

A Framework for Transitioning Designerly Ways; Interrogating 50 Years of Inclusive Design for Paediatric Mobility

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Inclusive paediatric mobility (IPM) design is a growing field in need of critical and foundational designerly transitions in order to better deal with a wicked problem. This article adopts an illustrative mapping review method to interrogate the past 50 years of IPM design, aiming to identify alternative designerly ways that could help transition the field towards a more desirable long-term future. IPM Design contributions between 1970 and 2020 are mapped chronologically across Theoretical, Methodological, Empirical, and Interventional categories. A Reflection-for-Transition framework of Designerly Ways is developed to identify existing and alternative designerly ways, through categorising key insights from the mapping review. The framework consists of five interrelated dimensions, including Designerly: Investigations, Processes, Contributions, Collaborations, and Contexts. Proposed alternative designerly ways include: exploring high-level narratives and social imaginaries; shifting focus towards problem-framing, child-centred design and transdisciplinarity; improved documentation and sharing to build a body of knowledge; and exploring extended design contexts.

Keywords: designerly ways; inclusive design; mapping review; reflective practice; transition design; inclusive paediatric mobility; child-centred design; assistive technology.

Introduction

Before being able to effectively tackle wicked problems, designers should first reflect on and question their designerly ways (Schön, 1983; Tonkinwise, 2015). This article aims to reflect on and improve the current state of design practice by observing and questioning the history and heritage of designerly ways within a specific context i.e. design for inclusive paediatric mobility.

Within the study of design, the term 'designerly ways' represents a vast and well-established

body of literature, first discussed by Cross (1982) in his paper ‘Designerly Ways of Knowing’, with the aim of establishing the criteria which design must satisfy in order to be treated as a coherent discipline of study. Over time, this body of literature has grown, alluding to multiple distinctive types of ‘designerly ways’ including: ‘Knowing’ (Cross, 1982), ‘Thinking’ (Oxman, 1999; Laursen & Møller Haase, 2019), ‘Acting’ (Cross, 2006), ‘Doing’ (Self et al., 2013), ‘Researching’ (Grocott, 2012), ‘Being’ (Tenenberg et al., 2014), and more recently, ‘Futuring’ (Joseph, 2019). In this article, the term ‘designerly’ is used in a sense which pertains to the academic design research tradition of studying design practice and linking it to design theory, as distinguished by Johansson-Sköldberg et al. (2013).

Rather than focusing on a specific type of designerly way from the outset, various designerly ways are explored and interrogated within a field-specific context; the case study of design for inclusive paediatric mobility (IPM) is chosen as an area of design which presents a wicked problem in need of designerly changes in order to transition towards a more desirable long-term future. Designerly contributions to IPM are used as a starting point to analyse design principles, practices, and techniques (Carlgren et al., 2016) and curate a narrative account (Grimaldi, 2013) of designerly ways in the field over the past 50 years. This article maps and synthesises findings to highlight gaps, issues and patterns and to propose alternative designerly ways to improve IPM design.

Design Meets Childhood Mobility

Inclusive Paediatric Mobility (IPM) design is the application of an inclusive design approach to create mobility interventions such as wheelchairs, walking aids and exoskeletons, with the fundamental goal of optimising the experience of childhood. IPM design unifies various design

elements and high-level approaches, making the content of this article pertinent to various neighbouring fields. Nesting within the wider field of inclusive design, IPM design draws heavily from Design Research, Child-centred Design, Design for Disability, and Mobility Design. The field is rich with technological, sociocultural and commercial considerations and inherits contradictory and permutable opinions and knowledge from a variety of disciplines, stakeholders and subject areas. The overarching problems that exist within IPM design are consequently wicked; they are ill-defined, complex, and are reframed whenever sociotechnical imaginaries transform (Taylor, 2003; Jasanoff & Kim, 2013) or societal narratives evolve (Venditti et al., 2017). For example, in the late 1970s, the widely accepted narrative used to address paediatric mobility disabilities began to evolve from the goal of ‘normalising’ children’s movement, with walking being the ultimate achievement, to the goal of encouraging children to use their ‘most efficient mobility approach’ to optimise their experience of childhood (Butler, 2009). This directly influenced the design of ensuing IPM interventions, and highlights the importance of interrogating societal narratives when reflecting on how and why designers arrived at their end products.

The contemporary landscape of IPM design materialised shortly after this, with a breakthrough in design thinking that embodied the new societal narrative; in 1983, the first paediatric power wheelchair was designed. The stark lack of independence-promoting IPM interventions other than walking aids up until this point was simply a reflection of society’s conventionally acknowledged narratives (Wiat & Darrah, 2009). New developments and knowledge in the field have since continued to grow, yet there remain myriad issues with the design of IPM interventions (Livingstone & Paleg, 2014).

The 'I' in IPM Design

Inclusive Design centres on the diversity of users' physical and psychosocial needs (Lim et al., 2020), often starting with considering 'extreme' users (Newell & Gregor, 1997), before exploring how further substantial structures of intersectional disadvantages such as race, gender, income and class, come to bear on design (Konstantoni & Emejulu, 2017). In the context of commercially available mobility interventions, young children are one of the most underserved and excluded age group of users (Feldner et al., 2016), hence becoming 'extreme' users of an already 'extreme' group.

There are three predominant approaches to the application of inclusive design (Figure 1) and it is important to consider all three in order to build a comprehensive, accurate and critical picture of the IPM design landscape. 'Special-purpose' design approach caters specifically for the needs of an extreme user group without serving a mainstream market, such as wheelchairs and walking aids. 'Customisable/modular' design approach enables mainstream products to be adapted to cater for the needs of extreme user groups, such as ride-on toy vehicles. The 'User-aware' design approach considers extreme user groups in the design of mainstream products, such as supportive tricycles and go-karts.

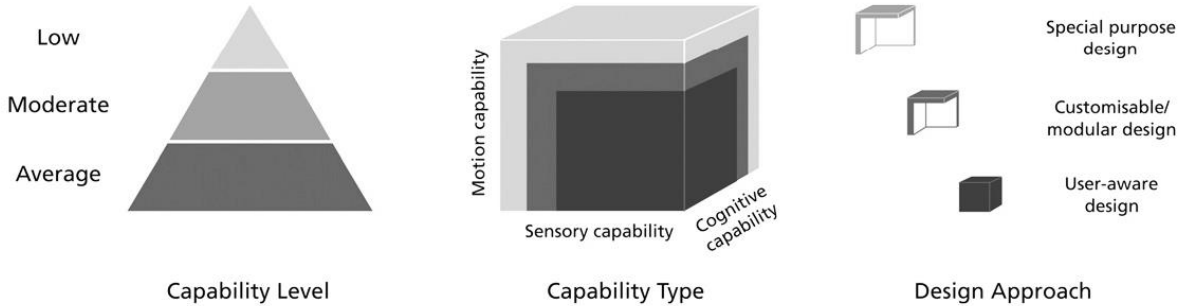


Figure 1. Three predominantly used Inclusive Design approaches (Clarkson & Coleman, 2015).

The Significance of IPM

Mobility, as well as being a human right, is a necessary and significant part of life that, amongst children in particular, influences multiple health outcomes. Independent mobility facilitates children's physical, emotional, psychosocial, perceptual and cognitive development (Nilsson et al., 2011; Bray et al., 2020), as well as providing opportunities to make social interactions (Guerette et al., 2013) and increase confidence and participation with peers in everyday activities (Casey et al., 2013). For infants and children with mobility disabilities, early intervention and provision of IPM can avoid irreversible developmental delays. Using independent mobility interventions has been shown to facilitate childhood development from as young as seven months old (Lynch et al., 2009).

Design Issues with IPM

A myriad of unresolved issues exist around IPM design, some of which act as barriers for incorporating IPM into a child's life. Many IPM interventions are as restrictive as they are enabling, are generally viewed as 'compromises' rather than 'ideals', and often exclude children with complex needs (Livingstone & Paleg, 2014; Feldner et al., 2016). Furthermore, they lack up-to-date integrated and assistive technologies, let alone desirability and childhood appeal which has long been the norm in parallel sectors. Hence, problems with IPM designs can be classified under three meta-levels:

1. Desirability, i.e. acceptability, pleasurability, emotional durability and personal meaning (Desmet & Dijkhuis, 2003).
2. Feasibility, i.e. functionality and features, technicalities and usability (Livingstone & Paleg, 2014).

3. Viability, i.e. economies of scale, affordability and sustainability (Pituch et al., 2019).

Whilst each problem has been separately investigated and addressed within adult services (Leaman & La, 2017), there is a considerable lack of holistic, convergent and innovative thinking within paediatric services (Feldner et al., 2016).

Design Opportunities for IPM

IPM is a global need as well as a worldwide market. From the perspective of health economics, there lies an opportunity to build a case for state provision of early IPM interventions and potential funding for further research and development in the field of IPM design. Children who receive adequate developmental opportunities during early childhood, have a better chance of becoming healthy and productive adults, which can reduce future costs of education, medical care and other social spending (Bray et al., 2020).

The combination of advanced manufacturing technologies, social product development and crowdfunding, provides a significant opportunity for continued development, full customisation and viable routes to market for IPM products. Open source design platforms can save time and money on research and development, whilst providing tools to drive rapid innovation at a global scale (Özkil, 2017). The emergence of new design approaches for solving complex or wicked problems (Tonkinwise, 2015) presents an opportunity to seek out improved designerly ways for the future of IPM design practice. This article aims to investigate such opportunities through reflecting on and questioning the past half century of designerly ways in the field.

Methodology

Data Collection Methods

An illustrative mapping review was used to objectively categorise designerly contributions to the field of IPM as one of four types, i.e. Interventional, Theoretical, Methodological or Empirical.

These four categories encapsulate all types of designerly contribution to the field of IPM (Wobbrock & Kientz, 2016). Table 1 outlines the contribution classification system.

Table 1. Classification of IPM Design Contributions.

| INTERVENTIONAL | THEORETICAL | METHODOLOGICAL | EMPIRICAL |
|--|---|---|--|
| New or improved products, services, systems, or artifacts. I.1 - Intervention was implemented or commercialised. I.2 - Intervention remained a concept or prototype. | T - Conceptual models, frameworks, policies, principles or important variations on those that already exist (e.g. disability studies). | M - Novel or refined methodologies, methods, processes, or techniques with sufficient detail to be replicated by others. | E - Data sets, surveys, arguments or findings based on empirical research which reveal formerly unknown insight and analysis of behaviours, capabilities, or interactions with interventions. |

Using these categories to chronologically map contributions at a high level of granularity, enables holistic visualisation and analysis of the field throughout history. It also enables identification of trends, clusters, deserts and gaps in knowledge (Grant & Booth, 2009) across all

types of designerly contribution. The data collection methodology (including all utilised search strings and databases) is outlined in detail on Mendeley data (O'Sullivan & Nickpour, 2020a) along with details of the captured contributions. It is suggested to review the aforementioned dataset before proceeding to the discussion section, in order to better engage with the analysis. Each search result was reviewed according to the inclusion and exclusion criteria outlined in Table 2.

Table 2. Inclusion and Exclusion Criteria.

| INCLUSION CRITERIA | EXCLUSION CRITERIA |
|--|--|
| Contributions from 1970 onwards (The field of IPM design field emerges soon after this time). | Interventions which do not provide a means of <i>independent</i> mobility (e.g. passive mobility via attendant). |
| Functionally novel or significant designerly contributions (i.e. excluding incremental updates and copycat products) | Contributions which lack record of the context of their creation. |
| Contributions relating to or developed for at least one child aged ≤ 18 years with a mobility disability. | Studies involving only non-disabled/fully mobile children or adults. |
| The development of technologies and gadgets specifically for the IPM field. | Non-English language publications with no English translation available. |

Data Analysis Frameworks

Contributions that met the inclusion criteria were categorised, mapped and then further analysed to enable a thorough understanding of the context of their creation and relationship to other

contributions on the map. Table 3 translates the objectives of this analysis into high-level questions and serves as the first of two frameworks used to structure this data analysis (O'Sullivan & Nickpour, 2020b). The questions are used to guide further investigation into each contribution and thus facilitate exploration of designerly ways.

Table 3. Contribution Analysis Objectives translated into High-level Questions.

| OBJECTIVE | QUESTION |
|---|---|
| Investigate levels and types of design contributions. | What is the type of design contribution? i.e. I.1, I.2, T, M, E (CLASSIFICATION) |
| Investigate if design contributions have increased/decreased/fluctuated/remained constant throughout history. | When have designerly contributions been made to the field of IPM? (YEAR) |
| Investigate the balance of contributions from stakeholder groups and explore diversity of perspectives and types of contribution. | Which discipline or stakeholder group does the contribution come from? (CONTRIBUTOR) |
| Investigate where in the world IPM contributions have come from and reasons why. | Where have designerly contributions been made to the field of IPM? (GEOGRAPHY) |
| Investigate the design approach used and if/how this influences the commercial success or impact of the contribution. | Which inclusive design approach has been used to develop it - User Aware, Customisable/Modular or Special Purpose (DESIGN APPROACH) |

A second framework was required in order to structure the identification and discussion of deeper insights around designerly ways, and to ensure they were rigorously reflected on and

questioned at multiple levels (Carlgren et al., 2016). Whilst various distinctive designerly ways have been well investigated, there appears to be a lack of existing theories, models, or frameworks which specifically facilitate reflection on, and questioning of, designerly ways on a macro-level, with a long-term, and future-oriented approach. Hence, relevant frameworks were reviewed, three were identified as points of reference and were synthesised to make a single framework suitable for this purpose. Combining the works of Schön (1983), Irwin et al. (2020) and Aristotle (Sloan, 2010), a new Reflection-for-Transition framework has been devised to capture and curate insights around multiple aspects of designerly ways (Figure 2).

Schön's (1983) reflection-on-action approach has been adopted in this framework to retrospectively contemplate the designerly ways utilised by contributions. Adding to this, the forward-oriented reflective approach of the Transition Design Framework developed by Irwin et al. (2020) has been adopted to facilitate long-term reflection at a macro-level. It also offers an action-planning aspect for new ways of designing which expands on the attitudes and actions required to reach the desired future. The final facet of the framework encapsulates Aristotle's 'elements of circumstance' to provide a comprehensive reflective structure for separating insights into types of designerly ways. These consist of seven questions used as a means of rigorous, contextual, and holistic information capture (Sloan, 2010). Adopting and adapting the elements of circumstance, the new Reflection-for-Transition framework of Designerly Ways consists of five types of designerly ways, each representing an instrumental dimension in the shaping of IPM contributions. These include: Designerly Investigations (Why); Designerly Processes (How and by What means); Designerly Contributions (What); Designerly Collaborations (Who); and Designerly Contexts (Where and When). Each designerly way is to be examined in the contexts of old and new ways, according to reflections, questions and visions

for transition, as illustrated in Figure 2. This framework will be used as a vehicle to identify, reflect on, and question key insights in both the context of the IPM design mapping review and the wider context of design practice.

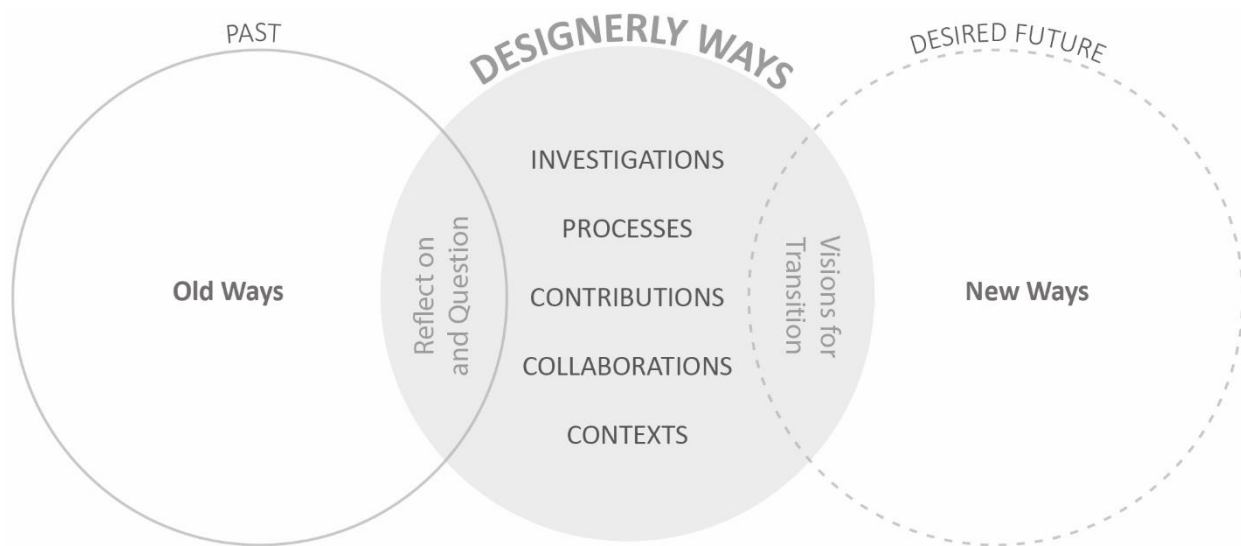


Figure 2. Reflection-for-Transition framework of Designerly Ways.

Illustrative Mapping Results

In total, 61 design contributions from the 1970-2020 period were deemed eligible for inclusion.

Full details of these results and their references are recorded in tables on Mendeley data

(O'Sullivan & Nickpour, 2020a). The data collection results were translated into a visual map

(Figure 3) to illustrate designerly contributions to the field of IPM based on type of contribution and contributors' stakeholder group(s).

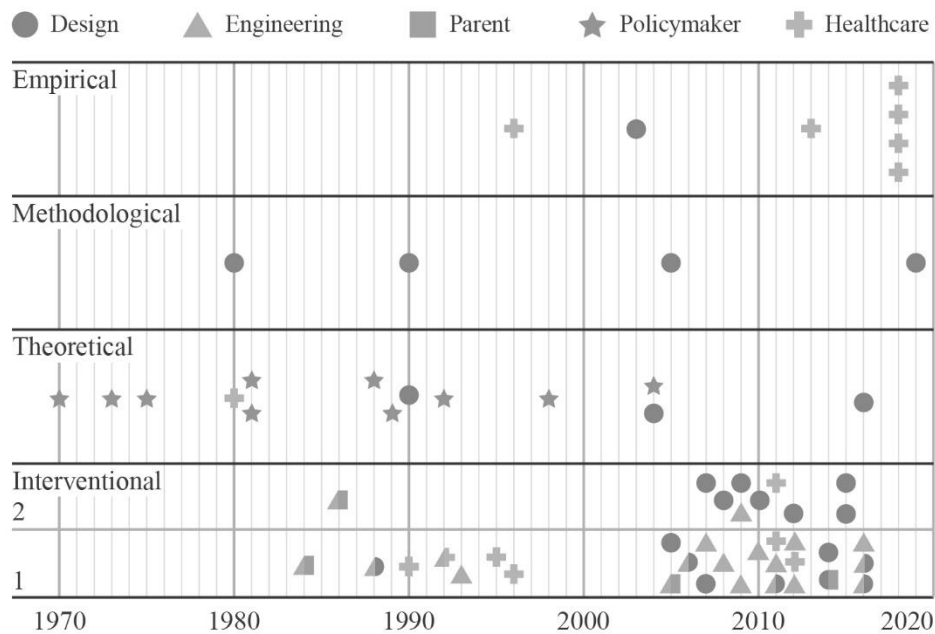


Figure 3. Illustrative map of designerly contributions in IPM between 1970 and 2020, based on type of contribution and contributor's stakeholder group(s).

Questioning Our Designerly Ways

The Reflection-for-Transition framework of Designerly Ways is used in this section to structure the discussion around 'Reflections On' old ways and 'Visions for Transition' to new ways regarding each of the five identified designerly ways.

Designerly Investigations

Designerly investigations account for the ways in which designers systematically explore a subject to identify, question, and make sense of insights, in pursuit of a definition or a direction. Designerly investigations tend to occur at the earliest stage of a design process as a sensemaking or framing exercise (Dillon, 1982) seeking to answer the question of *why* - to better understand and define the problem at hand.

Reflecting On & Questioning Designerly Investigations

Examining the mapping review data confirmed that interventional contributions to the field of IPM have primarily been driven by designers' habitual solution-focused impulse to specify and satisfy unmet 'user requirements', as their first point of investigation. This is archetypical of the design process (Cross, 2006) and often results in designers neglecting to interrogate higher level dominant and alternative narratives and social imaginaries around a problem, as part of the designerly investigation.

Narratives operate as an instrument of mind in the construction of reality and the way we perceive problems; they provide perspective or a point of view (Bruner, 1991; Grimaldi et al., 2013). Venditti et al. (2017) describe narratives as a way of presenting interpretations of reality, going beyond time, space, aesthetic form, and medium of conveyance. Narrative and theme investigations assist in broadening perspectives and understanding of a problem, which in turn enables designers to better define and frame a problem, and thus better solve it (Leeuwen et al., 2020). Within each act of design, proactively or passively, designers are either approving or rejecting a high-level narrative or ideology through conforming and contributing to it, transforming, challenging, or opposing it (Jakobsone, 2017).

Contemporary narratives put forward by Critical Disability Studies and Crip Theory around empowerment, techno-ableism, crip technoscience and design justice could help critique, alter, and reinvent the material-discursive world (Fritsch et al., 2019; Shew, 2018; Costanza-Chock, 2020). However, engagement with alternative narratives, social imaginaries, and approaches to framing IPM have remained underexplored and relatively unchanged. As a result, the landscape of IPM design has witnessed incremental changes focusing on the refinement of

existing products and technologies (e.g. power wheelchairs) rather than substantial innovation or critical design.

Vision for Transition & New Way of Designing; Investigations

Designerly investigations in the field of IPM design currently tend to focus on identifying and questioning underlying requirements and specifications for a design. It is proposed that designerly investigations transition to prioritise exploration, identification and questioning of alternative narratives and social and sociotechnical imaginaries to help reframe or even redefine the problems at hand, leading to critical design practices.

Designerly Processes

Designerly processes comprise the ways in which designers manage the application of their resources, including the nature and order of their actions, answering the question of *how* designers design (Bobbe et al., 2016). Processes represent a fundamental design characteristic influenced by both the lens used to view a subject, and the design approach adopted by the designer. Two distinct stages of the design process include problem framing and problem solving (Dillon, 1982). Nessler (2016) illustrates these in his Revamped Double Diamond model, as two sets of aims and outcome. Priority is given to first ‘designing the right things’, which establishes a point of view and enables ‘problem framing’, followed by ‘designing things right’ which embodies ‘problem solving’.

Reflecting On & Questioning Designerly Processes

Detailed analysis of interventional contributions illuminated a distinct spectrum of design profiles. Both ends are heavily invested in problem solving, and neglect to evidence investment in problem framing. On one end of the spectrum, exist designers who have a vested personal interest, lived experience, or social and corporate responsibility, such as family members or charities (e.g. Everard, 1983; Flodin, 2007). Designers at this end of the spectrum tend to have a strong point of view about the problem they are seeking to solve, or even an idea of a solution from the outset, and thus tend to jump into the design process without attempting to reframe or consider the problem from alternative perspectives.

On the other end of the spectrum, exist designers in larger commercial organisations which typically mass-manufacture adult mobility equipment. They tend to commence the design process with a closed brief or product specification that is framed from a commercial or health service provider perspective; to prioritise unit cost and physical user requirements, over children's lived experiences and personal preferences.

The mapping review illustrated a considerable number of interventional concepts or prototypes never making it to commercialisation, highlighting a disparity between design application and successful intervention or impact. With this being such a prominent characteristic of the IPM design landscape, it seems surprising that market sustainability is not framed as a higher priority design problem from the outset.

Vision for Transition & New Way of Designing; Processes

Designerly processes in the field of IPM design currently tend to commence with discovering and defining the needs of stakeholders with a solution-centred approach. Following on from designerly investigations, it is proposed that designerly processes transition their starting points

from problem solving to problem framing, and incorporate the opportunity to explore alternative narratives from the outset.

Designerly Contributions

Designerly contributions encapsulate the ways in which design efforts materialise to reflect *what* designers do on all levels. Theories, methods, interventions and empirical outcomes are all types of designerly contribution (Wobbrock & Kientz, 2016). The way a contribution is recorded forms a critical part of its ability to be communicated or shared, and thus significantly influences its representation. As the role of designers, and the very definition of design evolves over time, so too should the types of contribution that make up designerly knowledge.

Reflecting On & Questioning Designerly Contributions

The IPM mapping review revealed a somewhat disjointed and unbalanced landscape of designerly contributions, heavily focused on interventions. Moreover, these efforts were poorly recorded, making it difficult to locate and capture grey literature and unpublished fieldwork or artifacts, especially for discontinued interventional contributions. This could reflect an ‘end-result-oriented’ mentality that considers only certain polished aspects of a final solution valuable or worthy of being recorded, communicated, and represented (Wong & Radcliffe, 2000). Media coverage from IPM related design projects and competitions glorify well-presented inspirational prototypes, videos, or illustrations of final products as indicators of success (Norman, 2010) even if they never materialised or achieved impact (examples in Table 2 of: O'Sullivan & Nickpour, 2020a). Long-term measures of success, design processes, failures and empirical knowledge are typically kept in-house, if documented at all, and consequently have little or no representation as

contributions. Additionally, there are no rigorous principles or measures to assess quality, guide future thinking or define success within IPM design, which leaves little foundation for new contributions to learn from and build upon.

The representation of contributions by stakeholder groups suggests that documentation and dissemination of knowledge is typically encouraged and allocated more time in academic settings than in industry. This makes it highly likely that IPM design contributions, particularly interventional ones which did not reach commercialisation, could have been made by stakeholders unconnected to academia without being recorded in literature, and hence may not be represented in this mapping review.

Vision for Transition & New Way of Designing; Contributions

Designerly contributions in the field of IPM currently lack a balanced and holistic approach that recognises the full spectrum and potential of design contributions. Contributions are predominantly focused on interventions and delivering end products, hence neglecting and lacking attempt, recognition, documentation, investment, and prioritisation of other types of designerly contribution. It is proposed that the priorities for designerly contributions transition from being interventionally focused towards a more balanced representation of the spectrum of designerly contributions, placing greater value on theories, methodologies and empirical research.

Designerly Collaborations

Designerly collaborations embody the ways designers engage with others throughout the design process, answering the question of *who* designers work with and the nature of their engagement. There is a clear distinction between concepts of consultation, collaboration, and participation

(Ansell & Gash, 2008). While participatory design and co-design are well established within design, there is strong evidence around lack of uptake, misuse, and ineffective adoption of such approaches (Keast et al., 2007).

Reflecting On & Questioning Designerly Collaborations

The development of 30 out of the 36 interventional contributions in the mapping review were led by engineers or designers. There is little evidence or trend of continued involvement from other disciplines, stakeholders or children (users) throughout the design process. It seems, at best, collaborations in the field of IPM design have been multidisciplinary, but designers and engineers appear to have the final say on which features are compromisable or significant enough to be included in an intervention. Evidence shows that children, parents and therapists are not always satisfied with this (Pituch et al., 2019). Such critique echoes arguments from within crip technoscience (Fritsch et al., 2019), advocating expertise or even design initiation to be shifted from designers to those with lived experience, to minimise likelihood of designs being rejected by the disability community (Shew, 2018). In this case, utilising a child-centred design approach would ensure children's individual and collective voices, perspectives, priorities and lived experiences of IPM are captured and considered as a core part of the design process.

Due to the nature of the field, each stakeholder is equally knowledgeable when it comes to defining their perspective of the problems around IPM, and so all stakeholders need to be involved to frame the key questions and most important facets of the design problem. Jensenius (2012) proposes a spectrum of collaborative setups (Figure 4) and suggests that a closer collaborative effort to not only share information, but to work together to develop solutions and

ideas in a transdisciplinary approach, could transform the dynamics of IPM design and stimulate innovation in the field.

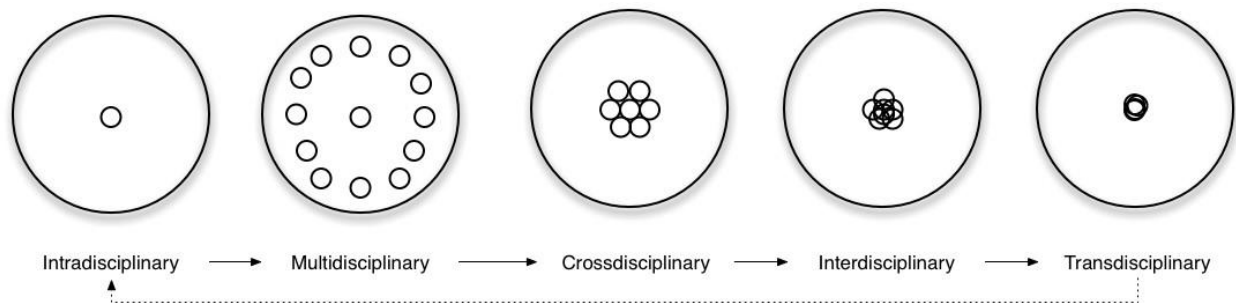


Figure 4. The disciplinary data integration spectrum (Jensenius, 2012).

Designers can support multi-stakeholder collaboration and foster co-creativity among fellow participants by taking on the role as a participant-facilitator (Aguirre et al., 2017). Involving children, key stakeholders and experts from foundational subject areas could bring new perspectives and narratives to the IPM field, stimulating and altering the way interventions are imagined, and subsequently designed. It is also important to acknowledge and balance tensions between disciplines regarding narratives and requirements.

Being a field of such specific scope puts IPM design at risk of contributing to the fragmentation of knowledge through siloing its discoveries if it does not maintain strong connections and collaborations with its broader foundational subject areas and adopt a unifying approach to knowledge.

Vision for Transition & New Way of Designing; Collaborations

Designerly collaborations in the field of IPM design have typically been multidisciplinary, however this has clearly not been satisfying the requirements and desires of all stakeholders and critiques (Livingstone & Paleg, 2014). It is proposed that designerly collaborations transition

towards a more child-centred and transdisciplinary approach, with designers taking on the role of a facilitator, a sensemaker and a bridge between a breadth of disciplines and stakeholders, both in terms of narratives and requirements. This will ensure design acts as an agent of knowledge unification throughout the design process, and is led with a rich array of experiences, skill sets, narratives and definitions of the problem.

Designerly Contexts

Designerly Contexts encompass the ways in which designers are influenced by factors connected with, or relevant to, the time (*when*) and place (*where*) they are designing for. Contextual sources of influence are dynamic and wide-ranging, embracing the breadths of social, technological, environmental, political, economic and legal states. As such, contextual influences manifest in a variety of forms, from deep-seated and imperceptibly evolving values, goals and interests at an individual level, to abrupt changes commanding immediate action at a global level. Having awareness of context and its influences bestows designers with greater consciousness over their design motivations (Mitchell, 1997), inspirations (Gonçalves et al., 2014), identity (Björklund et al., 2020), thinking and choices (Gray, 2013), all of which directly shape their design outcomes.

Reflecting On & Questioning Designerly Contexts

The dimension of Time can be related to short-term present thinking (immediate), or long-term future thinking (extended). It is interesting, yet unsurprising, that the first IPM interventions captured in the mapping review were created by parents (Everard, 1983; Flodin, 2007) as urgent responses to satisfy the mobility needs of their own children. These designs hence adopted an immediate approach to time. This relates closely to the ecological perspective of Place as the

level of proximity to the designer: at an individual level, designers address their own problem; at a community level designers address the problem of their connections or networks; at a national level designers address the problem of those with similar social and cultural values without direct contact; and at a global level designers address the problem at scale, for the benefit of all, crossing the borders of social and cultural values (Bronfenbrenner, 1979). Designers at the individual level are typically proactive in creating a design brief from their own understanding or lived experience of a problem. Designers who are designing at a less immediate level, or who are given a design brief, are typically reactive to somebody else's interpretation of a problem, making it important they unpick and interrogate the narratives, motivations, scope and any expected deliverables as part of their designerly investigation.

A more common interpretation of Place relates to geography. The mapping review highlights a significant lack of novel IPM design contributions recorded from developing regions of the world. This could be due to limitations of the search strategy, poor documentation of possible contributions, or general lack of contributions to the field of IPM design from these regions. Design for Scalability, Design for Diversity, and Context Variation by Design, are approaches and mind-sets that acknowledge large-scale wicked problems often occur in multiple contexts, and encourage designers to scale solutions across contextual boundaries (Kersten et al., 2018). These approaches start by intentionally sourcing insights from across all relevant contexts to create richer, more creative solutions that are more adaptable and adaptive for scalability. This can lead to lower end-to-end costs and shorter overall timelines for adoption on a substantial scale, which can be an effective way to extend the reach of IPM designs to also suit developing regions of the world (Nickpour and O'Sullivan, 2016).

Vision for Transition & New Way of Designing; Contexts

Designerly contexts in the field of IPM design currently tend to focus on the designer's immediateness in terms of both time and proximity to the problem. It is proposed that designerly contexts transition towards more extended perspectives, thinking about the longer-term landscape of IPM and considering it from a global sustainable perspective. This transition aims to provide designers with awareness of the bigger picture of IPM design, to be alive and responsive to the struggles of others and the planet, to set the world on a path to achieving better IPM design and thus more inclusively optimise experiences of childhood.

Summary of Transitions for Designerly Ways in IPM Design

The aforementioned 'Reflections On' old ways and 'Visions for Transition' to new ways regarding each of the five identified designerly ways in the field of IPM design are summarised in Figure 5. It is suggested that: Designerly investigations should change from capturing underlying requirements to first exploring high-level narratives and imaginaries; Designerly processes should shift focus from problem-solving to problem-framing; Designerly contributions should move beyond being interventionally-focused to attend more rigorously to documenting and sharing theories, methodologies and empirical research, to build a body of knowledge; Designerly collaborations should transition from multidisciplinary involvement towards transdisciplinary design teams; and Designerly contexts should progress from adopting immediate perspectives of time and place to exploring extended perspectives. Engaging in this reflective process has highlighted alternative designerly ways which could help the transition towards a more desirable long-term future for IPM design.

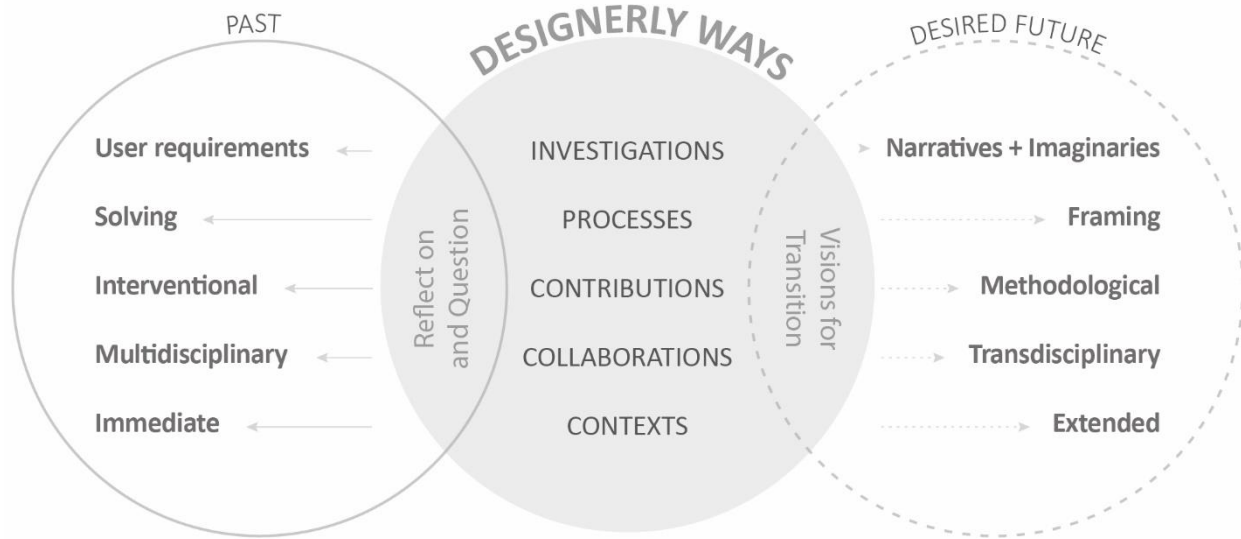


Figure 5. Reflection-for-Transition framework of Designerly Ways; 50 years of IPM Design.

Conclusion and Future Research

This article reviewed 61 contributions to the field of IPM design between 1970 and 2020. Adopting an illustrative mapping review method, design contributions were captured and classified under Theoretical, Methodological, Empirical, and Interventional categories.

On a macro-level, a *Reflection-for-Transition framework of Designerly Ways* was developed to curate key insights in a critical, reflective, and future-facing manner. The framework consists of five interrelated dimensions including Designerly: Investigations, Processes, Contributions, Collaborations, and Contexts. The framework could help identify existing and alternative designerly ways in both the context of IPM design over the past fifty years, and the wider context of design practice.

On a micro-level, key issues were identified with the current designerly ways of IPM and alternative designerly ways were proposed (Figure 5). These included: exploration of high-level narratives and social imaginaries prior to engaging with user and system requirements; shifting

towards problem-framing, child-centred design and transdisciplinarity; attending more rigorously to capturing theoretical, methodological, and empirical contributions to build a foundational body of design knowledge; and exploring extended contexts.

Going forward, the Reflection-for-Transition framework of Designerly Ways could be applied in other domains (both closely related and distant from IPM) as a framework to help capture context-specific insights, and as a framework to reflect on and transition the wider context of design practice as a whole.

Furthermore, future research needs to explore how each of the proposed new designerly ways should be applied in IPM design practice, in order to equip the next generation of designers with the tools, processes and knowledge required to drive progress, accelerate learning, and reimagine a more desirable future for IPM. Future design research in the field should prioritise establishing a more rigorous problem framing process, which will primarily entwine aspects of research into designerly investigations, processes and collaborations. This should pay specific attention to capturing stakeholders' narratives and optimising the child-centred design approach.

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