate responses?

- 6 countries participated in surveys
  25 responses per country (25 x 6 = 150)
  - 5 face to face interviews
  - 20 email/online questionnaire responses
2. How do your new products (goods and services) compare against competitive offerings?

2.1 For new or significantly improved products (goods and services) introduced in the last three years, how do they compare against competitive offerings in your marketplace?

Please ☒ one box only for each category

Technical performance in comparison to competitive products (e.g. efficiency, precision, speed, accuracy etc)

- Significantly worse
- Slightly worse
- About the same
- Slightly better
- Significantly better
- Not applicable

Functionality in comparison to competitive products (e.g. provision of different functions or capabilities)

- Significantly worse
- Slightly worse
- About the same
- Slightly better
- Significantly better
- Not applicable

Style or aesthetics in comparison to competitive products (e.g. how the product looks, its appearance or shape)

- Very dated, unattractive or unappealing
- Slightly dated, unattractive or unappealing
- About the same
- Slightly more up to date, attractive or appealing
- Significantly more up to date, attractive or appealing
- Not applicable

Brand identity in comparison to competitive products (e.g. how strongly customer’s associate with the brand or overall image of the product)

- Very weak brand identity
- Weak brand identity
- About the same
- Strong brand identity
- Very strong brand identity
- Not applicable

Delivery to customers in comparison to competitive products (e.g. speed of delivery, responsiveness, efficiency)

- Significantly worse
- Slightly worse
- About the same
- Slightly better
- Significantly better
- Not applicable

Sales price in comparison to competitive products

- Significantly lower
- Slightly lower
- About the same
- Slightly higher
- Significantly higher
- Not applicable
Conceptual/analytical framework

(A) Social and emotional utilities
- 7 firms
  - Financial: 4.05
  - Growth: 7%
  - Price: 3.25

(B) Functional utilities
- 10 firms
  - Financial: 3.67
  - Growth: 2%
  - Price: 4.25
- 9 firms
  - Financial: 3.9
  - Growth: 10%
  - Price: 2.63

(C) Non ‘product’ based utilities (delivery, efficiency, low cost)
- 5 Firms
  - Financial: 3.12
  - Growth: 7%
  - Price: 3.31
- 10 firms
  - Financial: 4.22
  - Growth: 19%
  - Price: 3.50
- 5 firms
  - Financial: 3.73
  - Growth: 15%
  - Price: 3.18

(D) Measures of financial or commercial success
- 5 firms
  - Financial: 3.12
  - Growth: 7%
  - Price: 3.31
- 5 firms
  - Financial: 3.73
  - Growth: 15%
  - Price: 3.18

(H) Ability to price at a premium
- 3 firms
  - Financial: 4.5
  - Growth: 17%
  - Price: 3.89
- 25 firms
  - Financial: 3.22
  - Growth: -2%
  - Price: 2.88

Performance in relation to main competitors in the firm’s market

Moderating influence of sector?
**Recommended Question 1: Introduction of innovations**

During the three years 20XX-20YY, did your enterprise introduce ...

Please tick Y or N in each case

<table>
<thead>
<tr>
<th>Goods that:</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide changes in technology, performance or functionality, including usability</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Provide lower costs of production</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Provide changes to product form (appearance) or packaging</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Services that:</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide changes in performance (e.g. efficiency, speed) or new levels of functionality to customers (e.g. internet banking, pick-up and drop-off services for rental cars)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Provide changes in user-experience</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Production process, distribution method or delivery method that:</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce the cost of manufacturing or delivering goods and services (e.g. automation equipment)</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Increase the quality of manufacturing or delivering goods or services</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Enable the production or delivery of an entirely new product or service</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marketing methods that:</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use new media or new techniques for promoting goods and services</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Use new methods for product placement or new sales channels for goods and services</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Create a new brand image, brand symbols or brand identities for goods and services</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Recommended Question 2: Comparison of new products against competitors

For products (goods and services) introduced in the last three years, how do they compare against competitive offerings in your market place? *Note: If your firm has multiple product ranges targeted at different market segments, please answer for the dominant or most significant products in your portfolio that best characterise your business.*

Please □ one box only for each category.
Technical performance or functionality in comparison to competitive products (e.g. efficiency, precision, speed, accuracy etc)

<table>
<thead>
<tr>
<th>Significantly worse</th>
<th>Slightly worse</th>
<th>About the same</th>
<th>Slightly better</th>
<th>Significantly better</th>
<th>Not applicable</th>
</tr>
</thead>
</table>

Style or aesthetics in comparison to competitive products (e.g. how the product or service looks, its appearance, shape or graphics)

<table>
<thead>
<tr>
<th>Very dated, unattractive or unappealing</th>
<th>Slightly dated, unattractive or unappealing</th>
<th>About the same</th>
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Brand identity in comparison to competitive products (e.g. how strongly customer’s associate with the brand or overall image of the product)

<table>
<thead>
<tr>
<th>Very weak brand identity</th>
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<th>Strong brand identity</th>
<th>Very strong brand identity</th>
<th>Not applicable</th>
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</thead>
</table>

Delivery to customers in comparison to competitive products (e.g. speed of delivery, responsiveness, efficiency)

<table>
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<tr>
<th>Significantly worse</th>
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</table>

Sales price in comparison to competitive products

<table>
<thead>
<tr>
<th>Significantly lower</th>
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<th>Slightly higher</th>
<th>Significantly higher</th>
<th>Not applicable</th>
</tr>
</thead>
</table>
### Recommended Question 3: Design resources for innovation

For the implementation of new products (goods and services), please indicate the type of design resources that best describes the resources that you use (examples are provided).

<table>
<thead>
<tr>
<th>Goods that:</th>
<th>Please tick the most appropriate option</th>
<th>In-house</th>
<th>Outsourced</th>
<th>Both in-house and outsourced</th>
<th>No specific design resources used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide changes in technology, performance or functionality, including usability</td>
<td>e.g. engineering designers, software designers, ergonomists, electronic designers</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Provide changes to product form (appearance) or packaging</td>
<td>e.g. Industrial designers, product designers, interface designers</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Services that:</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide significant improvements in performance (e.g. efficiency, speed) or new levels of functionality to customers (e.g. internet banking, pick-up and drop-off services for rental cars)</td>
<td>e.g. Service designers, process designers, user interface designers, web designers</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Production process, distribution method or delivery method that:</th>
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</thead>
<tbody>
<tr>
<td>Reduce the cost or increase the quality of manufacturing and delivering goods and services (e.g. automation equipment)</td>
<td>e.g. Engineering designers, production engineers, process designers</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Marketing methods that:</th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Use new techniques for promotion, use new methods for product placement or create a new brand image, brand symbols or brand identities for goods and services</td>
<td>e.g. Graphic designers, branding designers, strategic designers, web designers</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Conclusion

- Design as integrator at the outset of systemic innovation has a relevant role to economic and social growth.
- Policy makers need data.
- Data can be provided by introducing three questions.
  - How goods and services compete
  - Attributes of introduced innovations
  - Resources used
- Design as an economic contributor can be measured in the CIS.
Designing disruption
Norman Bel Geddes: Air Liner No. 4 1929
http://home.att.net/~dannysoar/BelGeddes.htm
Colani truck
Colani truck
Colani aeroplane concept
Seymourpowell Aircruise, 2010
Jacques Fresco, The Venus Project
Image from: http://4.bp.blogspot.com/-YjvsXgDo3T0/TpnepSKZhwl/AAAAAAAAAjg/3CtAll05anU/s1600/000.jpg
Space elevator
Philips fluid phone
Image from: http://genesigroup.files.wordpress.com/2012/04/philips-fluid-phone.jpg
1. Pre-science
2. Problem formulated
3. Hypothesis proposed
4. Hypothesis tested and results reported
Precursor Science

Supporting science and technology demonstrator

Applied science and technology (feasibility) demonstrators

Technology demonstrator

Embryonic Technology

Application demonstrators

Commercial application demonstrator

Future Application

Price-performance market demonstrators

Mass-market demonstrator

Growth Market

Basic research

Applied research

Experimental development

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Supporting science and technology demonstrators

Applied science and technology (feasibility) demonstrators

Technology demonstrators

Application demonstrators

Commercial application demonstrator

Price-performance market demonstrators

Mass-market demonstrators

Precursor Science S-T Embryonic Technology T-A Future Application A-M Growth Market

SRL 1 SRL 2 SRL 3

Basic research

Applied research

Experimental development
How and to what extent can design play a useful role in early stage scientific research?

How will the role and impact of design engagement be influenced by factors such as the type of science, the extent to which the science is applied and its complexity?
<table>
<thead>
<tr>
<th>Project</th>
<th>Dept</th>
<th>Time</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Oxygen Mask</td>
<td>Addenbrookes</td>
<td>6 months</td>
<td>Prototypes facilitated user testing and discussions with manufacturers.</td>
</tr>
<tr>
<td>2 Fluid Handling Device</td>
<td>Chemical Engineering</td>
<td>6 months</td>
<td>£150k product development. External design consultant employed.</td>
</tr>
<tr>
<td>3 Multistable Material</td>
<td>Engineering</td>
<td>3 months</td>
<td>Research proposal suggested.</td>
</tr>
<tr>
<td>4 Polymer Opals</td>
<td>Physics</td>
<td>3 months</td>
<td>Research Proposal suggested.</td>
</tr>
<tr>
<td>5 Biophotovoltaics</td>
<td>Chem Eng, Biochemistry, Plant Sciences</td>
<td>18 months</td>
<td>Research direction influenced. Joint research bids in prep.</td>
</tr>
<tr>
<td>6 Stem Cell Research</td>
<td>Regenerative Medicine</td>
<td>6 months</td>
<td>Software concept, potential for future funding.</td>
</tr>
<tr>
<td>7 Signal Processing</td>
<td>Engineering</td>
<td>2 months</td>
<td>Applications identified, research plans drafted.</td>
</tr>
<tr>
<td>8 Polymer Wood Composites</td>
<td>Chemistry</td>
<td>3 months</td>
<td>Applications identified, research proposal suggested.</td>
</tr>
</tbody>
</table>
Fluid Handling Device
BIOPHOTOVOLTAICS

Biophotovoltaic devices are biological solar cells that generate energy from the photosynthetic activity of living microorganisms such as algae. A brainstorming session was held with biologists and chemists to generate a series of conceptual designs to demonstrate potential future applications of this technology.

These concepts were presented at the Royal Society Summer Science Exhibition in London during the summer of 2010. One of the concepts, a Biophotovoltaic solar panel, is currently being prototyped so that it can be used by the scientific team to demonstrate the technology to investors.
BIOPHOTOVOLTAIC GENERATOR
A small group of algal solar collectors mounted on floating buoys which also harvest desalinated water.

LOCATION: Near-shore, warm climate

CAPACITY: Several units provide electricity and desalinated water for a small coastal community.
BIOPHOTOVOLTAIC POWER STATION
A field of large floating algal solar collectors.

LOCATION: Offshore, warm climate

CAPACITY: Provides electricity for a large coastal settlement
BIOPHOTOVOLTAIC SOLAR PANEL
A modular system of bio-solar panels containing algae which can be mounted on a building

LOCATION: Inland, near a water supply, warm climate

CAPACITY: Similar to existing solar panels – meets energy requirements of the building they’re mounted on.
ALGAE TABLE
A table incorporating a bio-solar panel which stores energy to power a light in the evening

LOCATION: domestic use, warm climates
CAPACITY: The lamp

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The hidden power of moss

Scientists at Cambridge University are exhibiting a prototype that demonstrates how biological fuel cells can harness energy from plants.

Moss is presented as a material by scientists who seek to evaluate its potential as a new source of energy. The project, led by Dr. James Wager, associate professor of renewable energy systems at Cambridge University, aims to develop a cost-effective method of producing electricity from biomass.

The prototype, which consists of a thin film of moss, is attached to a small solar panel. The moss is able to convert sunlight into electrical energy using a process called photosynthesis.

The project is part of a larger effort to develop sustainable energy sources that are both affordable and environmentally friendly. The scientists believe that the prototype has the potential to revolutionize the way we think about energy production.

Designers and biochemists partner on biophotovoltaic concepts

Designers and biochemists are working together to develop biophotovoltaic concepts that could revolutionize the way we generate energy. The project, led by Alex Driver and Carlos Peralta, is focused on developing materials that can harness energy from photosynthesis.

The team is exploring the use of living cells to generate electricity, a process known as biophotovoltaics. The project is part of a larger effort to develop sustainable energy sources that are both affordable and environmentally friendly.

The team has already developed a prototype that consists of a thin film of living cells, which can be used to generate electricity using light. The prototype is currently being tested in a laboratory setting.

The project is part of a larger effort to develop sustainable energy sources that are both affordable and environmentally friendly. The team believes that the prototype has the potential to revolutionize the way we think about energy production.
<table>
<thead>
<tr>
<th>STAM phase</th>
<th>Science</th>
<th>Technology</th>
<th>Application</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>T</td>
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<td></td>
<td>S</td>
<td>T</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>

- **Scientists' first bench prototypes**
- **Brainstorm sketches**
- **Scientists develop exhibition demonstrator**
- **Exhibition poster**
- **Algae solar panel CAD model**
- **Designers and scientists create algae solar panel prototypes**
- **Scientists create first moss device**
- **Designers and scientists develop moss device**
- **Scientists test moss device array**
- **Moss table**

*Project artefacts (in chronological order of creation)*
<table>
<thead>
<tr>
<th>Precursor Science</th>
<th>S-T</th>
<th>Embryonic Technology</th>
<th>T-As</th>
<th>Future Applications</th>
<th>As-A</th>
<th>Specific Application</th>
<th>A-M</th>
<th>Potential Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrating <strong>scientific principles</strong></td>
<td>Demonstrating <strong>technical feasibility</strong> of potential future applications</td>
<td>Demonstrating <strong>technical feasibility</strong> of a specific application</td>
<td></td>
<td>Beta-prototypes demonstrating <strong>market feasibility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Visualising</strong> potential future applications</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Demonstrating potential to <strong>scale-up</strong> the physical <strong>size</strong> of the science</td>
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<td>Demonstrators to <strong>convince</strong> potential funders</td>
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<td>Demonstrators to <strong>communicate</strong> within the scientific community</td>
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<td>Demonstrators to <strong>communicate</strong> outside of the scientific community</td>
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EXPLORING HOW INDUSTRIAL DESIGNERS CAN CONTRIBUTE TO SCIENTIFIC RESEARCH

Alex Driver
Carlos Peralta
Dr. James Moultrie

http://www.amazon.co.uk/Design-Science-Industrial-Contribute-Scientific/dp/1902546474/ref=sr_1_1?ie=UTF8&qid=1368196157&sr=8-1&keywords=design+in+science+moultrie

http://www.youtube.com/watch?v=tZ7pdk0q8ls&feature=relmfu
Future research challenges ...

How might design enable disruptive innovation?

What are the characteristics of ‘disruptive-designs’?

How to manage the disruptive-design process?

...?
Questions ...