# DESIGNING FOR THE DEEPEST NEEDS OF BOTH PUBLIC SERVICE CONSUMERS AND PROVIDERS; INNOVATION IN MENTAL HEALTH CRISIS RESPONSE

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## Abstract

Design is increasingly used as an approach to support innovation outside the traditional design domain, including the public sector. One of the design principles that is used in these so-called design innovation processes is gathering 'deep' insights into users or customers needs to support reframing of problems. In an earlier publication we proposed a model of levels of depth of insights into human needs. This model indicates that the deepest level to analyse human needs for design innovation is the thematic level which describes human values and meanings outside the context of the problem. Analysing those themes supports reframing of problems. In this paper we argue that innovation in the public sector can benefit from analysing these deepest needs beyond the needs of just the public service consumer, to include the needs of public service providers. Meeting the needs of service providers might positively influence the quality of the service itself. We illustrate this through a case study which was aimed at developing solutions for the systemic problem of supporting people with severe and persistent mental health problems.

**Keywords**: Design methods, human-centred design, design innovation, service design, social design

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# 1 INTRODUCTION

In the past decade design has been increasingly adopted by organisations in both the private and the public sector as a new approach towards innovation (Dorst 2015, Brown 2009, Martin 2009, Verganti 2008). The concept that links design and innovation is called design thinking or design-led, design-driven or design-inspired innovation. In this paper we will use the umbrella term *design innovation* to refer to approaches that do not just lead to the design of solutions, but also consider the implementation of solutions, which then leads to a new practice. Innovation in the public sector is usually not a physical artefact, but more often a change in the relationships between service providers and their users (Hartley 2005). It considers the design of products, services, processes, positions, strategies, governance and rhetoric (ibid). The application of design to public sector innovation is relatively new compared to its adoption in the private sector. Exemplary are the establishment of government innovation centres such as MindLab in Denmark and ThinkPlace in Australia, and initiatives such as the UK Design Council's Public Services by Design program. In parallel to these government institutions, academic research centres have been established recently for scholarly research into public sector design and innovation. At the Design Innovation research centre of the University of Technology, Sydney, we study the practice of design innovation in the public sector and explore how design can contribute to improving these practices.

One of the main principles that public innovation practices can borrow from design is the activity of (re-) framing problems (Dorst 2015). Studies into how expert designers think have shown that framing design problems is at the core of their practice (Cross 2007, Schön 1983, Dorst 2011). Another design principle that has been particularly popular in design innovation in the private sector is gathering 'deep customer insights' (Bucolo et al. 2012) and 'putting people first' (Brown 2009). In our work we have found that this human-centred approach to design innovation can support reframing of problems if people's needs are analysed at its deepest level. To describe this level we developed a model of levels of depth of insights into human needs for design innovation (van der Bijl-Brouwer and Dorst 2014). The deepest level of this model concerns 'themes', the human values and meanings that underlie needs for specific solutions or scenarios.

Innovation in the public sector is often about solving networked problems. This means that multiple stakeholders are involved who each are affected by the problem and/or can contribute to solving the problem. Developing solutions that meet the needs of each of these stakeholders makes sure that solutions allow people to contribute to, as well as benefit from that solution. In this paper we show through a case study how an exploration of the needs of a broad selection of stakeholders on particularly the deepest level of insights into human needs, the thematic level, supported innovation in the public sector.

In the next section we will first present the model of insights into human needs for design innovation, as well as show how an analysis of the themes at the deepest level of this model supports reframing problems and, through that, radical innovation.

# 2 HUMAN-CENTRED DESIGN INNOVATION

## 2.1 Levels of depth in insights into human needs

In the design field as well as in the broader design and innovation field there is general consensus that insights into human needs support design and innovation. To develop radically new designs these insights should be deep (Bucolo et al. 2012) and explore the 'why' or 'reason for existence' of products and services (Hekkert and van Dijk 2011). When studying what scholars and practitioners mean when talking about deep insights into human needs, we found that the definition of 'deep' is rather blurry. Based on the question 'how deep is deep?' we therefore developed a model of levels of depth of insights into human needs for design innovation (van der Bijl-Brouwer and Dorst, 2014). The model contains a solution, a scenario, a goal, and a thematic level (figure 1). The solution level describes *what* people need: products and services. In the public sector this level also includes other types of interventions such as policies and protocols. The scenario level describes *how* people want to interact with these interventions. The deepest levels, the '*whys*', are the goal and thematic levels. The goal level describes what people want to achieve with a product or service within the context of the problem, while the thematic level describes what people want to achieve outside the context of the problem, their underlying meanings and values. For example, the design of a sports car might be based

on the themes ‘identity’ and ‘independence’. The goals, in the context of a car, could be that someone likes to have a car all to him- or herself and that the car should fit that identity of independence. The scenario that achieves these goals is ‘getting attention while driving’, ‘being visible while driving’ and ‘driving a car by yourself’. The solution is a two-seater (just for yourself) and/ or a convertible car (being visible).

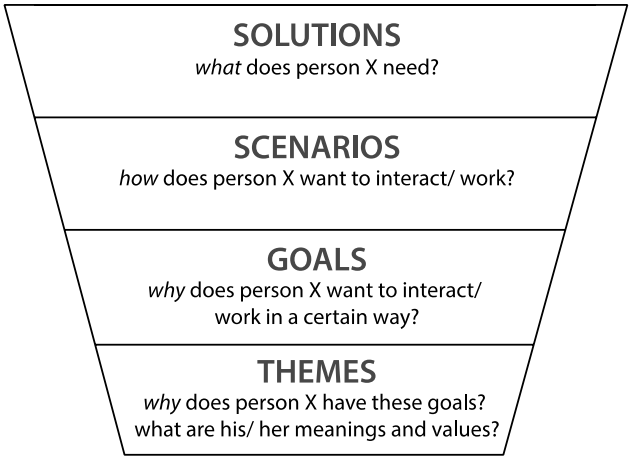


*Figure 1. four-layer model of insights into human needs for design innovation (van der Bijl-Brouwer and Dorst, 2014)*

Note that the model does not prescribe a step-by-step method. Insights on the top three levels can be gathered through several existing human-centred design techniques. We do propose a specific approach for identifying themes from these insights, and using these themes to reframe the problem, which then supports the generation of proposals for future scenarios and solutions.

## 2.2 Reframing problems through analysing themes

The idea to distinguish goals and themes is based on the work of Dorst (2015) on the role of themes in the design activity. Based on extensive studies of the practices of expert designers, various scholars have found that what designers are particularly good at is (re-) framing problems, finding new perspectives on a problem and through that developing new solutions (Cross 2007, Schön 1983, Dorst 2011). Dorst and Tomkin (2011) found that the explorations that designers engage in to be able to reframe problems are a subtle process of analysis that is very close to methods used in the creation of phenomenological descriptions of ‘lived experience’. Just like phenomenologists, designers analyse the situation by discerning the ‘themes’ in the life and world of the stakeholders (Dorst and Tomkin 2011). Phenomenological themes may be understood as the structures of experience. So when we analyse a phenomenon, we are trying to identify the themes: the experiential structures that make up that experience (van Manen 1990).

Dorst (2015) furthermore found that as the reframing practice of designers is similar to the practice of phenomenologists, we can borrow methods from phenomenologists to support reframing problems and through that design innovation. To identify and analyse themes we can use the method of hermeneutic phenomenology (van Manen 1990). We have applied hermeneutic phenomenology in design innovation projects in the public sector. The methods we use have evolved based on previous case studies (Dorst 2013), and are inspired by the guidelines for thematic analysis provided by Rijken (2013). First, existing human-centred design research methods are used to gather insights into stakeholder needs at the scenario and goal levels of the 4-layer model. For example, contextual inquiry (Beyer & Holtzblatt, 1998) can be used to gain insights into desired scenarios, and persona techniques (Cooper, 1999) can be used to identify desired goals (see for a comparable example (Tomkin and Watson 2013)). Next, themes are identified by searching for common patterns in those insights across stakeholders. We then proceed to further analyse these themes by investigating their meaning and relationships in workshop sessions. A core element of the method is to explore the themes by sharing personal experiences related to a theme. For example, Rijken (2013) explains how to investigate the theme ‘fear’ through asking workshop participants: have you ever experienced fear? What triggered it? What did it feel like? What were you thinking? What changed it? What did you do? Did others play a role? By having different team members share these experiences in an iterative process a pattern can

emerge that shows the structure of a theme. For example, fear is related in a structured way to insecurity, risks, confidence, uncertainty etc. Other ways to explore themes are consulting scientific literature and philosophy on specific themes; and gathering artworks that express a theme (Rijken, 2013). The universality of the themes makes it possible to analyse them independently of customers or end-users, and independent of the problem context. To move from the themes to reframe the problem, it is useful to look at how the elements of the theme are dealt with in domains outside the problem context (Dorst, 2013). Through using metaphors, a frame can then be created which forms a bridge between problems and solutions.

### 2.3 Designing for both service consumers and providers

In the above we explained how an analysis of themes at the deepest level of the model of insights into human needs for design innovation supports reframing and design innovation. Themes can be applied across a broad variety of innovation contexts in both the public and private sector (see Dorst, 2015). In this paper we focus on the question of *whose* needs should be considered in a public sector context.
Traditionally design theory and methods have been centred on the end-user of products, so called user-centred design (e.g.(Norman 1998)). The adoption of design innovation in businesses in the private sector has broadened the focus from the user to the customer or consumer, as the person who uses a product or service is often not the same person that purchases the product or service. Likewise, in the public sector the term citizen-centred public service design has recently emerged (Mager et al. 2013).
Design innovation in the public sector is mainly aimed at improving the public service. Service design is therefore a concept that is gaining popularity in this sector. Service design is a young field of practice and like traditional product design it is user-centred or customer-centred (e.g.(Stickdorn and Schneider 2010)). In service design we can generally distinguish two types of stakeholders: the service providers and the service consumers. Interactions between service provider and consumer can be either digital or through personal interaction. Although technology is rapidly replacing many personal interfaces, there are many services in the public sector that by their nature require personal interactions. For example in the case study we will present in this paper, we investigated services provided by ambulance, emergency departments and police.
We argue that particularly when services are provided through personal interactions, future interventions should not only meet the needs of the service consumers, but of the service providers as well. The underlying assumption is that if interventions meet the service providers' needs, the experience of providing the service will be positive which in turn will positively influence the quality of the service itself. A waiter or waitress with a satisfying waitressing experience is more likely to provide restaurant customers with a positive experience than one whose waitressing needs are not met. We furthermore argue that if needs of service providers are analysed at its deepest level, as suggested in the model of levels of depth in insights into human needs (section 2.1), this analysis supports radical innovation through reframing. In the next section we illustrate this argument with a case study.

## 3 CASE STUDY

### 3.1 Objectives

The case study concerns the design of interventions that were aimed at supporting people with severe and persistent mental health problems who acutely need help. These people are referred to by the service providers as 'consumers'. We were invited to support this project by a non-government agency that aims to generate and implement interventions for this problem through particularly looking at the systemic aspects of this problem. The systemic aspects concern the problems that arise from the fact that many service providers are currently involved when people with a severe mental health problem acutely need help when they are very unwell (for example when they are psychotic, severely anxious, and/ or suicidal). In these situations the first call can be made by the consumer him/ or herself, by carers (family or friends), landlord, or non-governmental organisations (NGO). Ambulance might be called to transport someone to the hospital or a mental health unit, the police might be involved when someone is threatening self-harm or harming others, the emergency department (ED) provides help when someone arrives at the hospital, and various service providers can be involved in follow-up care including general practitioners, social workers, mental health professionals, NGO's etc. The client wanted to engage all these stakeholders in the process of generating interventions, but had no capacity

for a process to (co-) create solutions. They believed that design innovation might be able to provide this process.
The objectives of the research project were twofold. Firstly, the project was aimed at generating solutions for the systemic problems of supporting people with severe and persistent mental health problems in emergency situations. Secondly, the project was aimed at exploring methods to gain insights into the deep needs of multiple stakeholders as well as investigating the usefulness of these insights for innovation.

### 3.2 Research method

The research method for the project consisted of a series of methods to gain insights into the needs of the various stakeholders and/ or reframe the problem based on a thematic analysis of those needs. The project can be summarised as follows (see figure 2):

- 10 semi-structured interviews with various stakeholders to gain insights into their needs
- A scoping session to focus the project. At this stage the project was focussed at emergency situations
- A stakeholder workshop with 20 different stakeholders aimed at investigating their needs and reframing problems. Tools applied in the workshop included personas, theme identification and analysis, reframing, and future scenario generation
- A frame creation session (see Dorst 2015) with 7 different stakeholders in which the insights from the different sessions were brought together and used to reframe the problem
- In parallel to these sessions we analysed the data from the interviews and sessions, and identified and analysed themes. The themes were fed back into the final frame creation session.

To evaluate the process itself we furthermore interviewed the participants after the last frame creation session.

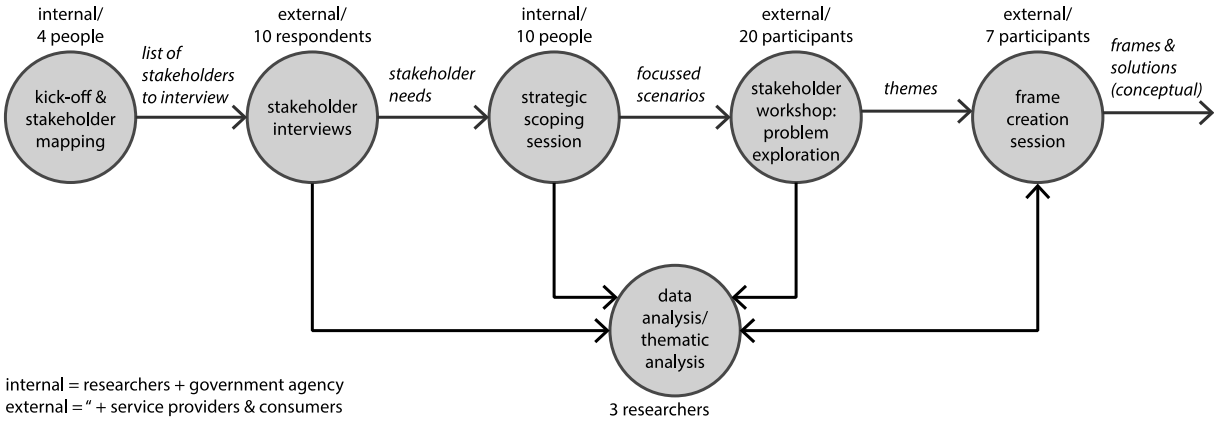


*Figure 2. visualisation of the research method*

Respondents and workshop participants included consumer representatives, carers, ambulance paramedics, police officers, emergency department (ED) nurses, social workers, case workers, mental health professionals, NGO's (e.g. an NGO that provides meals for the homeless), housing provider, indigenous housing support employees, and staff from the agency that organised the project.

## 4 RESULTS

### 4.1 Themes

Through the interviews and workshop we identified several themes. In this paper we will explain the themes of drive, growth, contribution, and care.

#### *4.1.1 Drive & Growth*

A reoccurring theme found in the interviews and in the stakeholder workshop was the theme of 'drive' or 'motivation'. All interviewees and workshop participants who work in the sector mentioned their motivation to make a difference. For example, an ambulance paramedic mentioned that 'there's no better feeling than saving someone's life'.

On the other hand we found several indications that it is difficult to sustain this motivation for stakeholders supporting people with severe and persistent mental health problems in emergency situations. Police officers for example indicated a sense of futility and frustration around repeat cases. Likewise, ambulance paramedics mentioned similar experiences as there is no quick fix to mental health problems: 'It's not like stopping the bleeding or starting the heart'. This frustration seems to be caused by a lack of feedback:

> *Police officer: 'If we do not hear from the person again, there is an assumption that one of three things happened to them: 1) they got better, 2) they moved away, 3) they died. We are essentially feeding our efforts into a 'cone of silence' that does not speak back.'*

The need for feedback to sustain a drive to do the work is indicated in the inner circle figure 3. One of the things that a hermeneutic analysis of this theme shows, is that when you are driven to do something, you feel a sense of achievement when you can see what the results of your efforts are. For example, when cooking for friends it feels good when these friends look like they are enjoying the meal or tell you they appreciate it. This feeling might in turn motivate you to continue organising dinner parties for your friends. Note that this is a simplified analysis of the theme 'drive' as there are other elements that contribute to this theme as well.

Feedback is also an essential element of learning or 'growth'. Apart from learning through training, people learn 'by doing' and reflecting on what they do (reflective practice). But you only learn if you know what the effects of your actions are (figure 3). In the cooking example you can only become better at cooking when you can taste the food or when your friends tell you (honestly) what they think of the meal you prepared for them. Feedback on actions is therefore essential. A police officer confirmed this and indicated it would be useful to know what works and what wouldn't. A part of the systemic problem of supporting people with severe and persistent health problems is therefore this broken cycle of motivation and learning, or drive and growth.

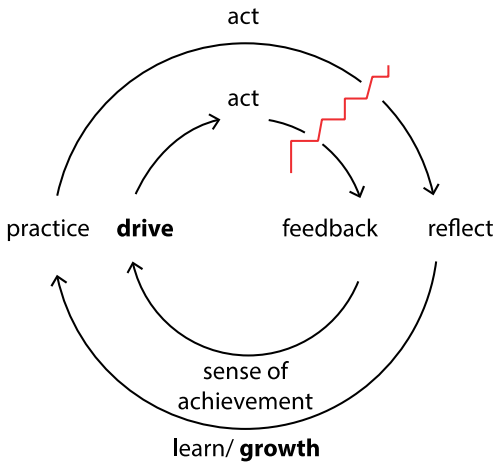


*Figure 3. analysis of the themes drive and growth*

#### *4.1.2 Contribution/ shared response*

A number of themes that came up in the interviews and workshops were related to responding together. They included 'participation', 'contribution', and 'shared response'. Workshop participants for example mentioned the importance of the right person in the right place being integral to responding effectively.

To be able to contribute (figure 4) you need to identify the area you can influence, the skills you have and the part you play. In order to know what your part is you also need to know the parts of others. A shared response is influenced by trust, expectations, coordination, inclusion and exclusion. Like the individual drive and growth cycle, shared response can also benefit from a feedback cycle which stimulates people's drive to continue contributing and which allows groups of people to learn about how to collectively respond next time.

In the context of situations in which people with mental health problems acutely need help there are a number of issues that sometimes lead to conflicts. This seems to be related to people not understanding each other's priorities and resources. For example there can be conflicts between police

and ambulance about whether someone needs to be transported and if so by whom, or between ambulance/ police and ED about the priorities of patients when transported to ED.

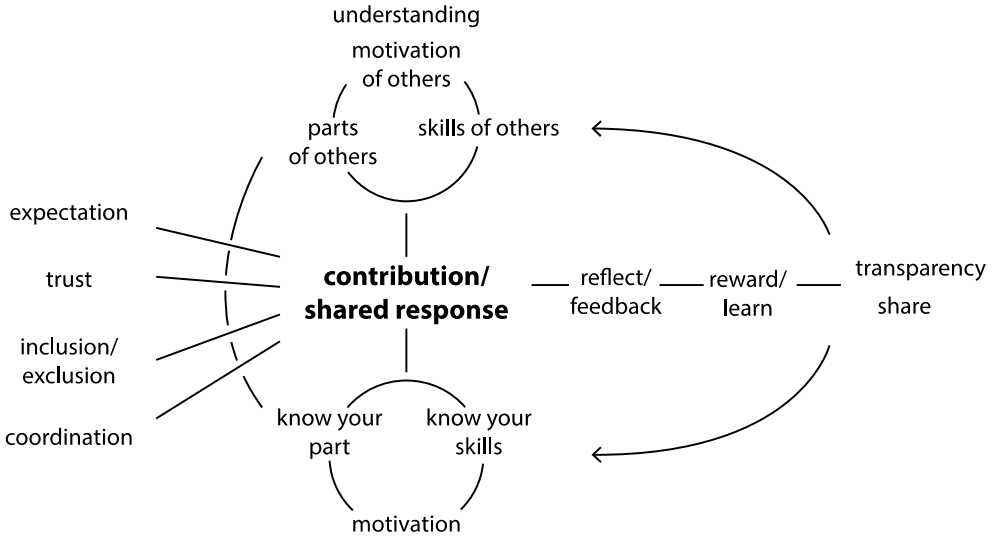


*Figure 4. analysis of the theme 'contribution/ shared response'*

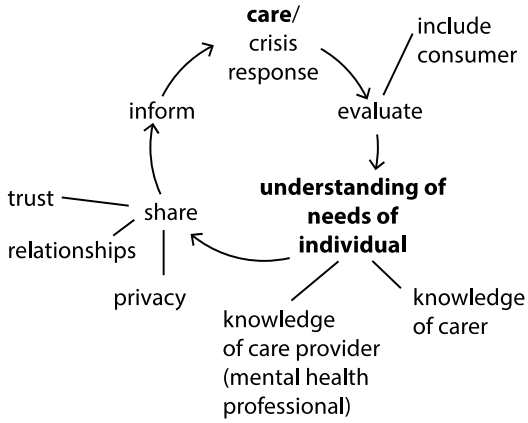


*Figure 5. analysis of the theme 'care' and 'understanding needs of individual'*

#### *4.1.3 Care: (shared) understanding of individual needs*

A reoccurring problem was that service providers in emergency situations did not know what the best course of action was for individuals, because they had no insights into the needs of individual consumers. In emergency situations consumers are not able to indicate what they need because of their mental illness.

> *Ambulance paramedic: "I wish there was someone more closely involved with Bob's [consumer] mental health management to consult"*
>
> *ED: "We would like to get advice and information flow from the mental health professionals dealing with patients to the emergency department to guide actions and decisions when dealing with this client."*

This problem is related to the theme of 'care' which is strongly related to (shared) understanding of individual needs. It is generally difficult to care for someone when you do not know what that person needs. An understanding of needs of an individual might be achieved by gathering that knowledge from experts or others who are closely involved with the individual, or by including the person who is cared for in a learning cycle in which care is evaluated and adjusted. Sharing information about someone's needs is related to issues of trust, relationships and privacy (figure 5).

With regard to the understanding of the needs of people with severe and persistent mental health problems we can again recognise a learning cycle when there is a repetitive cycle of crisis. Ideally a crisis response should then be evaluated together with a consumer to gain a better understanding of the

needs of the individual. If it would be possible to share this information, a next crisis response could then be better informed.
The analysis of the themes showed that a large part of the systemic problems of mental health crisis situations are rooted in incomplete learning cycles on different levels: the ability for individual service providers to learn about mental health response in general, the ability of groups of people to learn about collective response, and the ability of service providers to learn about the needs of individual consumers.
Furthermore, the abovementioned themes are all interrelated. For example, the ability to grow or achieve 'mastery' is intrinsically linked to people's drive (Pink 2009), and being able to contribute collectively as well as to care for an individual both contribute to growth and drive.

### 4.2 Frames and solutions

At the time of writing this paper we had only explored initial frames and solutions. We present some preliminary results here.
To frame the problem we looked at how the elements of the themes are dealt with in domains outside the problem context. Exploring these metaphors can lead to new frames (Dorst, 2013). A fruitful frame for 'shared response' was the local emergency management committee (LEMC). The LEMC is a support mechanism for the combat agency that's responsible in case of an emergency like flooding or a bush fire. The main characteristic of the LEMC is that a local multi-disciplinary committee comes together a couple of times a year to discuss a plan for potential emergencies. When there is an emergency the plan is executed by the combat agency and after recovery the complete response is evaluated together to be able to respond better next time. What we can learn from this for mental health crisis response is that there could be a multidisciplinary support committee on a local level that develops joint and individual response plans, informs service providers on a tactical level, and evaluates response. This solution particularly supports the themes 'shared response' and 'understanding individual needs'. If evaluations are fed back to service providers who work on a tactical level it could also potentially support 'growth'. A crucial element of this solution is the locality of the committee which allows people to see the results of their efforts and learn from it as well as get a sense of achievement that sustains a drive for future collective response.
The above solution also mentions an 'individual response plan' for consumers. This idea is related to the theme 'care' and 'understanding individual needs'. The plan should mention what an individual consumer needs in case of emergency (an example was mentioned of a consumer who should not be taken inside the emergency room as this person experienced that room as extremely traumatising) and what the wider support network of the consumer is. For a plan like this to work the complete learning cycle of care and understanding should be covered. The consumer should be involved in evaluating a crisis response and in case of emergency the plan should be available to inform the response. Participants mentioned that this could be achieved for example with a laminated card that briefly explains the main issues. Figure 6 illustrates how the developed solutions are related to the underlying scenarios, goals and themes. Note that both the scenarios and solutions need to be developed in more detail.

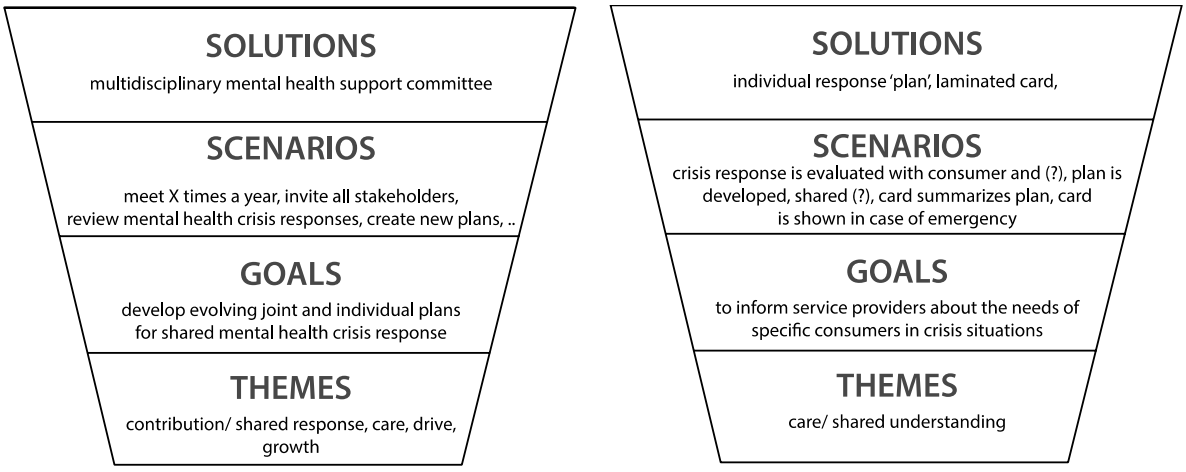


*Figure 6. insights into human needs for the case 'supporting people with severe and persistent mental health problems' on the four levels for the two solutions.*

### 4.3 Reflection on the process

In this project we used various methods to gain insights into what the different stakeholders needed. When comparing the results to the levels of insights into human needs presented in section 2.1, we found that in the interviews respondents mostly communicated on a solution or scenario level. For example they indicated the need for 'suitable services for patients' and 'supervision'. In the workshops we had participants think about underlying themes, but it was difficult for them to connect themes to scenarios and solutions within one session. We found it helpful to identify and analyse the themes and present them to the client, rather than facilitate the client and participants through a deeper analysis required to identify and expand on the themes. In the last session these insights could then be used to reframe the problem together with the stakeholders.

Different stakeholders participated throughout the various project stages. The only people who participated in all the sessions were the client and the researchers. When asking participants about the process they mainly appreciated being offered the opportunity to participate in the process and to step back and reflect on their work and the problem. They indicated the process was very engaging. Although this engagement is useful to stimulate future buy-in of new interventions, the engagement itself was not the main goal of the sessions. The problems we encountered with the ability of participants to identify and analyse themes, and reframe problems, might have been caused by the fact that they were only involved in parts of the project. Therefore it would have been difficult for them to connect the dots. Who to involve in workshops is therefore a trade-off between having as many as possible stakeholders engage on the one hand, and having a continuity of thinkers on the other. The latter would allow building capacity to connect insights to themes, and using themes to reframe the problem and generating solutions.

## 5 DISCUSSION AND CONCLUSIONS

In this paper we presented a case study in which the design process was centred on the needs of both service consumers and service providers in the public sector. We found that investigating the deepest needs of service providers supports a better understanding of the problem and potentially supports developing solutions that better meet these needs. The client particularly appreciated the way the process led to a coherent view of the service system as a whole, by showing the underlying themes. How this will support the further development and implementation of interventions is, at the time of writing, yet to be shown.

The application of design innovation and frame creation in the public sector to develop public services is still very new and more research is necessary to investigate what the benefits and limitations are of solving these kinds of problems through design compared to other innovation methods. However, the focus on needs of service providers seems to be an essential prerequisite for service systems including personal interaction to succeed. Not meeting their needs might unnecessarily frustrate or dissatisfy service providers, which might negatively influence the quality of the service itself. This seems particularly relevant in the context of innovation in the public sector in which people who work as public service providers are very rarely motivated by financial incentives, but are in the job to be able to 'make a difference'. The work should be a rewarding experience in itself to motivate people to do their work well.

The results of the case study also have implications for service system design in general. Theories and methods of design innovation now mainly consider service providers as *resources* to implement solutions. Tools such as the business model canvas (Osterwalder and Pigneur 2010) are aimed at mapping providers of these resources to roles in the supply chain of product-service systems. At the centre of the model is the customer who is provided with a 'value proposition' in return for revenue, which is then distributed amongst the service providers. Viewing the design of service systems as one in which the needs of all stakeholders need to be met leads to a different model of the exchange of value. Stakeholders in the systems are not viewed as *resources*, but as *people* who can each both contribute to as well as benefit from the service, in a process of give and take. For example, ambulance paramedics contribute to looking after someone with a severe mental health problem, and at the same

time could experience this as a rewarding experience through hearing about the results of their efforts, or to be able to learn. We could even think about a new role for end-users of a service in which they not only receive but also contribute. A consumer of mental health services could for example be actively involved in the generation of their care plans. The service system thus becomes both supporting as well as empowering.

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THE 20TH INTERNATIONAL CONFERENCE
ON ENGINEERING DESIGN (ICED15)

# DESIGN FOR LIFE

27th-30th July 2015
Politecnico di Milano, Italy

**Organised By**
Politecnico di Milano, Politecnico di Torino
and the Design Society

**Proceedings of ICED15**
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# Preface by the Programme Chair

We welcome you to the proceeding of the 20th International Conference on Engineering Design 2015 (ICED 15) held at the Bovisa campus of Politecnico di Milano, Milan, Italy. The theme of the Conference is “DESIGN FOR LIFE”, inspired by EXPO 2015 in Milan.

These proceedings of ICED 15 contain 427 double-blind peer-reviewed and accepted papers. The proceedings are published in different forms: a book of abstracts and a soft-copy of all contributions on a USB-based memory device for conference delegates plus printed books (11 volumes), which are available to the public via a print-on-demand service. All these different forms of proceedings are numbered against both Design Society and ISSN/ISBN referencing to allow wider access, better referencing and improved citation in the near and distant future. Additionally, all papers contain a citation proposal for a reproducible citation. The 11 volumes of the books are structured according to the conference topics and the sequence of the sessions. All papers in the proceedings have successfully fulfilled the criteria for acceptance in ICED 15.

Continuing on from the changes introduced for ICED 13, the papers in the proceedings were produced by combining an automatically generated cover page, based on the contribution details in the Conference Management System (ConfTool), with the paper as submitted by the authors, starting with the introduction section. This procedure supports consistent data for the papers, the conference programme, the Book of Abstracts, etc.
ICED 15 and its proceedings are the result of the dedicated efforts of many people:

- the authors who submitted excellent papers (both in content and form),
- the reviewers who provided timely comments and positive feedback that helped to optimise the quality of papers,
- the chairs, assistant chairs and members of the Programme and Organising Committee and the Design Society Administration who had to deal with details galore in getting the conference and the proceedings planned, structured, organised and ready to go (it was also fun, though!).

Thank you all very much!

On behalf of the Programme Committee we hope that you enjoy the programme and participate fully in what is arguably the Premier engineering design research conference in the world. We also hope that you find time to discover Milan and EXPO 2015, that you meet old friends and make some new ones, and that – besides work – you also have as much fun as we had when preparing the conference!

**Christian Weber**
Programme Chair

**Stephan Husung**
Assistant Programme Chair

## Preface by ICED15 Conference Chair

Having reached its 20th edition, ICED15 confirms to be a well-established conference in the scientific design community and we are very pleased and honoured to host this edition, which has received a very significant attention from researchers and practitioners throughout the world.

ICED15 is being organized at the same time and in the same location as the Universal EXPO. The EXPO has also inspired the theme of our conference - Design for Life - which has been further formulated as Design for a Healthy, a Sustainable and a Contented Life. While the submissions were arriving and the conference program was taking shape, we were very pleased to observe that this conference theme has indeed been picked up by many authors and has permeated their contributions. As an outcome of this emerging synergy between ICED and EXPO, we expect participants to return to their countries not only with the usual benefits that come from the ICED experience, but also with a stronger capability and determination to make positive and effective contributions to humankind through design research, education and practice.

If one looks at the program of previous ICED conferences, it is quite apparent that the field of design is continuously evolving, and that the Design Society community that is at the heart of ICED is also at the forefront of this continual evolution and adaptation to emerging opportunities and challenges. Specifically, ICED15 welcomes a growing number of contributions in fields pertaining to the human and social aspects of design, looking at humans both as actors and as recipients of the design activity. We all know that these advancements do not only take place in the formal presentation sessions, but also through other gatherings, including business meetings, information events, workshops and – of course –social events. The conference program has therefore been designed with the objective of providing ICED participants with a variety of opportunities for meeting and exchanging views.

All this will occur within the setting of a country such as Italy that – since ancient times, going through the Renaissance and until today – has been uniquely able to blend its technical know-how with an amazing quality of life. We therefore hope that you will make a memorable experience of ICED 15, the EXPO and of the ideal of Designing for Life.

**Gaetano Cascini**
Conference Chair

**Marco Cantamessa**
Conference Chair

# Preface by the Design Society President

ICED 15, the 20th edition of the International Conference on Engineering Design (ICED) is coming back to Italy, the country where the idea of a design conference first took shape. The first ICED took place in Rome in March 1981. The aims were, as its initiator Vladimir Hubka wrote in December 1980, set towards: *"… determining the latest state of knowledge in areas of scientific design methods, and of gathering information about current results and future trends in research, to achieve a free co-ordination of scarce research resources."*

This year, we are not in Rome, but in Milan - and for a good reason. The city of Milan itself is a synonym for quality of design as a way of thinking and living, in activity or in outcome. The conference themes indicate the broadness of thinking about design in and around the host city and connect the conference with the Universal EXPO that is also taking place at the same time. ICED 15 participants will have chance to experience the dynamics of a city that reflects all of the dichotomies that define design old and new, the art and technology, the research and practice, the chaotic and systematic. In the past thirty-five years the conference has become the event where all the richness of design research from all the continents is presented and all aspects of design explored ICED 15 sessions are the results of continuous improvements in every aspect of conference organisation. The format of the conference is based on the previous events with a programme made up of plenary sessions, podium presentations, discussion sessions with a focused debate and workshops led by the Design Society's Special Interest Groups. In addition, the Young Members' Event and PhD Forum extend the networking opportunities of ICED 15 for younger or first-time participants. The ICED 15 programme will provide an exciting opportunity for researchers and practitioners to learn about the latest developments in design research and practice.

The programme of ICED 15 is the result of a joint effort from great teams that have been working together since the last ICED conference in Seoul. The Society extends its gratitude to all the authors who have submitted their papers and all the reviewers who have helped to select papers ensuring an outstanding conference experience for all participants. A special thank you goes to all the authors and Session Chairs who will make this experience possible.

Many things have changed through the last 19 conferences. The conference started in Rome by WDK (Workshop – Design – Konstruktion), has, since 2001, been organised by the Design Society. Design as a field has expanded tremendously and the conference programme has become more interactive and complex, opening new opportunities and challenges. Organising a conference with such a history takes an enormous amount of work and attention to detail. I would like to express sincere thanks of the Society to Gaetano Cascini and Marco Cantamessa and all colleagues from Politecnico di Milano and Politecnico di Torino who have made this conference happen. Special thanks also to Programme Chair Christian Weber and Assistant Programme Chair Stephan Husung and all the members of Programme Committee for ensuring that this conference presents a tremendous quality of content. Finally, thank you to all of the participants whose attendance and input are a constant sign that this conference and design as a field are going in the right direction.

**Dorian Marjanovic**
Design Society President

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