

Design for All

Sustainability Through Social Innovation



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SSi Lab

Sustainability and Social Innovation Lab

Guest Editor: Dr. Sharmistha Banerjee

Assistant Professor | Department of Design & Associated Professor
Centre for Disaster Management and Research | Indian Institute of
Technology Guwahati

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Sharmistha Banerjee, PhD

Assistant Professor, Department of Design & Associated Professor, Centre for Disaster Management and Research, Indian Institute of Technology Guwahati

Email: sharmistha@iitg.ac.in

Website: <http://www.banerjeesharmistha.com> (personal), <http://www.sustainability-and-social-innovation.com> (SSI Lab)

I am an Industrial Designer with extensive experience in collaborative innovation and sustainable product design. Presently, I hold the position of Assistant Professor in the Department of Design at the Indian Institute of Technology Guwahati. My doctoral research explored Design for Sustainability, specifically focusing on the development of scale-appropriate agricultural equipment. My academic journey began with a Bachelor's degree in Industrial Design from IIT Guwahati, followed by a Master's degree in Integrated Product Design from the Technical University of Delft, Netherlands, culminating in a PhD from IIT Guwahati.

I co-founded the Sustainability and Social Innovation Lab at the Department of Design, IIT Guwahati, which aims to redefine systems for sustainable human consumption and production. Our design interventions strive for a profound transformation of the consumption structure. The lab is an active participant in the Learning and Education Network in Sustainability (LeNS), a global consortium of over 150 universities dedicated to sustainability. A significant portion of our work focuses on sustainable product-service development projects within the agricultural sector.

My expertise lies in Design for Sustainability, emphasizing the integration of environmental considerations into the design process. This includes Agricultural Product Design, aiming to improve the efficiency and sustainability of farming tools and equipment. I'm deeply involved in Lifecycle Assessment to measure the environmental impacts of products throughout their lifecycle. My work in Sustainable Product-Service System Design seeks to create innovative solutions that blend products and services for better sustainability. Additionally, my efforts extend to Medical Product Design, prioritizing user safety and environmental considerations. My strong foundation in User Experience Design and Human-Centered Design ensures that our products are not only sustainable but also user-friendly and responsive to human needs.

At IIT Guwahati, I teach various courses including System Design for Sustainability, Usability Engineering, User Research Techniques, Product Detailing, Interaction Design, Design Management, and Plastics and Composites. I have also developed a MOOC course on System Design for Sustainability for the SWAYAM platform, sponsored by MHRD.

Over the past few years, my professional journey has taken me across India, Bangladesh, and the Netherlands, collaborating with organizations such as ABB, Philips, Infosys, MIDCO, VU Medical University Amsterdam, Conpax Verpakking, Beat Belly, Botanische Tuin Delft, ACC Ltd, and numerous educational institutes and NGOs worldwide.

From Consumers to Changemakers: The Impact of Social Innovation on Sustainability Practices

Sharmistha Banerjee, PhD

Assistant Professor, Department of Design & Associated Professor, Centre for Disaster Management and Research, Indian Institute of Technology Guwahati

Email: sharmistha@iitg.ac.in

1.1. A Closer Look at Sustainability

The imperative for design for sustainability emerges from the urgent need to address the intertwined challenges of environmental degradation, resource depletion, and social inequities, necessitating a comprehensive and integrated approach (Manzini, E. and Vezzoli, C., 2003). This necessitates a shift towards sustainable consumption and production (SCP), which aims to decouple economic development from environmental degradation and improve the quality of life for all (UNEP, 2018). SCP emphasizes not just technological innovations or efficiency improvements but also a systemic re-evaluation of the ways in which goods and services are consumed, produced, and disposed of (Mont, O. and Plepys, A., 2008).

The emphasis on consumption practices, rather than solely on production, as the focal point for achieving long-term sustainability benefits marks a pivotal shift in the approach to sustainable development. This perspective underlines the realization that production patterns are driven by consumption demands, implying

that changes in consumption behaviors can lead to more significant and systemic environmental and social benefits (Cohen, J, M., 2005). The SCP framework, intentionally placing 'Consumption' before 'Production', underscores this paradigm shift, highlighting the need to address the root causes of unsustainable practices through altering consumer behaviors, preferences, and patterns (Tukker, A. et al., 2017).

Research indicates that focusing on consumption practices offers a broader array of levers for achieving sustainability, including reducing the demand for resource-intensive goods and services, promoting the use of more sustainable products, and encouraging lifestyles and consumption patterns that are in harmony with ecological limits (Thøgersen, J. and Schrader, U., 2012). This approach aligns with the understanding that sustainability is not only a matter of how goods and services are produced but also fundamentally about what is consumed, in what quantities, and how the consumption of these goods and services impacts the environment and society (Spaargaren, G. and Cohen, M., 2009).

Moreover, the SCP approach fosters innovation in policy, market mechanisms, and consumer engagement strategies, aiming to facilitate a transition towards sustainability by integrating economic, environmental, and social dimensions (Mont, O. and Plepys, A., 2008). By focusing on the 'C' before the 'P', SCP emphasizes the role of consumers in driving demand for sustainable products and services, thereby influencing production practices and contributing to a more sustainable economy (Heiskanen et al., 2005).

In the SCP framework, social innovation becomes critical, offering new solutions that are socially accepted and widely adopted, addressing the complex challenges of sustainability transitions (Westley, F. et al., 2014). Social innovations are instrumental in reshaping societal norms, practices, and relationships, thus playing a crucial role in facilitating the transformative changes required for a sustainable future (Murray, R., Caulier-Grice, J. and Mulgan, G., 2010).

Here are some examples illustrating how social innovation contributes to SCP:

- 1. Sharing Economy Platforms: Services like car-sharing (Zipcar) and tool libraries promote the use of shared resources among multiple users, reducing the need for individual ownership and consequently diminishing the environmental impact associated with production and consumption. This model encourages efficient use of resources and helps in lowering carbon footprints (Botsman, R. and Rogers, R., 2010)**
- 2. Circular Economy Models: Companies like Patagonia, through their Worn Wear program, encourage the recycling and resale of used clothing, extending the lifecycle of products and reducing waste. This model challenges the traditional linear economy of "take-make-dispose" by keeping resources in use for as long as possible (Stahel, R. W., 2016).**
- 3. Community-Supported Agriculture (CSA): CSA schemes where consumers buy shares of a farm's harvest in advance, directly support local agriculture, reduce food miles, and promote sustainable farming practices. This model fosters a**

closer connection between consumers and producers, encouraging more responsible consumption patterns (Feenstra, G., 1997).

4. **Sustainable Energy Cooperatives:** Initiatives like the community wind farms in Denmark or solar cooperatives in Germany demonstrate how collective investment in renewable energy can provide sustainable alternatives to fossil fuels. These cooperatives empower communities, promote local energy independence, and contribute to the transition to a low-carbon economy (Walker, G. and Devine-Wright, P., 2008).
5. **Zero-Waste Stores:** Retail outlets that eliminate packaging and encourage customers to bring their own containers address the issue of waste generation at its source. By promoting bulk buying and sustainable packaging alternatives, these stores support waste reduction and raise awareness about the environmental impacts of packaging (Milios, L., 2017).
6. **Digital Platforms for Sustainable Lifestyles:** Apps and websites that offer information on sustainable living, such as how to reduce energy use, find local sustainable food sources, or promote upcycling and recycling, help spread knowledge and encourage sustainable behaviors among a wide audience (Hilty, M, L. et al., 2006).

These examples demonstrate the diverse ways in which social innovation can facilitate the shift towards more SCP patterns. By challenging existing norms and practices, social innovations offer pathways for societies to transition towards sustainability. Therefore, the integration of design for sustainability (DfS) with a focus on SCP, underpinned by strategic social innovation, is vital for tackling the

multifaceted challenges of sustainability transitions and advancing towards a more sustainable and equitable world (Geels, W, F. et al., 2015).

1.1.1. Developed versus Emerging Economy

According to a comprehensive literature review by Wang, C. et al. (2019), the differences in SCP practices between developed and emerging economies are significant. Developed economies often lead in implementing SCP through advanced technological innovations, stringent environmental regulations, and high consumer awareness about sustainability. These economies have the financial and institutional capacity to invest in cleaner production technologies and promote eco-friendly consumption patterns. SCP policies in developed countries are usually integrated into broader sustainability and green economy strategies, focusing on reducing environmental impacts, enhancing resource efficiency, and fostering sustainable lifestyles among affluent populations.

On the other hand, emerging economies face different challenges and priorities. In emerging economies, SCP practices are shaped by the urgent need to balance economic growth with environmental sustainability and social inclusiveness. These economies face the dual challenge of addressing current environmental degradation while preventing future unsustainable practices as they industrialize and urbanize. Emerging markets are characterized by rapid urbanization, which presents both challenges and opportunities for SCP. Urban centers in these countries are exploring innovative SCP solutions in areas such as waste management, sustainable mobility, and energy efficiency, often leapfrogging to sustainable technologies. The implementation of SCP in emerging economies often involves bottom-

up efforts, focusing on small and medium enterprises (SMEs), informal sectors, and community-based initiatives. There is a growing emphasis on local solutions, traditional knowledge, and the involvement of local stakeholders in designing and implementing SCP practices.

Thus, at the Sustainability and Social Innovation (SSI) lab at the Department of Design of IIT Guwahati, we are driving sustainability through social innovation for SCP for our unique socio-economic circumstances. In this guest editorial, we will present some of the innovative work that we have been conducting in the domain of sustainability and social innovation. Our work is geared towards the specific needs of emerging economies like India, where the challenges of sustainability are intertwined with issues of social equity and economic development.

1.2. Exploring Sustainability through Social Innovation at SSI Lab

The SSI Lab was set up at the Department of Design in 2015 with the aim to foster sustainability across the three foundational pillars of sustainability: social, economic, and environmental. Myself and my colleagues Prof. Ravi Mokashi Punekar and Dr. Pankaj Upadhyay, together conceptualized the lab. We were funded by an Erasmus+ project and joined the international group of labs called Learning and Education Network in Sustainability (LeNS) in 2017 (LeNS-International., 2018) to further expand our research and collaborations.

Our initiative is aligned with the SCP's emphasis on integrating sustainability into consumption and production patterns, focusing on

both the end-use of products and services and their lifecycle impacts. The SSI Lab aims to serve as a hub for research and development in DfS, thereby contributing to the broader agenda of SCP by addressing the intricate balance between meeting human needs and ensuring the ecological integrity of our planet.

The objectives of the lab are multifaceted and designed to create a significant impact in the field of sustainability:

1. Infrastructure and Guidance for Student Projects: By offering the necessary infrastructure and expert guidance, the lab supports student projects that are aligned with DfS principles. This effort is crucial for nurturing a new generation of designers who are well-versed in sustainability challenges and solutions.

2. Training for Local Institutions and Bodies: The lab conducts training sessions aimed at disseminating knowledge and skills related to DfS among local institutions and bodies. This initiative is instrumental in building local capacity to implement sustainable practices across various sectors.

3. Research and Case Studies Development: Engaging in research related to DfS, Sustainable Frugal Design, and the development of case studies through project execution, the lab contributes to the academic and practical understanding of sustainability. These activities help in identifying and refining effective strategies for integrating sustainability into design practices.

4. Course Material Development: The creation of course materials related to DfS ensures that educational programs are

equipped to teach sustainability concepts effectively, preparing students to tackle future sustainability challenges.

5. Tools and Methodologies for DfS Implementation: Developing tools and methodologies tailored for the implementation of DfS in diverse contexts—including emerging, marginalized, and industrialized settings—is critical for the widespread adoption of sustainable design practices. This approach recognizes the need for context-specific solutions in achieving sustainability goals.

6. Forming Global Research Partnerships: The lab endeavors to establish collaborations with researchers worldwide to amalgamate diverse knowledge, methodologies, and insights. By doing so, it aims to cultivate a rich, global ecosystem that supports the development and dissemination of SCP interventions tailored to various local contexts. This global network facilitates the exchange of best practices and innovative solutions, ensuring that the pursuit of sustainability benefits from a broad spectrum of cultural, economic, and environmental perspectives.

7. Partnering with Local and Global Industries: Recognizing the critical role of industry in the transition towards sustainable practices, the SSI Lab seeks to forge partnerships with both local and global industries. The goal is to co-create SCP solutions that are specifically designed to meet the unique sustainability challenges and opportunities within different industrial sectors. These collaborations are pivotal in translating sustainability research into practical, scalable solutions that can be integrated into the core operations of industries, thereby driving systemic changes in production and consumption patterns.

In the following section and chapters, we showcase our industry collaborations that merge Design with Sustainability, illustrating the tangible impacts of our initiatives. Subsequently, we delve into our contributions to theoretical advancements in academia, elucidating their influence on SCP insights. These theoretical advancements are the result of our industry projects and PhD research. Additionally, we outline the innovative tools we have crafted to facilitate DfS across diverse contexts, enhancing practical application and effectiveness.

1.2.1. Sustainable Agricultural Mechanization

Sims, B. and Heney, J. (2017) describe sustainable, agricultural mechanization (SAM) “as mechanization that is economically feasible, environmentally sensitive and socially acceptable.” Food and Agricultural Organization of the UN (FAO., 2016) describes SAM as: “Sustainable agricultural mechanization covers all levels of farming and processing technologies, from simple and basic hand tools to more sophisticated and motorized equipment. It eases and reduces hard labor, relieves labor shortages, improves productivity and timeliness of agricultural operations, improves the efficient use of resources, enhances market access and contributes to mitigating climate-related hazards. Sustainable mechanization considers technological, economic, social, environmental and cultural aspects when contributing to the sustainable development of the food and agricultural sector.” Thus, it suggests that the farm mechanization design process should follow a system-oriented design approach that connects the “technical, economical and engineering aspects” of machinery design with the allied service ecosystem. The allied service ecosystem should contain “linkages and inter-dependencies with other sectors” which will together offer a holistic view of conducting agriculture.

At our lab we are committed to bridging this need for small farms of developing countries through development of SAM as well as theory (Banerjee, S. and Puneekar, M, R., 2020)(Banerjee, S., 2021).

1.2.1.1. Redesign of Two-Wheel Power Tiller Based Bed Planter for Bangladesh - Empowering Bangladesh's Rural Farmers and Machine Manufacturers

This project was part of the 'Cereal Systems Initiative for South Asia – Mechanization and Irrigation' (CSISA-MI) funded by the USAID Mission in Bangladesh. It embodies a participatory design approach to achieve SCP. The social innovation that participatory approach brings to this scenario is the fact that a mechanization project gave farmers, machine operators as well as illiterate or semi-literate stakeholders a say in how to design a mechanization ecosystem. This project focused on the redesign of a two-wheeled power tiller-based Bed Planter and its associated ecosystem (training, manufacturing, distribution, pricing, etc.) suitable for low-income farmers in rural Bangladesh. It exemplifies how SCP principles can be interwoven with human-centered design methodologies. By actively involving the consumers comprised of the farmers, machine operators, and local service providers, and the producers comprised of the small-scale manufacturers in the design process, the project not only aimed to address the immediate technical and ergonomic challenges associated with agro-machinery but also sought to empower the local farming and manufacturing community in making more sustainable choices.

The participatory design process facilitated a deep dive into the needs, aspirations, and constraints of the stakeholders, ensuring that the solutions were not only technologically sound but also socio-

economically sustainable. Through semi-structured interviews, contextual inquiries, co-creation workshops, and mock training sessions, a comprehensive understanding of the local ecosystem was developed. This approach not only led to the design of a more effective and accessible Bed Planter but also strengthened the local manufacturing capabilities, creating employment opportunities and fostering a sense of ownership and empowerment among the rural farming communities.

The project highlights the critical role of participatory design in achieving SCP goals. By giving voice to the local farmers and stakeholders in the design process, the initiative demonstrates how tailored, scale-appropriate technological interventions can significantly enhance agricultural productivity and sustainability, marking a significant step forward in the journey towards sustainable rural development of a region. The key takeaway from this project is published at [\(Banerjee, S. and Puneekar, M, R., 2020\)](#). The learnings from the project also resulted in development of a methodology and a set of guidelines for SAM of small farms of developing countries [\(Banerjee, S., 2021\)](#) and is detailed in the next sub-section. Figure 1 and 2 show the first prototype of the machine being tested in field and the CAD model respectively.



Fig. 1 First prototype being tested on field.



Fig. 2 CAD model of the bed planter attachment

1.2.1.2. G-SAM (Guidelines for Sustainable Agricultural Mechanization)

From the above-mentioned project and several other such projects (Sustainability-and-Social-Innovation-Lab., 2024), we concluded that for achieving SAM of small farms of developing countries, we need to connect social innovation, SCP and the three dimensions of sustainability in the following manner:

1. Social Dimension: Improve the livelihoods and well-being of small-scale farmers by developing agricultural mechanization solutions that are not only accessible, affordable, and user-friendly but also aspirable. Thus, we need to bring in:

- **Inclusive Stakeholder Participation:** Engaging a wide spectrum of stakeholders, including farmers, local service providers, and technical staff of the manufacturer, in the design process creates a socially inclusive platform, leading to machinery that is more squarely aligned to the needs and constraints of the end-users, thus promoting greater social equity in agricultural communities.
- **Empowerment through Local Manufacturing:** Benefits such as fostering local skills through training programs and the creation of manufacturing guidebooks, supports community development and capacity building, enhancing social cohesion, providing local employment opportunities, easier access to customized machinery and cheaper and faster repairs and maintenance.
- **Empowering Illiterate and Semi-literate**

Stakeholders: By valuing all forms of knowledge and communication styles, the design process empowers these stakeholders, ensuring that their voices are heard and their needs as well as aspirations considered, reducing social disparities.

- **Training and Capacity Building:** The development of training programs as part of the machinery's service ecosystem builds local competencies and supports knowledge transfer, contributing to social sustainability by elevating skills and expertise within the community.
- **Training for Manufacturers' Workers:** Ensuring that local workers are trained adheres to the principles of decent work and human rights, contributing to a more equitable society.

Economic Dimension: Ensure that the adoption of agricultural mechanization is financially viable for small-scale farmers and contributes to their economic prosperity through:

- **Sustainable Product-Service Systems:** The focus on designing PSS rather than standalone products suggests an innovation in business models where services (such as machinery leasing) are offered in conjunction with products. This can reduce the economic burden on individual farmers, increase access to advanced technology, generate employment and promote more efficient use of resources, aiding economic sustainability.
- **Improving Livelihoods:** Designing machinery that is cost-effective and increases agricultural productivity directly

influences the economic well-being of farmers by potentially increasing their income, hence contributing to economic sustainability.

- **Economic Empowerment:** Establishing local manufacturing capabilities for precision components of agricultural machinery can stimulate local economies, reduce repair times, decrease costs, and create jobs, thereby improving the overall economic well-being of communities.
- **Logistics and Inventory Planning:** These elements suggest the development of new systems for efficient resource management, which can have knock-on economic benefits by reducing waste and optimizing production and service provision.

3. Environmental Dimension: Ensure the conservation of natural resources, reduction of environmental degradation, and promotion of sustainable farming practices by incorporating the following elements into our design process:

- **Positive Agronomic Impact:** By examining the impact of machinery on soil, water, and biodiversity, and optimizing for sustainability, the design supports environmental stewardship and resource conservation, directly benefiting the environmental sustainability of the service ecosystem. Both short and long-term benefit needs to be taken into account.
- **Lifecycle Assessment Approaches:** Incorporating assessments that consider the full lifecycle of the machinery ensures that environmental considerations are factored into

design decisions, which can result in reduced ecological footprints of agricultural practices.

- **Sustainability Assessment through Checklist:** Designers need easy to use tools which can help evaluate the environmental impacts of machinery across its lifecycle. LCA using databases requires higher amount of data and expertise, which is missing in the context of small farms of developing countries. Checklist based assessment can promote the creation of machinery that is more resource-efficient, generate less waste, and reduce negative ecological impacts, while being simpler to implement in low resource contexts.
- **Visual Tools for Conceptualization:** SAM needs multiple stakeholders to be able to together visualize a large number of factors and their complex interactions, like that between agricultural practices and environmental impacts, fostering more responsible decision-making and awareness regarding environmental conservation. Using visual tools can aid stakeholders in doing these tasks and conceptualizing for SAM.

A multi-stakeholder approach to social innovation leverages the interconnectedness of social, economic, and environmental dimension of sustainability. In the broad service ecosystem associated with agricultural machinery, one needs to integrate the following:

- **Extension Services Providers:** Those who provide training and support to farmers on the use of machinery contribute to social sustainability through capacity building and educational initiatives.

- **Local Supply Chains:** Developing a local supply chain for components and maintenance can drive economic sustainability by keeping more financial resources within the community.
- **Policy Makers:** Their role in creating conducive environments for sustainable practices, like providing subsidies or tax incentives for sustainability-oriented agricultural machinery, plays into economic sustainability.
- **NGOs and Community Organizations:** These groups often fill gaps in education, training, and social welfare, contributing to the social dimension by ensuring equitable access to resources and support structures.
- **Environmental Regulators:** They are essential for ensuring that environmental concerns are integrated into the design and deployment of agricultural machinery, thereby shaping environmental sustainability within the service ecosystem.

By intertwining social innovation with sustainability, our research emphasizes the need to design not just for technical efficiency but for comprehensive sustainability that respects and enhances the social fabric, economy, and environment of agricultural communities. Thus, we developed a tool called G-SAM (Guidelines for Sustainable Agricultural Mechanization) (Table 1), which provides a framework for incorporating sustainability principles into the assessment, design, development, and implementation of SAM (Banerjee, S., 2021,

pp 101-122). Figure 3 shows how G-SAM guidelines show up to aid in assessment.

Table 1. Structure of G-SAM

Dimension	Criterion	Impact Category
Environmental Dimension	System Life Optimization	Soil
		Water
		Biodiversity
		Productivity
		Agricultural Machine Characteristics
		Service Level
		System Level
	Optimization of Resource Management	Soil
		Water
		Material Cycles
		Agricultural Machine Characteristics
		Service Level
		System Level
	Transportation/ Distribution Reduction	Agricultural Machine Characteristics
		Service Level
		System Level
	Waste minimization/ Valorization priority	Material Cycles
		Waste
		Agricultural Machine Characteristics
		Service Level
System Level		
Conservation/ Biocompatibility	Water	
	Energy	
	Agricultural Machine Characteristics	
	Service Level	
	System Level	
	Soil	
	Energy	
	Air	
	Waste	
	Agricultural Machine Characteristics	
	Service Level	
	System Level	
	Economic Dimension	Market position and competitiveness
Profitability or added value for companies		Service Level
Added value for customers		System Level

	<p>Long-term business development or risk</p> <p>Partnership or Co-operation</p> <p>Macroeconomic effect</p>	
Social Dimension	<p>Empower or valorize, local resources</p> <p>Improve social cohesion</p> <p>Favor or integrate, weaker and marginal strata</p> <p>Enable a responsible and sustainable consumption</p> <p>Improve equity and justice in relation to stakeholders</p> <p>Improve employment and working conditions</p>	<p>Agricultural Machine Characteristics</p> <p>Service Level</p> <p>System Level</p>

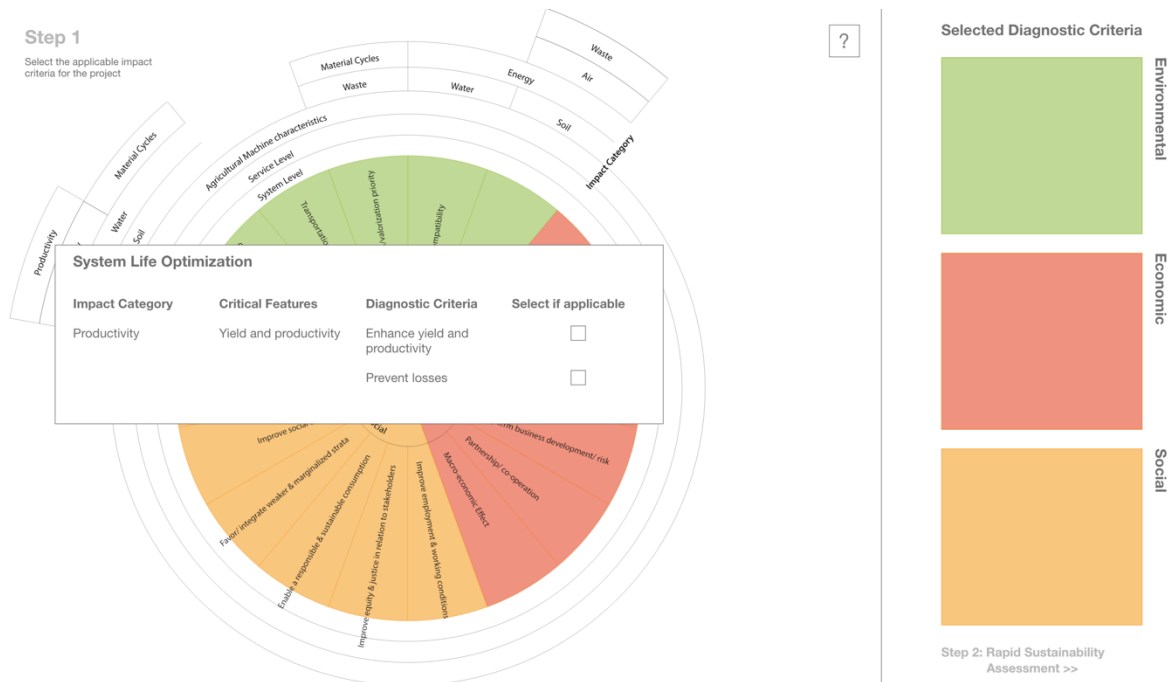


Fig. 3 Screenshot of the G-SAM assessment page.

Building upon the holistic framework established for SAM, we next delved into exploring the application of similar principles within a broader socio-economic context, the revitalization of local production practices through the lens of social innovation and design. The next section delves into the nuanced challenges and opportunities presented by the need for resurrection of “Making” practices amongst people of developing economies like India. It is crucial for fostering

environmental stewardship, cultural preservation, and economic viability, especially in rural and semi-urban areas of emerging economies.

1.2.2. Design for Motivation to Facilitate the Adoption of Assisted Self-Production in Emerging Economies

The revival of “Making” practices in emerging economies, particularly within rural and semi-urban contexts, presents a significant opportunity for addressing a multitude of sustainability challenges (Pattnaik, K, B. and Dhal, D., 2015). These challenges range from labor migration and environmental pollution to the loss of cultural heritage and the consequences of unsustainable urbanization. Our PhD scholar, Ms. Prarthana Majumdar, in her thesis, defines the concept of “Assisted Self-Production” (ASP) to articulate the Making practices in the Emerging Economies. She argues that it is a pivotal strategy, aiming to rekindle local production practices that are environment-friendly, culturally relevant, and economically viable. This approach not only supports SCP goals but also aligns with the broader aspirations of social innovation. (Majumdar et. al, 2019).

Social innovation, in this context, refers to the creative and community-driven solutions to societal problems, often leveraging local knowledge, materials, and traditions. ASP acts as a vehicle for social innovation by enabling communities to harness their intrinsic resourcefulness, creativity, and entrepreneurial spirit. This is particularly relevant in the backdrop of the historical trajectory of consumerism in countries like India, where colonial legacies and subsequent economic liberalization have shaped unique consumption and production patterns.

In her thesis she further argues that due to the current wave of consumerism and Indian education system, the youth are moving away from Making. The move is happening as they don't find any intrinsic motivation in the process of Making. Thus, she explores how Design can play a role in bridging the gap between the potential of ASP and its adoption within communities. In her research, she outlined the importance of design in motivating and facilitating the uptake of ASP practices, especially among the youth. Her study explores how design can be employed to embed intrinsic motivations into products and product service systems (PSS) that resonate with the target communities and motivate them to re-adopt Making (Figure 4). This approach is grounded in the understanding that sustainable behaviors are more likely to be adopted and sustained when they are intrinsically motivated.

The framework she developed, named "Catalyst: Design for Motivation to Induce Behavior Change," emphasizes the psychological components of behavior change, specifically focusing on motivation (Figure 5). By adopting theories like Ryan and Deci's Self-Determination Theory and Csikszentmihalyi's Flow Theory, the framework guides designers in creating products and PSS that are not only appealing but also meaningful to the target audience. The methodology encourages designers to delve deep into the community's perceptions of competence, autonomy, and relatedness needs, using these insights to craft designs that are slightly more challenging than the users' current skill levels, thereby engaging them in a process of learning and mastery.

Using the Catalyst framework, expert as well as novice designers designed Making tools and workshops for school children. The designers found her framework very useful and effective for designing

products with motivation embedded in it. We tested these tools and workshops with school children and found them to be very effective in motivating the teenagers in making with their hands and engaging in creative activities. The teenagers kept challenging themselves into going beyond what was asked them to achieve in the workshop.

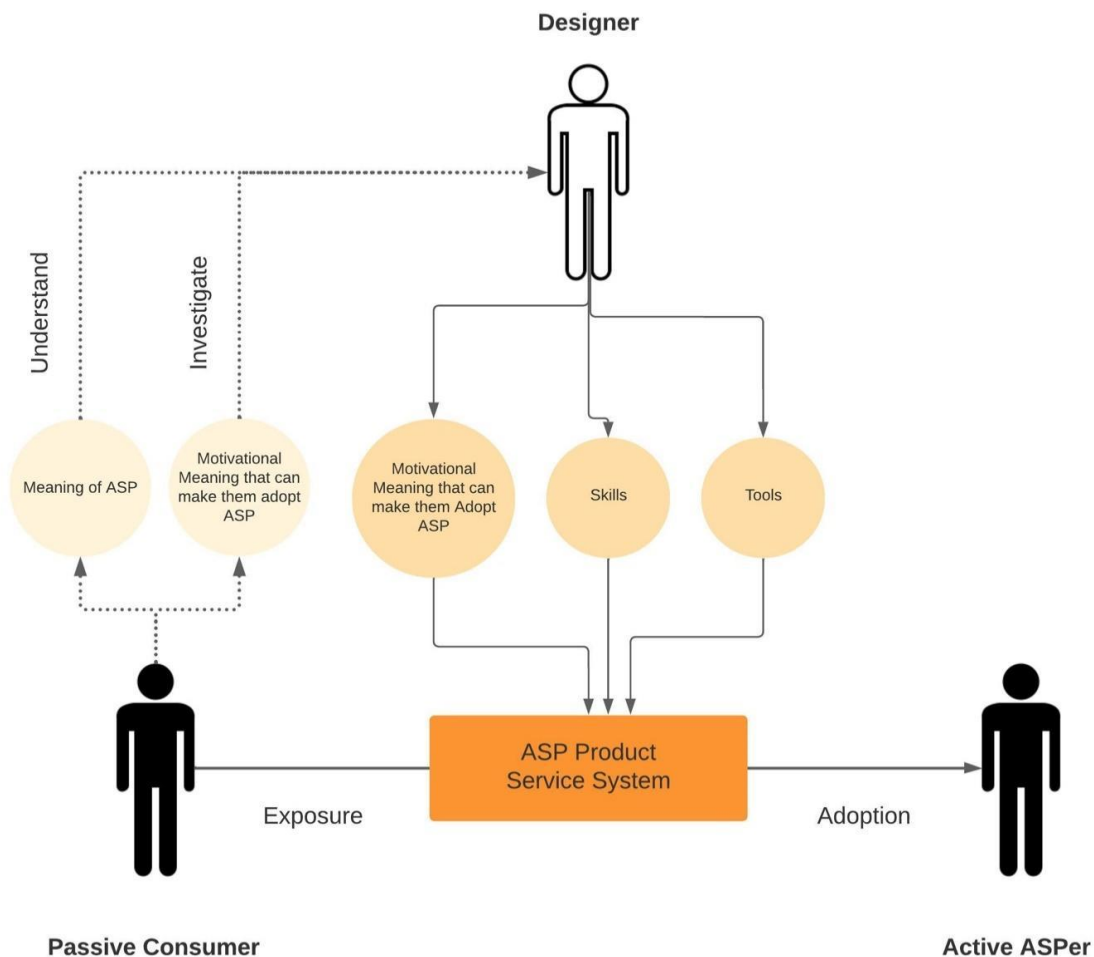


Fig. 4 Schematic showing the pathway of behavior change induced by providing new meaning to an ASP practice and considering the skills and materialities of the practice.

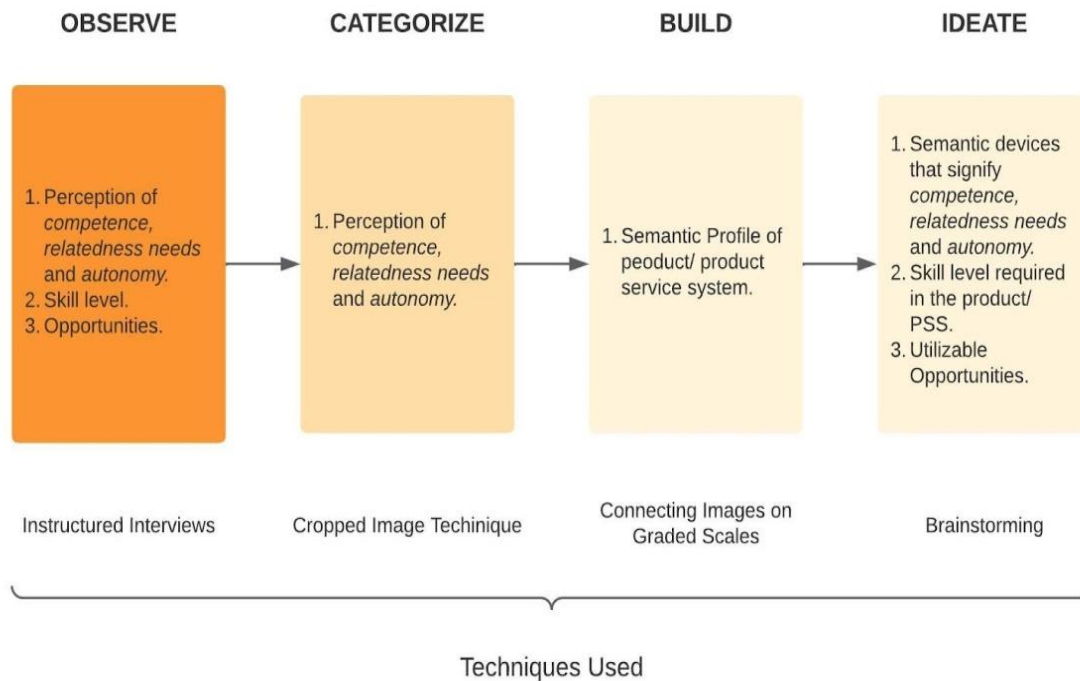


Fig. 5 The steps of the framework that aids designers in understanding motivations and embedding them in products/ PSS.

1.2.3. Bringing Social Innovation, SCP, and Design Together: Reimagining Craft Education

Mr. Shivram Kumar, yet another PhD scholar at SSI Lab is looking at Making from a different angle. His research started with the question, what happens once one has decided to adopt Making for a living or in other words has decided to enter the crafts sector? How is the craft education in India? Is it in tune with todays needs and realities?

Craft has always been an integral part of the cultural heritage and economic asset of various regions in India. Traditionally, handicrafts emerged as utilitarian products catering to local markets, and they carry the identity of the people who create them. However, in today's India, the craft sector is facing a challenge as the teaching-learning

methods of the past are not aligned with the needs of the current generation. This has led to a lack of adequate preparation among the younger generations to see craft as a potential means of earning their livelihood.

Craft education in India needs to evolve to meet the demands of the modern world. It should integrate traditional techniques with contemporary design and marketing approaches. The focus should be on equipping the younger generation with the skills and knowledge required to thrive in the craft sector and make it a sustainable source of livelihood. This transformation in craft education will not only preserve the cultural heritage and identity but also contribute to the economic development of the regions.

In order to address this pressing issue, Mr. Shivram Kumar's research is exploring the current state of craft education in India and its alignment with the present needs and realities. The aim is to reimagine the craft education system that can effectively prepare and motivate the younger generations to pursue careers in the craft sector. By combining social innovation, sustainable consumption and production, and design thinking, the research seeks to overhaul the existing craft education framework and make it more relevant and appealing to today's youth.

His research looks at craft education as a pedagogy-andragogy-heutagogy continuum as described below in Table 2.

Table 2. Craft education as a pedagogy-andragogy-heutagogy continuum.

Aspect	Pedagogy	Andragogy	Heutagogy
Definition	The art and science of teaching children.	The practice of teaching adults.	Self-determined learning.
Learner Role	Passive recipients of knowledge.	Active and self-directed.	Highly autonomous and self-determined.
Teacher Role	Authoritative figure, primary source of knowledge.	Facilitator of learning.	Mentor or facilitator provides support.
Learning Focus	Curriculum-based, standardized objectives.	Problem-centered, relevance to life.	Development of learner capability, critical thinking.
Approach	Didactic, structured lessons.	Flexible, responsive to individual needs.	Encourages exploration, inquiry, creation of knowledge.
Contextual Example	Basic Craft Skills: Introducing young or new learners to fundamental craft techniques and safety procedures. Ideal for foundational skills that require initial direct instruction and close supervision.	Intermediate Craft Skills: Suitable for adults with some experience or knowledge, focusing on improving skills and learning new techniques. Emphasizes practical application and problem-solving within craft projects.	Advanced Craftsmanship: Ideal for experienced craftsmen pursuing mastery or innovation within their craft. Encourages self-directed projects, research, and development of new methods or designs.

From SAM to local production had been an amazing journey for us and then we decided to broaden our perspective, extending into the critical area of disaster resilience through Disaster Risk Management

(DRM). Now, in Section 2.4, we explore how Design for Sustainability (DfS) in Disaster Risk Management (DRM) incorporates these overarching principles to create resilient infrastructures and communities capable of withstanding, adapting to, and recovering from disasters. This section underscores the critical importance of integrating environmental, economic, and social dimensions into DRM, thereby not just responding to disasters but proactively enhancing community resilience. Through the lens of Community-based Disaster Risk Management (CBDRM), we see the embodiment of participatory action research methodologies, which emphasize local knowledge and engagement in disaster preparedness activities.

1.2.4. Design for Sustainability in Disaster Risk Management

DfS studies are increasingly recognized for their critical importance in the context of DRM, offering a holistic approach that integrates environmental, economic, and social dimensions into the design and development of resilient infrastructure and communities. DfS emphasizes the creation of systems, processes, and products that not only meet current needs without compromising the ability of future generations to meet theirs but also enhance the capacity to withstand, adapt to, and recover from disasters. Realizing the importance of this synergy, I have joined the Centre for Disaster Management and Research (CDMR) at IIT Guwahati.

As part of this new role, we at SSI Lab have initiated research in CBDRM. CBDRM is a participatory approach that engages communities in disaster risk reduction (DRR) activities. This approach is rooted in participatory action research methodologies, enabling communities to identify and mitigate their own vulnerabilities. (Sim, T., Dominelli, L.

and Lau, J., 2017). The Sendai Framework for Disaster Risk Reduction 2015-2030 underscores the significance of CBDRM, advocating for multi-sectoral engagement in Disaster Risk Reduction (DRR) (Sim, T., Dominelli, L. and Lau, J., 2017)(Aitsi-Selmi, A. et al., 2015).

We currently have two PhD scholars working on CBDRM. Ms. Aradhna Moktan is focusing on how CBDRM can be integrated within sustainable settlement design frameworks. The aim of this research is to develop an interdisciplinary, integrated framework that explicitly connects principles of CBDRM with sustainable settlement design. Integrating CBDRM principles into settlement design ensures that communities are better prepared for, can more effectively respond to, and recover from disasters quicker. This approach leverages local knowledge and engagement in disaster preparedness activities, thereby enhancing the resilience of communities to withstand adverse events. The development of such a framework can guide policymakers and planners in integrating disaster risk reduction and sustainability principles into urban and rural development plans. This can lead to more coherent and effective policies that address the interconnected issues of disaster risk, environmental sustainability, and community well-being. The figure 6 shows the pillars for effective and sustainable CBDRM which can be incorporated into various aspects of sustainable settlement design.

Another PhD scholar, Mr. Pankaj Kavidayal, who is also 2nd in Command, 1st Battalion, National Disaster Response Force (NDRF), Assam, is exploring the role of women in CBDRM. His research aims to understand the unique contributions and challenges faced by women in disaster risk reduction processes in North-east India which is prone to several natural disasters from earthquakes, landslides, cloud bursts to annual floods. The region is also inhabited by

communities from several ethnic backgrounds who have their own cultural practices and social dynamics. (J. Moreno and D. Shaw, 2018) Research emphasizes the unique position of women in disaster scenarios, where they can be both victims and critical agents of change. Studies indicate that women's involvement in disaster preparedness and response can significantly enhance community resilience and recovery. The North-Eastern region's vulnerability to natural disasters is compounded by its complex socio-political landscape, with issues ranging from ethnic conflicts to inadequate infrastructure. This complexity necessitates a nuanced approach to DRM that incorporates the perspectives and needs of women. Also states like Meghalaya, Manipur, and Mizoram show lesser degrees of gender inequality, which could influence DRM in certain way. Hence, the topic attracted our curiosity.



Made with  Whimsical

Fig. 6 Pillars for effective and sustainable CBDRM

In Sections 2.1 through 2.4, we have traversed a comprehensive landscape that outlines a blueprint for sustainable development across various domains—from SAM and ASP to the reimagining of craft education and integrating DfS into DRM. Each of these sections, in its own right, underscores the necessity of adopting a holistic approach that harmonizes technological advancements with traditional knowledge and participatory design to address the multifaceted challenges of our time. Section 2.5, on the other hand, introduces a critical dimension to our sustainable development discourse: Enhancing Product Sustainability through Disassembly-Oriented Design and End-of-Life Management. This section underscores the imperative of incorporating considerations for the end of life (EoL) of products right from the design phase, aligning with the principles of a circular economy.

1.2.5. Enhancing Product Sustainability through Disassembly-Oriented Design and End-of-Life Management

Product designers can create sustainable products, reduce waste, and decrease costs associated with disposal by considering factors such as the ease of disassembly, the use of environment-friendly materials, and the ability to reuse or recycle components. End of life (EoL) options for a product include landfilling, incineration, recycling, composting, repurposing, and remanufacturing. Disassembly is an important EoL option for products, especially those with hazardous materials or components that are difficult to recycle or dispose of. However, disassembly can be challenging, as products are often not designed with disassembly in mind, making the process time-consuming and labour-intensive.

Incorporating disassembly into the product embodiment design process is critical for ensuring optimal EoL performance and reducing the environmental impact of products. It also aids in creating circular economy-oriented products that maximize the potential for material reuse and recycling to minimize environmental impact.

We created a methodology termed Design for Optimal End-of-Life Performance (DfOEP), which mandates that during the embodiment design phase, product designers must account for a product's environmental footprint at its EoL. Essentially, this method encourages designers to expand their traditional focus on aesthetics, functionality, and production criteria to include considerations for the disposal or recycling of the product after its service life concludes. By implementing DfOEP principles during the product embodiment design phase, a company can create sustainable products, reduce waste, and decrease costs associated with disposal.

The novelty of the DfOEP analysis method developed by us are as follows:

- 1. We developed a comprehensive methodology for identifying a "Disassembly score" for a product which can be used to improve the embodiment design in an iterative manner.***
- 2. We created a graphical representation schema for presenting a product's disassembly sequences.***
- 3. We have developed a three-layered cost-benefit analysis methodology to optimise EoL performance, while considering three strategies: disassembly, recycling, and disposal, as well as the effect of the region where the EoL management and treatment is taking place. What sets our cost-benefit analysis apart is that it allows designers to choose which layer they would like to perform***

the analysis on. The layer of analysis can depend on the amount of time and EoL information available.

- In layer one, the designer can input the Design Bill of Materials (D-BoM), along with the material specification and weight, then select the disposal and recycling scenario, and segregate the product into sub-assemblies and components. Thereafter, a cost analysis (comparing labour cost versus scrap value) informs the designer about the profitability of the disassembly process. An analysis of the eco-cost of disposal versus recycling gives an idea of the best EoL strategy for each sub-assembly or component of the product.***
- In layer two, the designer can use the disassembly sequences already generated and perform a cost-benefit and eco-cost analysis per sequence to identify the most optimal and profitable sequences.***
- In the third layer, we propose an EoL Indexing method using a multi-criteria decision-making process called Analytical Hierarchical Process (AHP) to factor in various other factors that cannot be otherwise computed using an utility function. One such factor is the total cost of disposal, which can vary greatly depending on a number of factors, such as the time required to complete the process, the environmental impact created by the disposal (including factors such as air and water pollution, the release of greenhouse gases, and the impact on local ecosystems), and the value of the material being disposed of. In cases where the material has significant value or could be put to use in another way, the cost of disposal could potentially be offset by the revenue generated***

from recycling or repurposing the material. The EoL Index converts these multitude of factors into one index value, which helps in making appropriate decisions.

Applying these methodologies to various products, we achieved the following major outcomes:

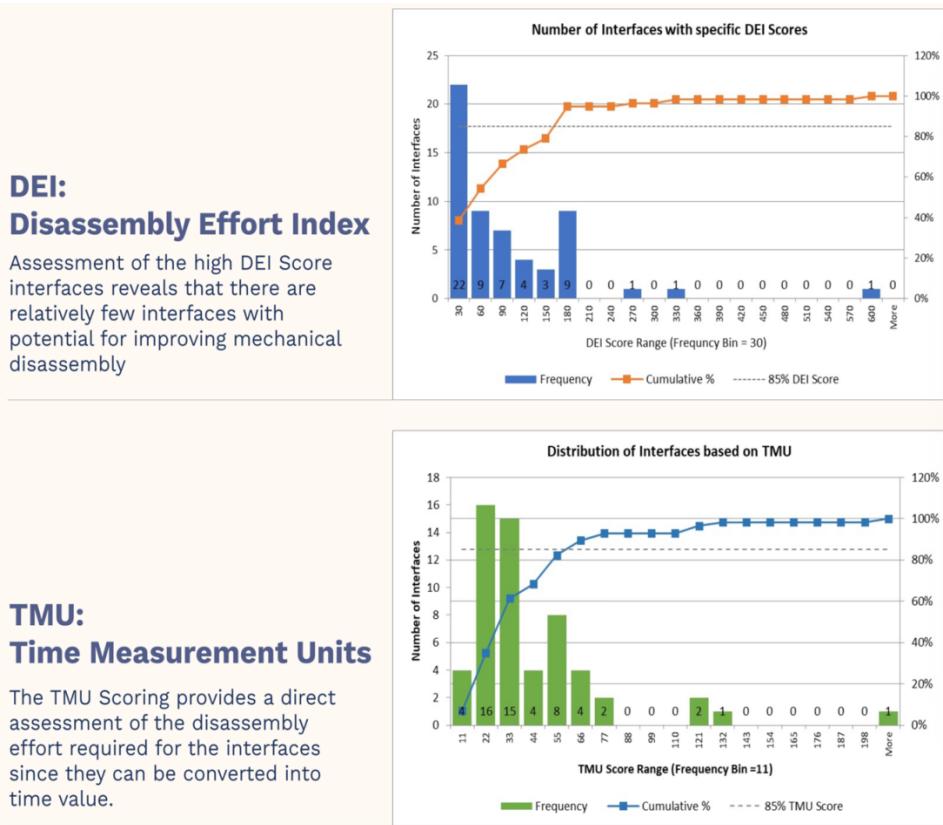
- *Disassembly architecture and sequence diagrams for the product*
- *Disassembly score for the product*
- *Key parts and subassemblies that could be redesigned based on the results*
- *Alternate disassembly sequences*
- *Cost-benefit analysis of the alternate disassembly sequences*
- *Disassembly cost comparisons considering different regions*
- *Recommended EoL strategies for disassembly and design of the product*

The analysis results can be used to redesign the product for better EoL impact. Moreover, the methodology used is robust and scalable, making it applicable to products from various industries. We have tested and validated our approach on a range of products, including electronic devices, automotive components, and household products. The DfOEP methodology is explained below in Figure 7-9.

Key highlights

<p>DfOEP Methodology</p>	<p>Disassembly Score</p>	<p>Visual Representation</p>	<p>Three-Layered Cost-Benefit Analysis</p>	<p>Geographic Influence</p>
<p>Environmental impact considerations during the embodiment design phase contributes to sustainable product design.</p>	<p>A tool that aids product designers in iteratively improving the ease of disassembly.</p>	<p>Provides a clear visual guide to the disassembly sequences of the electrical component.</p>	<p>Considers the economic and environmental costs and benefits of three key strategies: disassembly, recycling, and disposal.</p>	<p>Impact of geographical considerations on EoL strategy considered, uncovering insights into global sustainability practices.</p>

Fig. 7 Key highlights of the DfOEP methodology.



a tangible impact on communities, industries, and ecosystems. Our focus on social innovation, sustainable agricultural mechanization, assisted self-production, craft education, disaster risk management, and disassembly-oriented design underscores our commitment to an integrated approach to sustainability that encompasses social, economic, and environmental dimensions.

Our work exemplifies how innovative practices and collaborative efforts can lead to significant advancements in sustainable consumption and production (SCP). Through participatory design, community engagement, and the development of inclusive, scalable models, we are empowering communities, influencing policy, and fostering a culture of sustainability that resonates with diverse stakeholders. Our research not only contributes to the theoretical underpinnings of SCP but also demonstrates the transformative potential of social innovation in creating sustainable futures.

The SSI Lab's endeavors highlight the necessity of interdisciplinary collaboration and the importance of contextual, culturally sensitive approaches to sustainability. As we continue to explore, innovate, and implement, our research serves as a beacon for sustainable development, inspiring others to join in the collective effort to build a more sustainable, equitable, and resilient world. Through our work, we underscore the critical role of academia in driving social change and contributing to the global sustainability agenda.

The subsequent chapters in this issue present the work our researchers are doing to tackle pressing sustainability challenges.

Join us in this exciting journey!

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Aradhna Moktan, PhD Scholar.

Centre for Disaster Management for Research.

Email: m.aradhna@iitg.ac.in

I have completed my Bachelors in Geography from Loreto College, Kolkata. then perused my master from TISS Mumbai in disaster management. I have worked with the communities at the grassroot level at central tribal belt of India focusing on field work. I had the opportunity to work at with National Institute of Disaster Management (MHA) New Delhi and after 5 years of professional experience I have perused my career to join as PhD Scholar at Centre for Disaster Management and Research (IIT Guwahati)

Design for Sustainability in Disaster Risk Management

Aradhna Moktan,

PhD Scholar, Centre for Disaster Management and Research, Indian Institute of Technology, Guwahati.

Email: m.aradhna@iitg.ac.in

2.1. How is the community-based Disaster Risk Management approach a sustainable way of dealing with hazards?

Incorporating Community-Based Disaster Risk Management (CBDRM) principles into settlement planning is crucial for enhancing community resilience and readiness for disasters. Why do we think of only making the community resilient but not sustainable? Is it enough to have a community that can withstand disaster or reduce the risk of it or can we think beyond that as well? The community must become resilient but the focus should also be on the overall well-being of society so that they can flourish and sustain long-term resilience. Sustainable settlement design is a bigger picture or goal and incorporating the CBDRM principle not only helps the community to be better prepared but can see through long-term resilience. Often during a disaster, the communities are the ones devastated and facing maximum loss.

This integration ensures that settlements are better equipped to withstand and recover from various calamities. By adopting CBDRM

principles, settlements can enhance their resilience through active community engagement, implementation of risk reduction measures, promotion of social cohesion, and adoption of flexible planning strategies. This approach allows settlements to adapt to changing risks and emerge stronger in the face of disasters. Overall, integrating CBDRM principles into settlement design enables communities to better prepare for, respond to, and recover from disasters by utilizing local knowledge, implementing proactive measures, and fostering community cohesion.

This approach allows settlements to adapt to changing risks and emerge stronger in the face of disasters. Overall, integrating CBDRM principles into settlement design enables communities to better prepare for, respond to, and recover from disasters by utilizing local knowledge, implementing proactive measures, and fostering community cohesion (Nguyễn et al., 2023). The CBDRM approach presents a sustainable means of addressing disasters by emphasizing local engagement and empowerment. (Dube, 2015). Unlike hierarchical methods, CBDRM acknowledges the significance of utilizing the knowledge, assets, and bottom-up approach to decision-making. Why do we look at communities to be victims when they can be the first responders? By involving community members in all stages of disaster risk management, including readiness, reaction, and recuperation, CBDRM cultivates a sense of ownership and accountability among residents. Moreover, the people residing in the area will know about the critical condition of the place which they face in everyday life. This participatory strategy not only enhances the efficacy of disaster management endeavours but also encourages long-lasting sustainability by fostering resilience from grassroots levels (Van Niekerk et al., 2018). Additionally, CBDRM promotes the

establishment of robust social networks within communities, which play a crucial role in coordinating responses and offering mutual aid during emergencies. The residents will also know about the shortcut roads, road map, and whereabouts of the area which can be very helpful during an emergency. Overall, CBDRM emerges as a sustainable approach to mitigating disaster risks by harnessing local strengths, nurturing community cohesion, and advocating self-reliance in challenging circumstances. In Thailand, there is a rampant growth of Community-based disaster management organizations tackling urban floods in the vulnerable community.

Fig. 10 Disaster Management Cycle consist of four phase (i)Mitigation phase (ii)Preparedness (iii)Relief (iv) Response, which is divided into Pre-Disaster management phase and Post Disaster Management Phase.

Here are some examples illustrating how CBDRM is practiced:

- 1. In South East Europe, it focuses on safeguarding critical medical infrastructure.***
- 2. In New Zealand indigenous knowledge/practices for community-owned DRM strategies are practiced.***
- 3. Nepal's CBDRM includes awareness raising, climate data use, and specialized training.***
- 4. Georgia employs participatory methods for assessing vulnerabilities and responding to debris flow hazards.***
- 5. The Philippines utilizes CBDRM as a community organizing tool to mitigate flood and landslide damages.***
- 6. In South Africa's informal urban areas, CBDRM follows a collaborative risk governance model.***

- 7. Community participation was pivotal in the reconstruction efforts following the Gujarat earthquake of 2001 (Samaddar, 2016)**
- 8. In Orissa, community-based early warning systems were established, proving effective during subsequent cyclones (Parida et al., 2021)**
- 9. Local communities (fisherperson and boatperson) played a vital role in rescue and relief operations during the Kerala floods of 2018 (Joseph et al., 2020)**

These examples demonstrate diverse ways in which CBDRM is practiced at different geographical location. CBDRM takes on various forms worldwide, adapting to the specific circumstances and needs of different area. Therefore integrating Sustainable Settlement Design with focus on reducing the risk of disaster through community interventions.

2.1.1. Conceptually Similar Terminologies

There are other terms may resemble CBDRM in ideology and are sometimes interchangeable, but they possess unique characteristics. These concepts all aim to engage local communities in disaster risk management, but they vary in their emphasis, scope, and the nature of their activities.

- 1. Community-Based Disaster Risk Reduction (CBDRR):**
Aims to reduce the impact of disasters on communities' lives and livelihoods.

- 2. Community-Based Disaster Preparedness (CBDP):** Primarily concerned with developing emergency plans, conducting drills, and providing training.
- 3. Community-Based Vulnerability Assessment (CBVA):** Focuses on assessing community vulnerabilities to hazards.
- 4. Community-Based Adaptation (CBA):** Empowers communities to take action using their own knowledge to increase resilience to climate change.
- 5. Community Resilience Framework:** Aims to enhance communities' ability to adapt to new situations and recover quickly from disasters.
- 6. Local Disaster Risk Reduction (LDRR):** Focuses on building resilience and capacity to recover from disasters with minimal external assistance

2.2. CBDRM - A Bottom-up Approach

A bottom-up approach is often seen as more sustainable due to several factors. This method prioritizes local ownership and empowerment, fostering community responsibility and long-term commitment. Especially in rural India institutions at grassroots like panchayat, self-help groups, mahila mandal, and farmer producer organizations have played a very important role in decision-making and social reform. Customized solutions tailored to the specific needs and contexts of each community increase effectiveness and relevance. By utilizing local resources and knowledge, interventions become integrated into existing community systems, reducing dependence on external aid (Tanwattana, 2018). Additionally,

focusing on internal resilience building strengthens social networks, fosters cooperation, and enhances local capacities for future challenges. The inherent adaptability and flexibility of bottom-up approaches allow communities to continuously evaluate and adjust strategies in response to changing circumstances, further enhancing their sustainability and effectiveness in addressing complex issues (Osti & Miyake, 2011)

One of the key strengths of the bottom-up approach lies in its ability to tailor solutions to the specific circumstances of individual communities. By recognizing and leveraging local resources, knowledge, and cultural norms, interventions are not only more effective but also more relevant and sustainable in the long term. This integration of local assets not only reduces dependency on external aid but also fosters a sense of self-reliance and resilience within the community (James & Paul, n.d.). In Iran, school drills have been the most relevant method of awareness generation of earthquakes in the context of school safety resilient communities.

Moreover, the bottom-up approach facilitates the strengthening of social networks and the promotion of cooperation within communities. By focusing on internal resilience-building measures, such as community capacity building and the establishment of support networks, this approach enhances the community's ability to withstand and recover from challenges (Pal et al., 2021). These strengthened social ties not only facilitate more effective responses to disasters but also contribute to the overall well-being and cohesion of the community. In Honduras, community-based soil-bioengineering techniques are used for the effective mitigation of soil erosion and shallow landslide.

Furthermore, the inherent adaptability and flexibility of bottom-up approaches equip communities with the capacity to respond dynamically to changing circumstances (Ceptureanu & Ceptureanu, 2019). This agility allows for continuous evaluation and adjustment of strategies, ensuring that responses remain relevant and effective in the face of evolving challenges. Ultimately, these characteristics enhance the sustainability and effectiveness of bottom-up approaches in addressing complex issues, including disaster management, by fostering local empowerment, resilience, and adaptability.

2.3. Dimension of Sustainability on social, economic, environmental, multi-dimensional Resilience

CBDRM encompasses multiple dimensions including social, economic, environmental, and governance aspects. Social resilience, characterized by community involvement and local knowledge, is consistently highlighted. Economic resilience often involves resource allocation and long-term planning, while environmental resilience focuses on risk assessment and sustainable land management. Governance, crucial for effective management, underscores the importance of local institutions and stronger frameworks. Papers increasingly recognize the interconnectedness of these dimensions. Future efforts to enhance resilience prioritize technological advancements, financial stability, and social well-being.

- *Social resilience is emphasized, highlighting community involvement, awareness, and local knowledge.*
- *Economic resilience is linked to resource allocation and long-term planning.*
- *Environmental resilience focuses on risk mapping and*

sustainable land use.

- *Governance is crucial, with emphasis on local institutions and institutional frameworks.*
- *There's a trend towards recognizing the interconnectedness of different sustainability dimensions.*
- *Future resilience efforts prioritize technological advancements, financial stability, and social sustainability.*

Social capital and local institutions play vital roles in enhancing disaster preparedness, response, and recovery capacity within communities. Social capital, which encompasses the networks, relationships, and trust among community members, forms the bedrock for effective disaster management(Bhandari, 2014). These social connections facilitate communication, coordination, and cooperation during all stages of a disaster, enabling communities to mobilize resources and provide mutual aid in times of need, thus bolstering resilience. Poor communities have strong mechanisms to manage disaster such as windward island communities they have been able to put forward the efforts to address Disaster Risk Reduction.(Partelow, 2021).

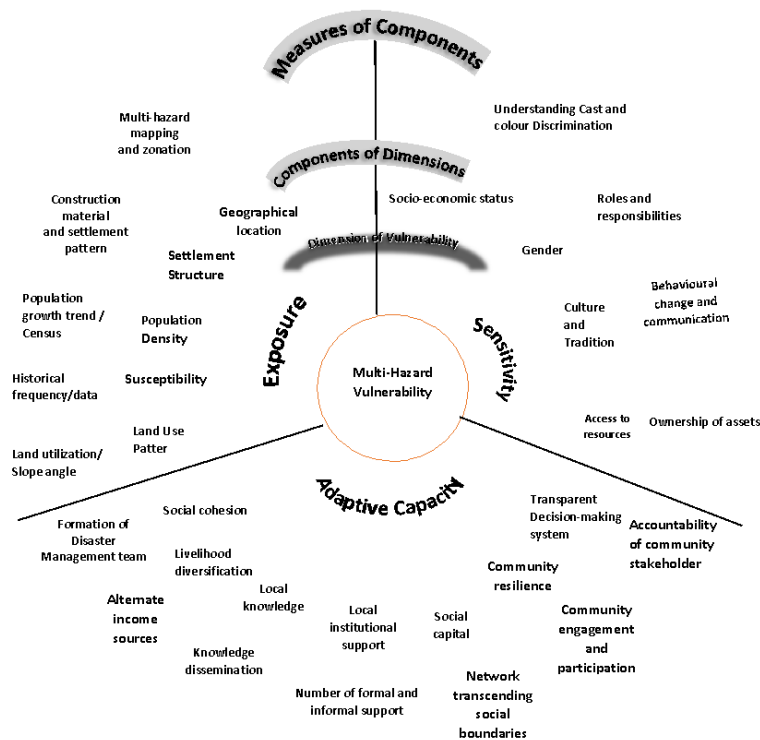


Fig. 11 The Vulnerability Scoping Diagram (VSD) is a conceptual framework that breaks down vulnerability into three main dimensions: exposure, sensitivity, and adaptive capacity. It also outlines the specific elements within each dimension.

2.4. Capacity building in CBDMR

Local institutions, including community groups, governmental bodies, and non-governmental organizations (NGOs), contribute significantly to capacity building in disaster management. (Abarquez Imelda & Murshed Zubair, 2008) With their intimate knowledge of local dynamics, these institutions develop tailored strategies for disaster risk reduction and response. Additionally, they serve as conduits for information dissemination, implementation of preparedness measures, and coordination of response efforts, providing essential guidance and support during emergencies. In Australia project led by a community called "Be Ready Warrandyte" to control bushfires

where the community was able to develop tools and resources more safely to reduce the risk.

2.5. Social capital in CBDRM

In concert, social capital and local institutions synergize to strengthen community resilience to disasters. Social capital fosters trust and collaboration among community members, while local institutions provide the organizational structure and resources necessary to translate these social connections into effective actions (Behera, 2023). By harnessing the power of social capital and leveraging the capacities of local institutions, communities can navigate disasters more effectively, mitigate risks, and facilitate coordinated responses, ultimately enhancing their overall resilience to future hazards (R. Shaw (Eds.) L. William, 2012). The main agenda of CBDRM is to transform vulnerable communities into resilient communities for the long term. The Kerala floods of 2018 are a classic example of a community resilience mechanism where the majority of the respondents who participated in the rescue activities were fisherperson and boatpersons.

2.6. Conclusion

The integration of Design for Sustainability (DfS) studies within Disaster Risk Management (DRM) offers a comprehensive approach, blending environmental, economic, and social dimensions to fortify infrastructure and communities against disasters. DfS prioritizes the development of systems, processes, and products that meet current needs while safeguarding resources for future generations, thus enhancing resilience to disasters. Recognizing the significance of this holistic approach, initiatives like CBDRM have emerged, emphasizing community participation and empowerment in disaster risk reduction

endeavors. Moving forward, continued investment in research, exemplified by endeavors at the Centre for Disaster Management and Research (CDMR) at IIT Guwahati, will be pivotal in advancing sustainable practices in disaster management. Through collaborative efforts and engagement across sectors, we can collectively strive toward creating more resilient and sustainable communities capable of confronting the challenges of the future.

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Pankaj Kavidayal

PhD Scholar, Centre for Disaster Management and Research, Indian Institute of Technology, Guwahati.

Email: p.kavidayal@iitg.ac.in

I am core Border Security Force Officer. I have successfully served in various capacities in extremely inhospitable and sensitive segments of International Border with Pakistan & Bangladesh, LoC and Internal Security duties in different parts of the Country. I joined the NDRF on deputation in 2020.

As Second in Command in the National Disaster Response Force stationed in Guwahati. I have dedicated 24 years of unblemished service, and have been awarded Police Medal for Meritorious Service, by President of India. I am currently pursuing a PhD in Disaster Management from the Centre of Disaster Management and Research at IIT Guwahati.

I have supervised disaster responses during significant incidents such as the coal mine incident in Krem Ule Village (Meghalaya), the boat capsizing in river Brahmaputra at Nimatighat (Jorhat), and a massive landslide in Tupul (Manipur).

Additionally, I have contributed to community capacity building through Community-Based Disaster Risk Reduction (CBDRR) techniques, including the creation of trained disaster response teams and conducting mock exercises. I have collaborated with various authorities and organizations to introduce new initiatives such as early warning alert systems to mitigate disaster impacts.

Gender-sensitive approach to Disaster Risk Reduction

Pankaj Kavidayal

PhD Scholar, Centre for Disaster Management and Research, Indian Institute of Technology, Guwahati.

Email: p.kavidayal@iitg.ac.in

3.1. Introduction

Gender refers to the societal expectations and norms regarding the roles, behaviours, and attributes deemed appropriate for individuals based on their assigned sex at birth. (José Antonio Gutierrez & Gibbons, 2020). Recognizing the gender dynamics and implications of natural disasters and climate change is essential for effective disaster risk management, enabling communities and nations to build resilience. It's important to acknowledge that not all women, men, girls, and boys experience disasters and climate change impacts in the same way; differences exist within and between these groups, including individuals with disabilities, minorities, indigenous populations, the elderly, those with chronic illnesses, unaccompanied children, households headed by children or women, and widows (Lewis, 2016).

Gender perspectives provide valuable insights into various aspects of human life, including disaster preparedness and response (Valdes et al, 2009). In the past, women were often overlooked or portrayed solely as victims in disaster scenarios. Women are considered to be vulnerable, meek, shy and weaker section of society. However, recent

research highlights the unique abilities and advantages of women in disaster situations. Women tend to have a higher level of risk perception and maintain stronger community networks, enabling them to play a significant role in caring for victims and contributing to post-disaster recovery efforts (Yadav et al, 2021).

It is often assumed that gender studies are linked with female, concentrating primarily on female roles whereas the focus on male contribution are often terms as gender neutral information. Instead of assuming sensitive approach to gender analysis, we emphasis on relationship between "masculinity" and "femininity". Masculinity is a social construct necessarily related to notions of femininities and to often marginalised masculinities.

While men's contributions to disaster management may span various scales, including institutional and systemic levels, women's contributions are often observed at the community level. (Maobe, 2021) Despite recommendations from several studies, women in patriarchal societies are frequently viewed as assistants rather than leaders in disaster management tasks. Gender issues related to community-based disaster prevention are of concern in both less developed and developed countries. In less developed countries, women's input is crucial due to insufficient disaster prevention infrastructure, while in developed countries, there is a focus on gender mainstreaming and equality in disaster prevention efforts (Mehta, 2007).

3.2. What is a gender-responsive approach to DRR planning?

A gender-sensitive approach to Disaster Risk Reduction (DRR) planning entails incorporating gender-based disparities and concerns

into the formulation of policies, strategies, plans, or programs, while actively promoting gender equality during their execution (Parkinson et al, 2018). Essentially, this involves conducting a thorough assessment of disaster risks that takes into account the influence of gender norms, roles, and inequalities on the vulnerability and resilience of individuals, both male and female (Tarnaala, 2016). Through gender analysis, a deeper insight is gained into the activities, assets, needs, and priorities of men and women, as well as the prevailing power dynamics.

Taking into account the distinct needs and priorities of men, women, boys, and girls when formulating Disaster Risk Reduction (DRR) policies, plans, and programs is not only aligned with human rights principles but also makes economic sense (Lewis, 2016). So addressing gender inequalities and empowering women, DRR interventions can effectively meet the needs of both genders? This is a question to look upon. Moreover, adopting a gender-responsive approach offers a chance to enhance the pre-disaster environment by bolstering the capacities of men and women to mitigate risks and fostering more equitable social dynamics(Valdes et al, 2009). Ultimately, this approach can contribute to agricultural, economic, and social development.

It is important to ensure a gender-responsive approach in DRR processes and crucial to acknowledge the inherent social dimension of risk and vulnerability (Ciampi et al, 2011). This involves recognizing that men and women have different approach and perspectives regarding specific natural hazards, which should inform all activities related to DRR planning. Allocating resources within the planning budget to hire gender experts and to collect, analyze, and utilize sex-disaggregated data is essential (Smyth, 2012). Moreover,

efforts should be made to enhance the capacity of DRR practitioner in addressing gender equality through comprehensive training (Kadir,2021).

3.3. Gender Mainstreaming in Disaster Risk Management

Ensuring gender equality is integrated into the guiding principles of the DRR plan or policy involves committing to including women and men, particularly from marginalized socio-economic groups, in decision-making processes and action implementation (Kaur, 2020). It requires making a dedicated commitment to reducing the gender gap and empowering women by outlining specific actions to meet the diverse priorities of women and men in disaster response. Additionally, incorporating the vision of achieving equality between men and women of different ages to enhance their resilience within the plan is essential (Ginige et al., 2014). Addressing the needs of women and men within strategic actions involves involving women in local Disaster Risk Management (DRM) committees and related training to improve their access to early warning messages. Identifying stakeholders representing the perspectives of rural women and minority groups in institutional mechanisms for DRR planning and implementation is crucial (Kaur, 2020). Developing new agricultural practices through consultation with target communities to integrate local knowledge and cater to the specific needs of women and men to access resources, assets, and knowledge successfully is necessary. Considering the time use and existing workloads of men and women to prevent additional burdens, especially for women, is vital (Ginige et al, 2014). Designing gender-responsive measures to ensure that hard-to-reach groups, such as women and youth heads of households, have access to preparedness initiatives is imperative. Ensuring that gender-related work is part of the DRR Implementation

plan involves defining responsibilities for integrating gender issues into DRR activities, including gender specialists in teams or committees, monitoring progress with gender-sensitive indicators, allocating separate budget lines for gender-related actions, identifying gender-responsive communication methods, and conducting case studies to document the beneficiaries and identify good practices for future scaling.

For instance, in Sweden, even though the country is known for its high degree of gender equality awareness, female volunteers faced criticism when performing tasks traditionally assigned to men during disaster relief efforts. In Taiwan, despite significant progress in disaster prevention infrastructure development, there are still challenges related to insufficient resources for disaster prevention and relief. While Taiwan has actively promoted Community-Based Disaster Risk Management (CBDRM), gender issues are often overlooked by CBDRM professionals due to the country's high level of gender equality. (Gomes, 2020).

In the aftermath of disasters, the focus shifts towards restoration and reconstruction efforts. However, there is a noticeable lack of attention given to hygiene interventions, particularly Menstrual Hygiene Management (MHM). Post-disaster research and documentation on MHM are scarce, leaving a gap in effectively addressing women's needs during recovery. (Nawaz et al.2010) argue that inclusive approaches to Water, Sanitation, and Hygiene (WASH) programming are essential for addressing menstrual hygiene needs for women and adolescent girls. They suggest that empowering women through interventions such as water provision, water quality improvement, and hygiene promotion can be achieved by prioritizing women and girls' menstrual needs and preferences in response strategies.

(Atuyambe et al .2011) emphasize the importance of considering the safety concerns of women and girls during emergency sanitation interventions, as females typically manage water, safeguard water quality, and maintain domestic hygiene. Parker et al. (2014) observed a lack of consultation with women and girls regarding their menstrual needs in internally displaced people camps, neighbouring villages, and schools in the Katakwi district of Uganda, which resulted in poor MHM practices among them.

While disasters themselves do not discriminate based on gender, their impacts and subsequent recovery processes display significant gender disparities. It is widely acknowledged that men and women experience disasters differently, and existing gender dynamics heavily influence their ability to withstand and recover from these events. Gender inequalities often lead to disparate impacts of disasters, with women facing additional hurdles in accessing resources and support during both immediate relief efforts and long-term rehabilitation. (Davies, 2019; Gomes, 2020) Societal norms, such as the denial of women's property rights and limited participation in decision-making processes, exacerbate these challenges, contributing to their disproportionate vulnerability to disaster impacts. Women's roles in reproductive, productive, and community management work further compound the effects of disasters, often leading to increased burdens and hindered recovery efforts.

Despite these barriers, it is crucial to shift the narrative from viewing women solely as victims to recognizing their active and essential role in disaster preparedness, response, and recovery. Formalizing and acknowledging women's participation in these efforts can yield positive outcomes not only for disaster resilience but also for

advancing gender equality within communities.(Thorlund, 2009) Policy and program design must incorporate a nuanced understanding of gender dynamics in disaster risk and resilience, with a focus on developing gender-inclusive approaches to post-disaster recovery and resilience building. This entails not only addressing immediate needs but also integrating resilience building into broader economic planning processes, particularly concerning livelihoods for women.(Eger et al, 2018) Establishing national frameworks for gender-inclusive disaster recovery and resilience building is imperative to ensure comprehensive and effective disaster preparedness and response efforts. Disasters also present opportunities for promoting gender equality and institutionalizing inclusive practices, such as developing gender action plans led by women and enhancing women's leadership roles in recovery and resilience initiatives.

3.4. Intersectional approaches to Disaster Risk Reduction

Disaster researchers, policymakers, and practitioners are increasingly recognizing the imperative to comprehend and address the disparities experienced by various individuals and groups before, during, and after disasters. This necessitates collaborative efforts aimed at deliberate and systemic change. (Lee et al., 2022) Intersectional approaches are instrumental in scrutinizing and challenging discriminatory practices that disproportionately affect historically marginalized populations in disaster contexts. Intersectionality emphasizes the interconnectedness of different forms of privilege, power, and oppression, which contribute to unequal socioeconomic outcomes based on individuals' identities and circumstances. These approaches offer multifaceted benefits in disaster studies, revealing systemic patterns of vulnerability and resilience.(José Antonio

Gutierrez & Gibbons, 2020) However, their full potential remains largely untapped, with issues such as oversimplification, uneven focus on specific intersections, and dominance of Western perspectives needing attention to address the complex interplay of privilege, power, and oppression shaping disparate disaster experiences and outcomes.

The existing literature on disaster research often portrays women as being at a relative disadvantage compared to men. Women tend to have lower socioeconomic status and higher social vulnerability, leading to more severe consequences when disasters occur. (Yadav et al., 2021)They are disproportionately affected by disasters, with higher mortality rates and increased risks of sexual assault and violence, particularly in shelters. Women with additional disadvantaged statuses, such as disabilities, immigrants, ethnic minorities, and elderly individuals in poverty, are among the most vulnerable populations, and disasters exacerbate their vulnerability. (Maobe, 2021) While some studies have focused on the health status of pregnant women during disasters, others have highlighted the reliance of women displaced by disasters on sex work to support their families.

The differentiation of gender roles throughout the disaster process is attributed to various factors such as parenting responsibilities, poverty, social networks, traditional roles, and discrimination. (Mehta, 2007)However, women also demonstrate strengths and advantages in disaster management, particularly in mitigation, preparedness, response, and recovery stages. They exhibit high risk perception and willingness to evacuate, emphasizing the need for gender-sensitive frameworks in disaster response. Women are considered resilient after disasters and are recognized as core

partners and leaders in disaster risk reduction efforts. Empowering women in disaster decision-making has been shown to effectively reduce vulnerability (Parkinson et al., 2018).

Despite their resilience, women experience gender-related vulnerabilities and face additional responsibilities during disasters, which often impact their mental and physical health. While there is a growing literature on women and disasters, there are still gaps in understanding due to the complexity of the context. Further exploration and understanding of the situation of women in disasters, along with the inclusion and clarification of gender issues in disaster research, will contribute to a more comprehensive understanding of risks and disasters in society. Gender plays a complex role in determining vulnerability and resilience to disasters. Disasters disproportionately affect the poorest communities, with marginalized and discriminated individuals and groups facing the greatest vulnerability. (Ciampi et al., 2011b) Gender intersects with other structural vulnerabilities, such as ethnicity, race, disability, age, and social status, shaping individuals' experiences throughout their life cycle. Women, in particular, are often more vulnerable, facing higher risks of mortality and receiving less aid compared to men. This vulnerability is exacerbated by existing inequalities, with women in many countries being more likely to experience poverty, landlessness, and malnutrition (Lewis, 2016).

During disasters, women often bear significant responsibilities for household and family care, including providing food, water, and emotional support. Cultural norms may restrict women's mobility and access to information and support services, contributing to their increased risk of mortality (Valdes et al., 2009). In the aftermath of disasters, women may be left to rebuild their lives as sole providers

for their families, facing challenges such as food insecurity and increased violence against women. Young girls are particularly vulnerable to disruptions in education, forced marriages, and trafficking (Ciampi et al., 2011a).

Despite their vulnerabilities, women also demonstrate resilience in the face of disasters. They play active roles in creating community cohesion, organizing communal activities, establishing support networks, and advocating for their communities' needs (Zaidi & Fordham, 2021). However, post-disaster responses often inadvertently reinforce gender inequalities by prioritizing resources for male-headed households, ignoring women's small businesses, and excluding women from decision-making processes. It is essential for post-disaster activities to empower women and challenge the constraints they face, promoting their resilience and adaptive capacity (Kaur, 2020)

3.5. Conclusion

Gender refers to the societal expectations and norms regarding the roles, behaviours, and attributes deemed appropriate for individuals based on their assigned sex at birth. Recognizing the gender dynamics and implications of natural disasters and climate change is essential for effective disaster risk management, enabling communities and nations to build resilience (José Antonio Gutierrez & Gibbons, 2020). It's important to acknowledge that not all women, men, girls, and boys experience disasters and climate change impacts in the same way; differences exist within and between these groups, including individuals with disabilities, minorities, indigenous populations, the elderly, those with chronic illnesses, unaccompanied children, households headed by children or women, and widows. These

differences are influenced by various factors such as social, economic, and ethnic backgrounds.

The concept of women actively engaging in DRR is relatively recent, contrasting with the traditional approach of viewing women solely as a vulnerable group. Despite some successful examples, efforts to enable women's active participation in DRM remain scarce and fragmented (Erbaydar et al., 2021). Sustainability of such initiatives largely relies on broader engagement from governance institutions beyond the DRM sector.

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Ankit Basak

PhD Scholar, Department of Design, IIT Guwahati

Email: basak.ankit18@gmail.com

I am a research scholar in the Sustainability and Social Innovation Lab within the Department of Design at the prestigious Indian Institute of Technology Guwahati. My academic journey started with a Bachelor's degree in Design from IIITDM Jabalpur, where I honed my foundational skills and passion for product design. Building upon this foundation, I pursued a Master's degree in Design from Tezpur University in Assam, where I deepened my understanding of design principles and their applications and grew interest in research. Currently, my research focuses on product design for social innovation.

Big Fish in Small Pond: Social Innovation in the Context of Fish Farming

Ankit Basak

PhD Scholar, Department of Design, Indian Institute of Technology Guwahati

Email: basak.ankit18@gmail.com

Abstract: Fishes have long been recognised as a vital source of nutrition, prompting the growth of fish farming, particularly in recent decades. However, despite technological advancements improving various aspects of the industry, there remains a notable gap in addressing the needs of the fishermen community, both internationally and within the Indian context. This paper highlights the challenges faced by fish farmers, ranging from disease management to environmental sustainability while emphasising the lack of attention given to the welfare and empowerment of fishermen. Drawing from existing literature and field study, the importance of social innovation in effectively addressing these unmet needs has been underscored. The article highlights different issues the fisherman community faces and presents a systems map of the fishery. The article informs that the social aspect has been overlooked. In this context, social innovation is characterised by novel and collaborative approaches to solving challenges faced by the fishing community, offering promising avenues for enhancing the sustainability and profitability of fish farming while prioritising the well-being of fishermen. By integrating social innovation into the fish farming sector, stakeholders can foster inclusive solutions that

leverage local knowledge and promote community empowerment. This paper advocates the need for a shift towards holistic approaches that prioritise social impact alongside economic gains in pursuing a more sustainable and equitable fish farming industry.

Keywords: *Social Innovation, Sustainable production, aquaculture*

4.1. Introduction

Fishes are a good source of high-quality protein, essential fatty acids, vitamins, and minerals. It is also low in saturated fat, making it a nutritious food choice for maintaining a healthy diet. Hence, it has been a significant source of protein in many people's diets, and the practice of Fish farming can be dated back thousands of years (Nash, 2011). In the last few decades, it has been the fastest-growing sector in agriculture when seen at an international level. The industry is more diverse regarding feeds, produce, business models, diseases and issues (FAO, 2016). Fisheries have been the slowest adopters of the technology, but people have realised that the technology can help develop sustainable and profitable opportunities (Yue & Shen, 2022). Over time, Technological Advancements have been utilised to solve some of the issues tackled by the fish-farming industry, such as drones used for monitoring purposes of cages (Sousa et al., 2019), sensors to collect data for pollutant concentration, pH values, salinity, etc. (Su et al.)(xing et al.). Apart from these, it can be noted that significant work has been done in the field of disease control (Adams, 2019)(Fuji et al., 2007)(Gudding & Muiswinkel, 2013), production (Gratacap et al., 2019) while some researchers have some light on the equipment (Chu, 2020). These contributions to the fish farming industry have significantly improved the field, especially in the last 50

years. However, despite these improvements, prior research has also reported that there is still considerable scope for making the sector more sustainable and profitable (FAO, 2016) (Yue & Shen, 2022). While the research domain has focussed on the engineering and production of fish and the conservation of species, there has been a dearth of research addressing the issues of the fishermen community. Within the context of social innovation, the different issues of fishermen directly or indirectly impact society. The social aspect has been overlooked in the context of fish farming, and hence, addressing the issues faced by the fishermen would ultimately lead to sustainable production in this domain.

4.2. Literature

Several studies have highlighted the challenges fish farmers face, including the lack of information on fish diseases due to various factors, such as the absence of diagnostic infrastructure, the high cost of diagnosis, and the lack of well-equipped veterinary laboratories (Opiyo et al., 2018). Additionally, the lack of technical knowledge, poor quality fingerlings, and fish feed have been identified as significant issues affecting the fish industry (Subedi & Shrestha, 2020). Furthermore, infectious diseases have been recognised as significant constraints to aquaculture and a limiting factor for the economic and socioeconomic development of fish farmers in various countries (John et al., 2023). Moreover, the adoption of improved aquaculture technologies among fish farmers has been studied, revealing that the choice of farming as a secondary occupation, particularly crop production, presents a dynamic in adopting these technologies (Olaoye et al., 2016). The study also emphasises the importance of training and knowledge dissemination among fish

farmers, as a lack of training in aquaculture has been identified as a significant constraint (Mithun et al., 2021).

Furthermore, assistance and training services for fish farmers have been recognised as a strength in the organisation of the aquaculture sector in certain regions, indicating the potential for more rapid dissemination of scientific research results among fish producers (Kristanto et al., 2019). In addition to these challenges, the issue of sustainability and profitability of aquaculture has been addressed, with studies highlighting the susceptibility of the aquaculture sector to financial perils that favour the loss of investment among fish farmers (Mensah et al., 2021). Furthermore, the environmental problems associated with fish farming, such as pollution and genetic contamination of wild stocks, have been identified as severe issues that must be addressed (Honkanen & Olsen, 2009).

India has 1.95 lakh km of rivers and canals, 7.95 lakh hectares of floodplains and wetlands, 24.33 lakh hectares of freshwater ponds and tanks, 29.26 lakh hectares of reservoirs and 11.55 lakh hectares of brackish water ponds. After China, India is the second largest fish producer in the world (Lakra & Gopalakrishnan, 2021; Elkaradawy et al., 2021), making India an appropriate place for fish farming. However, the research in Indian aquaculture has focused chiefly on fish diseases, integrated farming, bacterial diseases, and fish production. Similar to the international scenario, in the Indian context, there is a dearth of data on the different stakeholders involved in the culture. This significant difference between the attention given to increasing fish production and the disregard for the needs of fishermen highlights an essential problem in discussions about fish farming. While it is crucial to maximise fish output for

economic reasons, focusing on the health and success of the fishermen who work hard to sustain the industry is just as important. It was observed in the literature that the context from the perspective of the fishermen's community has been explored less, hence providing scope for making the context of fish farming more sustainable. A field study was planned in and around Guwahati City to cross-check the issues found in the literature and explore further problems for the fishermen. In the further sections the article presents a systems map of the fishery and highlights few problems faced by the community.

4.3. Methodology

Through secondary research, it became evident that multiple stakeholders influence the workings of the fisheries, particularly when it comes to maintaining the fish farms. The double diamond design process (Figure 12) was utilised as the methodology (Council, 2016). It is a widely recognised design approach that consists of four stages: discover, define, develop, and deliver. The first diamond, discover and define, involves understanding the problem and its context, gathering relevant information, and defining the problem statement. The second diamond, develop and deliver, focuses on generating and developing solutions, prototyping, testing, and delivering the final product. This methodology was deemed appropriate for this project because it is a user-centred design process that prioritises understanding the users' and stakeholders' needs and wants. Additionally, it is a flexible methodology that allows for iteration and refinement throughout the design process to ensure that the final product meets the desired specifications and requirements.

Definition

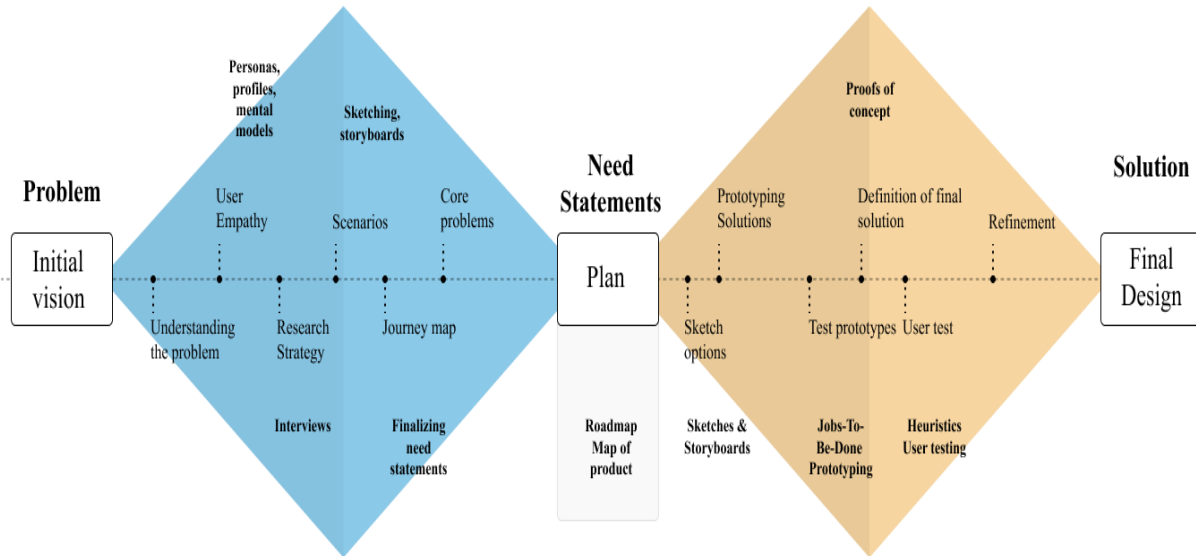
Strategy and planning. Why? How?

Execution

The goal is to offer an optimal solution. What?

Iteration

Iterative testing and learning



Discover

Research and Observation, Insight into the Problem

Define

Synthesis and Problem Definition, Explore Define, Scope down the Focus

Design

Ideation and Design, Develop Test, Potential Solution

Deliver

Implementation and Measurement, Deliver Listen, Solutions that Work & Receive Feedback

Fig. 12 Methodology

By thoroughly examining existing literature, industry practices, and expert insights, this research sought to provide valuable insights and recommendations for the context of Fisheries. The data for this research was collected from various fish farms and other related contexts located in and around Amingaon, Hajo and Panjabari. A

combination of data collection methods was employed to ensure a comprehensive understanding of the workings of fish farms.

4.3.1. Direct Observation for Design Research

Direct observation collected first-hand information about the live fish transportation process (Marshall & Rossman, 2014). Researchers visited the selected fish farms and closely observed the activities, including feeding, cleaning, use of tools, and testing practices. This approach allowed for an in-depth understanding of the existing transportation system, potential challenges, and areas for improvement. Observational data included transport container types, water quality management, stocking densities, and overall operational procedures.

4.3.2. Contextual Inquiry for Design Research

In addition to direct observation, Contextual inquiry was utilised to gain insights into the practical aspects of live fish transportation within the Guwahati context (Holtzblatt et al., 2004). Researchers engaged with various stakeholders involved in the process, including fish farm owners, transporters, and fishermen. These interactions involved in-depth discussions and interviews while they were performing the task, allowing for a deeper understanding of the stakeholders' challenges, requirements, and perspectives. Contextual inquiry provided valuable information regarding the local environmental conditions, logistical constraints, and specific issues related to fish fingerling transportation in Guwahati.

4.3.3. Interviews

Interviews were conducted with stakeholders to gather their expertise and opinions regarding live fish transportation (Kvale &

Brinkmann, 2009). Stakeholders included fish farm owners, transporters, government officials, and researchers with experience in aquaculture and fisheries. Structured interviews were designed to explore their knowledge, experiences, and insights on working in a fish farm, including required infrastructure, technology, best practices, and regulatory considerations.

4.4. Insights

It was identified that most of the work is done by the fishermen or labourers working in the fish farms while the final decision is taken by the owner, which is in line with the information found from the secondary data. The contextual enquiry also helped to understand the fishery system, the flow of information among the users, the flow of finances, the flow of matter, and where the stakeholders are providing physical effort.

Interviews were conducted with the different stakeholders gov, government officials, and scientists in Dispur. The interviews were then transcribed, and an affinity map was created. Once the affinity map was created, it was realised that a few other points were left unanswered, especially points concerning management and finance; hence, a second round of interviews was conducted to understand those points, and the affinity was updated with the new data.

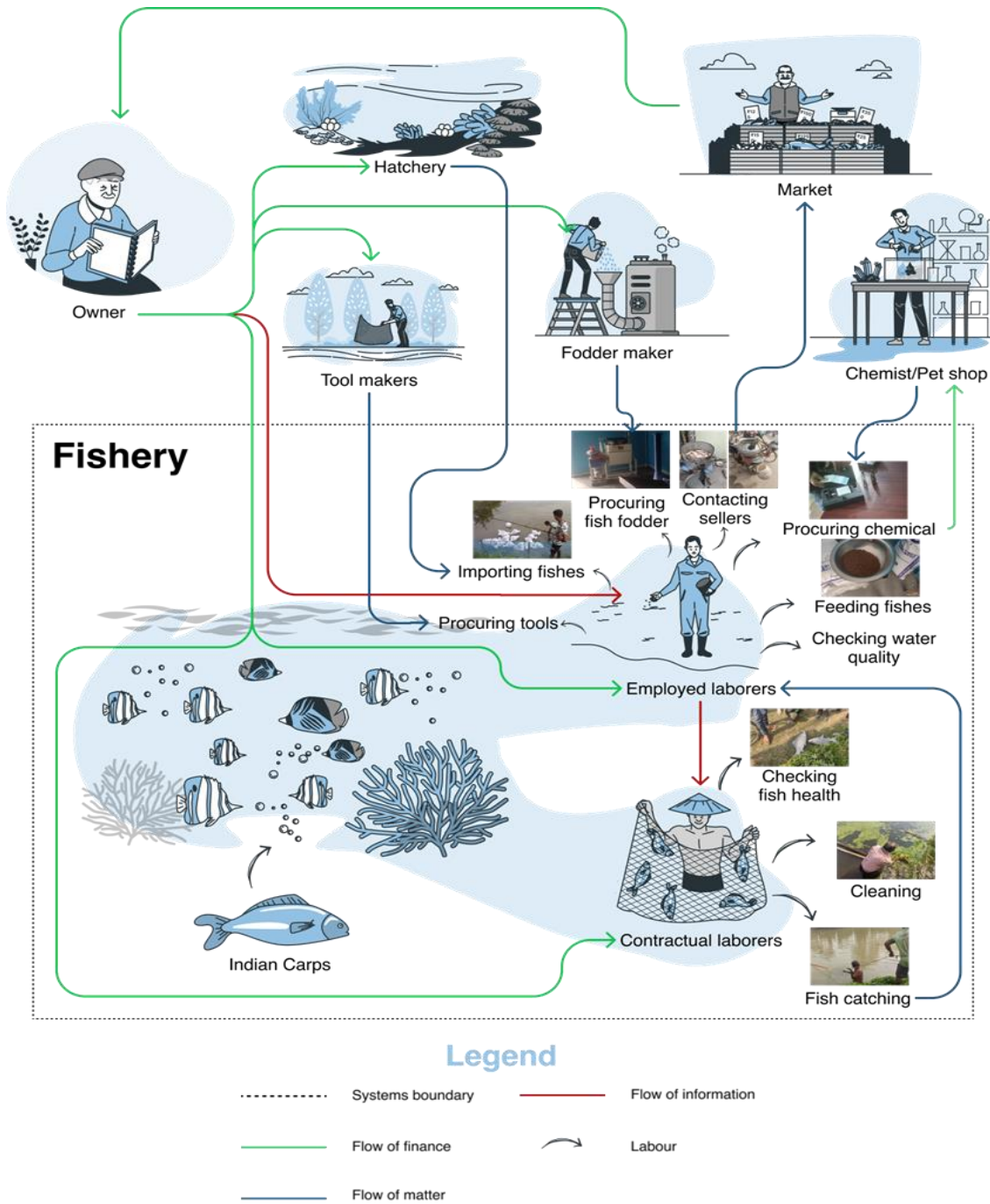


Fig. 13 System map of fisheries

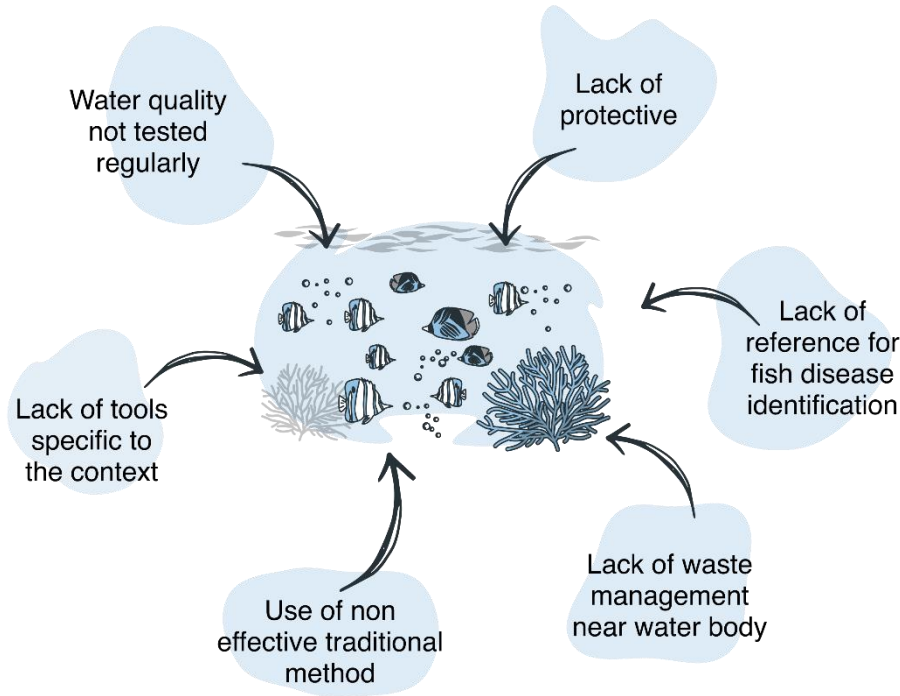


Fig. 14 Design opportunity in the domain fish-farming

4.5. Discussion and conclusion

It is evident from the problems found in the literature that the context is required to solve the unmet needs of the fishermen community. Hence, to solve the problems, social innovation would prove advantageous for society. In this context, social innovation from the design perspective will involve developing product design solutions that are economically viable and socially impactful and fostering positive change within communities. Social innovation here will emphasise collaboration, co-creation, and participatory approaches involving designers and community members.

Integrating social innovation into fish farming would not only meet the urgent requirements of fishermen but also cultivate a spirit of teamwork and empowerment among community members. When fishermen actively participate in crafting solutions, social innovators

tap into their local wisdom and skills, resulting in strategies that not only work well but also align with the community's values and endure over time.

This article advocates for a shift towards addressing fishermen's issues through the lenses of sociology and social innovation for sustainable production. This perspective would acknowledge the interconnectedness between social structures, cultural norms, and economic dynamics within fishing communities. By adopting a sociological approach, researchers and designers would gain insights into the underlying social factors influencing fishermen's livelihoods and well-being, thus enabling more holistic and sustainable interventions. Furthermore, by incorporating social innovation principles, interventions can be designed to empower fishermen, promote social cohesion, and enhance community resilience.

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Baishalee Sonowal

Research Scholar, Department of Design, IIT Guwahati

Email: baishalee@iitg.ac.in

I am a PhD Scholar in the Department of Design, IIT Guwahati. My research focusses on creating a design support for assessing and designing products for environmentally sustainable end-of-life performance. I have done my Master's degree in Microelectronics and VLSI Design and a Bachelor's degree in Electronics and Communication Engineering from NIT Silchar. In the past, I served as a Project Associate at Tezpur University's Technology Enabling Centre, focusing on facilitating the development, deployment, and diffusion of technology.

Sustainable Product Design and End-of-Life Management

Baishalee Sonowal

PhD Scholar, Department of Design, IIT Guwahati

Email: baishalee@iitg.ac.in

5.1. Motivation

The continuous development of technology has changed the way we live, introducing a plethora of technological goods into our everyday life. From smart gadgets to alternative energy sources, electronics are everywhere. However, the boom in technological innovation poses considerable hurdles, notably in terms of sustainability and end-of-life (EoL) management.

As electronics advance at an unprecedented rate, adding complicated components and cutting-edge capabilities, our current mechanisms for managing their end-of-life stages struggle to keep up. The rising misalignment between the complexity of electronic devices and the capability of current EoL management systems necessitates a paradigm shift. As researcher, I seek to bridge this gap, create creative techniques, and imagine a future in which sustainability is seamlessly incorporated throughout the whole lifespan of electrical and electronics devices. The complexity of these devices require a more effective and proactive approach to their design, taking into account the end-of-life consequences from the beginning.

Furthermore, as worldwide awareness of environmental concerns rises, legislative bodies are responding. Directives from the European

Union, for example, emphasise responsible disposal of electronic and electrical equipment, highlighting the need of sustainable product design and end-of-life management.

5.2. Environmental Assessment in Product Design

The process of designing or developing a product is collaborative and appealing to a wide range of competencies. It has an influence on all of a company's actions that involve introducing a new product to the market. It often involves the design, marketing, and production divisions in the organisation. Pahl and Beitz outline the design process as a sequence of four primary phases: requirement clarification, conceptual design, embodiment design, and detail design. This progression aims to transition from defining functional needs to realizing a tangible physical form (Rio et al., n.d.).

Product lifespans in industrialised cultures have significantly fallen over the last decade. This has resulted in greater material consumption and waste. As a result, the environmental consequences of material manufacturing and processing are increasingly becoming critical. Material efficiency, or developing goods with less materials, is addressed in most design projects since it reduces costs and is considered good business practice. However, most design processes do not systematically address product life extension (via prolonged product life, refurbishment, and remanufacturing) or product recycling (Bakker et al., 2014).

Assessing sustainable product design involves a multi-criteria decision-making (MCDM) challenge encompassing customer needs, enterprise constraints, and available resources. Experts must consider a range of factors and constraints in the early stages of product design to make optimal decisions. The solution methods can

be categorized into two main classes: 1) synthetic assessment approaches, such as weighted sum, analytical hierarchy process (AHP), technique for order performance by similarity to ideal solution (TOPSIS), VlseKriterijumsko KOMPromisno Rangiranje (VIKOR), AHP and evidential reasoning (ER), AHP and TOPSIS, and fuzzy synthetic evaluation, and 2) approaches based on life cycle assessment (LCA) (Tian et al., 2016).

Environmental concern has led to the emergence of life cycle design (LCD) in environmental engineering. LCD symbolises a comprehensive design approach that spans the full product lifespan, or "cradle-to-grave". The LCD relies on proven approaches such as life cycle assessment (LCA) and life cycle cost (LCC) to quantify performance in terms of both the environment and economics (Kiling et al., 2021). The goal of LCA is to reduce the environmental impact of product manufacturing, usage, and disposal (S. G. Lee et al., 2001). LCA has been frequently utilised in product design to quantify the environmental implications of products throughout their lifespan. However, LCA is sometimes inefficient in early design phase owing to a lack of data, the intensity of labour and time, and the urgency to make quick decisions. Thus, it needs to be simplified to drive rapid judgements by product developers, especially those who are not knowledgeable in LCA (Kiling et al., 2021). LCA also necessitates thorough product development data, which may not be available during the first conceptual stage of product design. To address this issue, eco-design principles and standards are developed to assist designers in improving the environmental consequences of their goods through better early design decisions (Chiu & Chu, 2012). Product environmental information is vital to the success of sustainable product development. Good product information is

needed for successful implementation to enhance the product's environmental performance(H. M. Lee et al., 2014).

LCC assesses the overall cost incurred during the product's lifespan. An LCC analysis can help product developers understand the link between costs and design parameters by identifying cost factors. Nonetheless, its analysis in Product design have traditionally been carried out in fixed scenarios, assuming a static product lifespan. Accurately estimating the lifespan of a product during the early stages of design is challenging. This static approach may lead to discrepancies between LCC-driven and actual costs, resulting in inaccurate cost estimations. Therefore, it is imperative to ensure accurate LCC calculations during the design phase to guide product developers in specifying cost distributions across the product lifecycle. It's worth noting that Life Cycle Assessment (LCA) faces a similar challenge in dealing with dynamic product lifespans(Kiling et al., 2021).

5.3. Circular Economy and Challenges

The circular economy (CE) paradigm proposes for the transition of our economies from linear to circular models, in which waste and recycled materials are transformed into resources. It has intentions to halt or decrease human-caused environmental harm to our planet, as well as to preserve its future habitability and the wellbeing of people(Reuter et al., 2019). The circular approach stands in opposition to the conventional linear business model, which involves the production, consumption, and disposal of goods. Unlike the linear model, circular business models prioritize deriving profits from the continuous flow of materials and products over time rather than simply selling artifacts. This shift allows for economically sustainable practices by

promoting the ongoing reuse of products and materials, with an emphasis on utilizing renewable resources when feasible. It was observed that Circular Economy (CE) is frequently associated with sustainability. The significant connection, particularly with environmental sustainability, underscores that CE, when applying its principles, provides practical solutions to alleviate the human impact on natural ecosystems. (Bocken et al., 2016).

One of the greatest obstacles to attaining a 'closed' loop of materials from consumer goods, especially electrical and electronic products, is a lack of effective collection and recycling infrastructure. Furthermore, the complex architecture of modern items complicates end-of-life (EoL) treatment procedures. Recycling technologies are surpassed by evolving complex and elementally varied products. This is making resource recovery increasingly challenging (Parajuly et al., 2016).

Scholars' engagement with Circular Economy (CE) is intimately tied to sustainability, with a predominant emphasis on environmental aspects often combined with economic evaluations. However, the relationship between CE and sustainable development remains a subject of lively debate among academics, lacking clear and defined boundaries. Some argue that CE transcends sustainable development, suggesting that the latter is constrained by linear thinking strategies, and the circular approach could provide a remedy for sustainability shortcomings. Conversely, others position CE within the broader sustainability movement, considering it a tool to implement sustainable development principles effectively. While sustainability seeks to integrate environmental, economic, and social dimensions, CE predominantly focuses on environmental concerns, presenting a targeted approach to addressing them. One possible explanation for

this focus is that CE is situated in an industrial context, typically not addressing social issues. When connecting Circular Economy (CE) to the broader concept of sustainability, there is a tendency to overlook the social consequences of a circular system. Nevertheless, CE demonstrates a positive correlation, particularly with intergenerational considerations, as a decrease in natural resource consumption creates more prospects for future generations. Hence, there is a growing need to enhance the integration of the social aspects of the CE framework (Merli et al., 2018).

5.4. Design for End-of-Life (DfEoL)

At the conclusion of its functional lifespan, a product has various end-of-life options, including reuse, remanufacturing, primary or secondary recycling, incineration, or disposal in a landfill. The decision hinges on whether the goal is to minimize environmental impact or address resource deficits (or maximize surpluses) (S. G. Lee et al., 2001). Given the present issues of environmental waste effect and landfill saturation, selecting an appropriate end-of-life (EOL) destination for discarded items is becoming more critical for most produced products. To solve these concerns, a product's design must be optimised with the goal of implementing an ecologically sustainable end-of-life scenario that respects economic and statutory restrictions (Remery et al., 2012). Thus, for design engineers, it is very important to proactively plan for product retirement(S. G. Lee et al., 2001). It is well known that combining product design with suitable end-of-life (EoL) processing may significantly increase resource recovery from electronic devices (Parajuly et al., 2016).

Design for End-of-Life (DfEoL) is a component of a novel design approach known as 'design for environment' (DfE). Its objective is to

enhance a company's overall environmental performance by minimizing the impact generated at each stage of the product life cycle, while maintaining key aspects like quality, functionality, and cost (Parajuly et al., 2016). It aims to improve the environmental performance of goods throughout their life cycles by systematically incorporating environmental components of the EoL stage into product design. In simple terms, it is to create a product with 'an end in mind'. Since the 1990s, there have been research initiatives in the domain of DfEoL spanning from design for disassembly, recovery timeframes, EoL methods for diverse goods, and design for recycling methodologies. However, no one incorporates all element of EoL (H. M. Lee et al., 2014)

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Anmol Mohak

MSR, Center for Disaster Management and Research, IIT Guwahati

Email: m.anmol@iitg.ac.in

I am Anmol Mohak currently pursuing my Master's in Disaster Management and Risk Reduction from IIT Guwahati. I hold a Bachelor's degree in Mechanical Engineering from KIIT University, Bhubaneswar, and have professional experience as a deputy manager at TSDPL. Additionally, I have actively contributed as a member of the ISHARE Society. Beyond my academic and professional pursuits, I am deeply passionate about machine learning and data analysis techniques. I believe in leveraging these technologies to address complex challenges in disaster management and risk reduction, aiming for more efficient and effective solutions. My interest in machine learning and data analysis stems from their potential to extract valuable insights from vast datasets, which can significantly enhance decision-making processes and improve disaster preparedness and response strategies.

Designing of “BIHU”: A harvester suitable for small farms of Assam

Anmol Mohak

MSR, Center for Disaster Management and Research, IIT Guwahati

Email: m.anmol@iitg.ac.in

6.1 Introduction

Rice (*Oryza sativa*) is a fundamental staple food in the Asia-Pacific region, contributing to over 90% of the global rice production and consumption (Papademetriou et al., 2000). In India, home to approximately 1.4 billion people, rice is the primary food source for 65-70% of its population, playing a pivotal role in the livelihood of millions of farmers and ensuring national food security (Abdullah et al., 2006). Assam, in particular, dedicates about 70% of its cultivated land to rice farming, accounting for 6% of the national rice area and 4% of India's total production (Mech, 2017). Enhancing productivity and improving resource utilization efficiency are critical to meeting the demands of a growing population.

6.2 Assam Context

Assam's rice cultivation encompasses three primary types: winter rice (sali), autumn rice (ahu), and summer rice (boro), each with distinct yield potentials (Bhowmick et al., 2006). The challenges faced by small and marginal farmers, such as labor scarcity and mechanization limitations, necessitate innovative solutions to improve their livelihoods and food security. The state's vulnerability to excessive and untimely rains, as well as river floods, significantly affects rice

cultivation (Talukdar and Beka, 2005). Approximately 39.58% of Assam's total area is flood-prone, highlighting the need for effective flood management strategies (Borah and Barman, 2019).

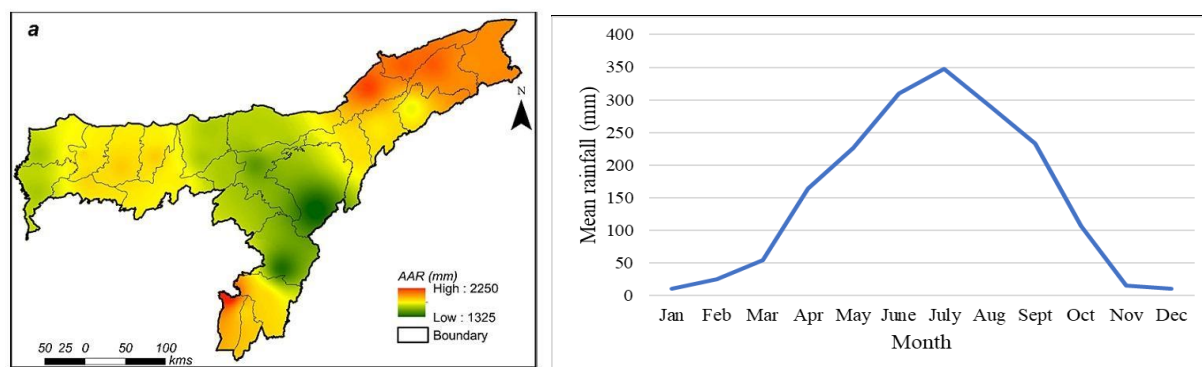


Figure 12: Assam Rainfall from (1981-2017) (Gogoi et al., 2022) (a) District-wise, (b) Month-wise

The prevailing flood situation shown in figure 12 highlights the crucial role that our product aims to fulfil, particularly focusing on small-scale farmers and those involved in seed-selling businesses. Figure 13 shows the area that is under seed cultivation. We can say that the large area is used to cultivate seed for paddy (summer + winter) therefore, rice dominates any other crop in Assam.

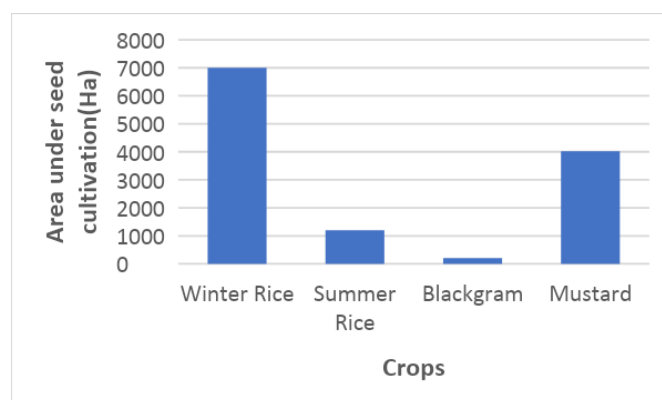


Fig. 13 Area under seed production for the year 2017-18 (Assam State Seed Certification Agency, n.d.)

During floods, labour shortages are rampant due to transportation hindrances and the inundation of family-owned land patches. Mechanization offers a solution to alleviate these labour constraints and enhance efficiency. Due to labour shortage, labour costs also increase as shown in Figure 14.

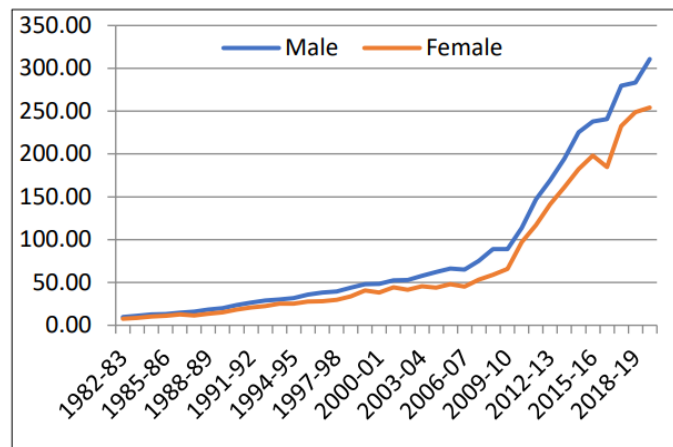


Fig. 14 Labour Cost (Saha et al., 2022)

However, challenges such as high machinery costs and limited access to credit impede widespread adoption among small-scale farmers. Existing issues such as traction problems in the soil and difficulties manoeuvring in small farms, necessitate a more adaptable and cost-effective solution. By integrating traditional techniques with machinery, our harvester seeks to optimize resource utilization while addressing specific challenges faced by paddy farmers in Assam, such as uneven terrain and flood-prone areas. The proposed design focuses on direct thrashing, reducing processing stages and promoting sustainability through the use of renewable materials like nylon or coconut husks for bristles. This innovative approach, tailored to local conditions, not only enhances efficiency but also contributes to more environmentally friendly agricultural practices, showcasing the

intersection of social innovation and sustainability in addressing pressing agricultural challenges.

6.3 Impact of Rain just before harvesting

Rainfall just before harvest poses significant challenges for seed producers, impacting both the quality and quantity of the seed yield in various ways. Preharvest sprouting induced by rain can lead to seed quality degradation, rendering seeds nonviable for future planting (Foolad et al., 2007). Additionally, wet conditions favor the proliferation of diseases and pests, such as rice blast caused by *Pyricularia oryzae*, compromising seed health and future crop yields (Talbot, 2003). The increased moisture content complicates seed processing and storage, potentially leading to mold or decay, which adversely affects germination rates (Nelson, 1980). Yield loss is another critical concern, as lodging from rain can reduce the available seed stock for sale or future planting, impacting the economic viability of seed production (Setter et al., 1997). Furthermore, the economic implications extend beyond immediate yield loss, affecting the cost of disease management, drying, and storage, thereby impacting overall profitability (Gooding et al., 2003). The market reputation of seed producers is also at stake, as the sale of poor-quality seeds can damage their reputation and have long-term business implications (Lacey, 1991). To mitigate these risks, farmers need to adopt strategic planning and management practices, such as utilizing covered or raised drying areas, investing in disease-resistant seed varieties, and implementing rigorous quality control measures (Bewley et al., 2013). Harvesting challenges due to wet soil conditions further exacerbate these issues, highlighting the need for timely and efficient harvest strategies to minimize quality and yield losses (O'Sullivan et al., 1999).

6.4 Places Visited

The primary research phase of this project aimed to complement the theoretical insights gained from the literature review with practical, on-the-ground perspectives. Through a combination of interviews with local farmers (Rangia, Jorhat, Dole Gaon) and a visit to Assam Agricultural University in Jorhat, a fundamental understanding of the challenges and opportunities in rice cultivation in Assam was sought. (Figure 15).



Fig. 15 Places visited for fieldwork.

6.5 Conclusion

The exploration into the challenges and opportunities of rice cultivation in Assam underscores the critical need for innovative agricultural solutions tailored to the unique environmental and socio-economic contexts of small-scale farmers. The adverse impacts of pre-harvest rainfall, including seed quality degradation, increased disease and pest incidence, and the subsequent economic and reputational damages, highlight the vulnerability of the agricultural sector to climatic variabilities. Moreover, the field visits and interactions with local farmers have provided invaluable insights into the practical challenges faced on the ground, such as labor shortages, mechanization barriers, and the specific needs for efficient, cost-

effective harvesting solutions. These findings underscore the importance of developing a harvester that not only addresses the immediate challenges of seed quality and yield loss but also contributes to the broader goals of sustainable agriculture, economic resilience, and food security in Assam. The proposed "BIHU" harvester is envisioned as a step towards realizing these objectives, offering a practical, innovative solution designed with the needs of Assam's small-scale farmers in mind.

6.6 Proposed Design

The "BIHU" harvester is designed as a human-carried device, aimed at addressing the unique challenges faced by small-scale paddy farmers in Assam, particularly in the context of pre-harvest rainfall and its associated impacts. The design of "BIHU" focuses on simplicity, efficiency, and adaptability to the small and uneven terrains typical of Assam's agricultural landscape. The harvester integrates three main processes:

- **Dislodgement:** The device employs a gentle yet effective mechanism to dislodge grains from the stalks, minimizing damage and loss. This process is crucial for maintaining seed integrity, especially in wet conditions that may predispose the grains to pre-harvest sprouting and fungal infections.
- **Suction:** Following dislodgement, the "BIHU" harvester uses a suction mechanism to separate the grains from the chaff and other debris. This step is designed to ensure the cleanliness of the harvested grains, reducing the need for extensive post-harvest processing and thereby saving time and resources.
- **Collection:** The harvested grains are then collected in a storage

unit attached to the harvester. This component is designed for ease of handling and efficiency, allowing for continuous operation and minimizing the need for frequent emptying.

The "BIHU" harvester's design incorporates materials and components that are locally available, durable, and cost-effective, such as nylon or coconut husks for the bristles used in the dislodgement process. This consideration not only makes the harvester accessible to small-scale farmers but also supports local economies and promotes sustainability. By reducing the stages involved in processing and employing renewable materials, the "BIHU" harvester aligns with the principles of environmental stewardship and social innovation, offering a practical solution to the challenges of rice harvesting in Assam's flood-prone areas.

In summary, the "BIHU" harvester represents a targeted approach to enhancing agricultural productivity and resilience in Assam, addressing the specific needs of small-scale farmers while contributing to broader objectives of sustainable development and food security.

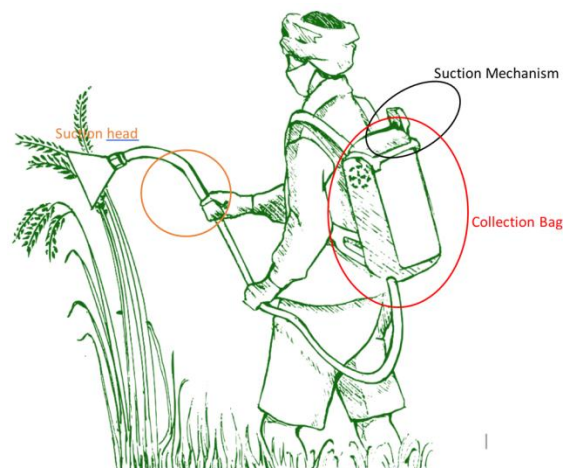


Figure 4: Proposed Design

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Saptarshi Samanta, PhD Student (3rd Year)

Phd Student in Department of Design under the supervision of Dr Pankaj Upadhyay

Email: saptarshi.samanta@iitg.ac.in

Website: <https://thecreativesage.weebly.com/> (personal)

I am an experienced industry professional with more than 12 years of working experience. At present I am pursuing my PhD in Design in the Department of Design, IIT Guwahati. My area of research is in determining the relation between haptic experience and game design requirements for entertainment digital games.

I graduated with a B.Tech in Mechanical Engineering from Haldia Institute of Technology, West Bengal, in 2007. After graduating I started my professional journey by joining TVS Motor Company Pvt Ltd. I worked in R&D Engines for TVS Motor Company for almost 8 years in engine transmission design and development for the three-wheeler vehicle segment. My extensive work in this domain resulted in 2 patents to my name as well.

After gaining a significant and in-depth understanding of the engineering and technical aspects of product design and development

I proceeded to do an MBA from IIM Lucknow to understand the business aspects of products and how business requirements are tied into the entire process. Post completion of my MBA I worked in Shapoorji Pallonji Group in Corporate Strategy. I was primarily involved in business strategy and business plan development for various group level projects and new product development business planning for various subsidiaries of the Shapoorji Pallonji Group.

After this corporate stint I returned to academics and became a PhD student in Department of Design where I could bring my extensive industry experience related to product development and business planning to the field of design and marry it with my long-time passion about digital games and contribute to the field of research in game design and player experience.

An exploration of how game design can contribute to sustainability

Saptarshi Samanta, PhD Student (3rd Year)

Phd Student in Department of Design under the supervision of Dr Pankaj Upadhyay

Email: saptarshi.samanta@iitg.ac.in

Games have been a part of human society since times immemorial. Games have served as an avenue to relax, have fun and socialize. Though with the passage of time the way humans play games have evolved into more complex forms, the core purpose of games to provide humans with the means of entertainment and enjoyment remains unchanged. In the current era games have taken a digital form, often referred to as video games, and can be experienced easily within the comfort of our homes.

The video game industry generated a revenue of about 347 billion dollars in 2022 (*Video Games - Worldwide | Statista Market Forecast, n.d.*) and is expected to grow at a CAGR of 8.74% between 2023-27. The number of active users stood at 2.5 billion in 2022 and is expected to reach 3.1 billion users by 2027. The video game industry is also much larger than the movie industry. All these facts and figures highlight the economic potential and reach of the video game industry and the impact it has on human society. This might lead one to wonder what does the video game industry and game design have to do with sustainability.

So naturally the question does arise what relation does game design have with sustainability? This can be best explained by first walking through one of the core concepts of sustainability. In most literature related to sustainability; it has been posited that sustainability has three core pillars namely, environment, social, economic. It will be possible for design solutions to encourage movements towards sustainability by influencing any of these three pillars or all of them.

Game design has the ability to influence social behaviour. For through games, it might be possible to spread awareness about how we consume our resources and influence the behaviour of the masses. Hence, it can be inferred that game design can influence the social pillar of sustainability and can contribute towards achieving a socially sustainable behaviour. The effect of video games on social behaviour has been researched since 1994. Since 2005, the research on the effects of video gaming on social behaviour has been increasing and continues to pique the interest of researchers. As new technologies keep emerging so does video game design keep changing and hence the necessity to understand how it affects social behaviour. The existing research on game design has focused on both the positive as well as the negative aspects of video games on social behaviour. Some positive aspects identified by research include improvement in hand eye coordination, improved problem-solving abilities, better learning of different educational concepts. Likewise, some negative aspects of video games identified by research include increased propensity for violence in real life, addiction to gaming, anti-social behaviour to name a few. These examples highlight the importance that video games and game design have in influencing social behaviour and the potential it has in affecting the social pillar of sustainability as well. Furthermore, given the extensive reach and penetration that video

games have in terms of number of users its effect of the social fabric of society can be quite pronounced. In literature related to research it was observed that from 2014 onwards, the effects of game design on sustainability have gained an increased focus.

The existing research on game design and sustainability can be broadly categorized into the domains of serious games, human computer interaction (HCI), usage of sensory modalities, behaviour and motivation and psychology. In the case of serious games, the focus of game design and sustainability is on educational games. The intent in this case is that awareness about sustainability can be increased by imparting knowledge through educational games and thus influence the social behaviour pillar of sustainability. The multimodality research domain deals with three sensory modalities at present namely visual, aural and haptic. Haptic modality is one of the latest additions in the multimodal sensory experience of game design and has also been commercially deployed across multiple platforms. Apart from the above-mentioned modalities there are two other modalities namely olfactory and gustatory. However, these two modalities are still in very early stages of research and their potential for incorporation into game design and sustainability is vastly unknown. The research domains of motivation and psychology deals with effects of game design and human behaviour. The research domain of motivation mostly focuses on how to influence a more sustainable human or social behaviour through game design whereas the domain of the psychology deals with evaluating how existing game design elements affect social and personal behaviour in relation to sustainability in the given context.

Game design engages users or players by means of three forms of engagement namely cognitive engagement, emotional engagement, and behavioural engagement (Ouariachi et al., 2019). If one is to affect the social pillar of sustainability, then all three forms of engagement in game design must incorporate themes and concepts of sustainability into the game design process. The three forms of engagement coupled with concepts of sustainability can only be achieved if the game features or attributes are adequately linked to different facets of sustainability. At present the game features to consider while designing a game to meet the above linkage between sustainability and social behaviour are achievable, challenging, credible, efficacy enhancing, experiential learning, feedback-oriented, fun, identity driven, levelling up, meaningful, narrative driven, rewards driven, simulating and social (Ouariachi et al., 2019). If one is to influence social behaviour towards sustainability, then these game features must incorporate elements of the concepts of sustainability. This can be best explained by assuming a video game scenario. Let us assume a video game is made where the player is in charge of building a town or city within a natural setting, but the player will win points and level up better if the player is able to use the available resources within the game environment judiciously for developing his town or city without indulging in over consumption for rapid expansion or development. From this scenario we can see the game features of achievable, challenging, experiential learning, fun, levelling up, and reward driven being a part of the proposed video game setting. Hence from this example we can see what the game design process must undertake if it is to influence the social pillar of sustainability and bring about a behaviour change with respect to consumption patterns.

On reviewing the existing research on game design and sustainability it is observed that the use of serious games which dealt with education as one of the prevalent means of using game design to spread awareness about the concepts of sustainability (Boncu et al., 2022). The games dealt primarily with increasing awareness about climate change (Fernández Galeote et al., 2023), bio economy (Tatar et al., 2023), social sustainability (McGowan et al., 2023), management of natural resources to achieve sustainability (Strada et al., 2023) (Falk et al., 2023), ecological crisis (Heijmen & Vervoort, 2023), waste management (Hoffmann & Pfeiffer, 2022), sustainable lifestyle choices (Arboleda et al., 2022), and energy management (AlSkaif et al., 2018) to name a few. The serious games incorporated several of the above discussed game features in order to engage the users. Several of reviewed research focused on how serious education games can affect the social pillar of sustainability. While some of the research process focused on the method of the game design process and educational goals to influence social behaviour towards a path of sustainability. This gradual realization in academia about the importance of game design in influencing social behaviour for sustainability is an important aspect for achieving sustainability.

Even though game design processes and serious games, particularly educational games, are being used to influence social behaviour to achieve sustainability a lot remains to be done in this space. The reach and penetration of serious games and educational games is much lower than its entertainment counterpart. Furthermore, in cultures where games are regarded as a waste of time, educational games will be treated no differently. Hence it can be inferred that the expected impact of educational games intended for influencing social behaviour

for sustainability will not be as effective as desired. It can be suggested that popular game studios interact with academia to build strong narrative driven entertainment games which also have a strong link to sustainability concepts. This might help in a wider dissemination of the concepts sustainability and spread awareness and might have a more lasting impact on the social pillar of sustainability.

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Letter from the Chairman's Desk By Sunil Bhatia PhD

The product is not what the designer designs, it changes its character over time with use to guide the users and can memorize what is needed in the future.

It is my habit to ajar the door of my room to maintain my privacy and keep an eye on other parts of the house. One day I pushed the door sitting on my bed with a jerk from my feet and found the door stopped where usually I kept the door. I thought it might be some coincidence. A few days later, I pushed the door with my hand and its jerk was enough to stop it in my desired place. I found the door stopped at the same spot. One day my mood was upset and I pushed the door a little hard and saw the door hit the door frame with a bang and returned to stop at the same usual place. This action surprised me and I thought 'Does the product have its mechanism of memorizing for guiding the needs of users?'

I could not sleep thinking over this thought and realized 'yes' it has a mechanism. The entire planets of the cosmos have a memory of attraction and repulsion that never allows any collision. What makes it rotate in a circle? What makes the magnet when to attract and repel? Is it not one kind of product of a compass made with a magnet that guides the users with its memory for navigation? Has the magnet of the compass ever failed?

I remember reading of religious book by my mother. She never knew the concept of a marker, either by folding the corner of the last visited page or placing a hard piece of small rectangle paper in between pages or thread attached with a book for placing in between her last pages visited. As she opens her book, pages more or less open from the last reading page she read. I thought she might have pressed the place near the binding with her hands after opening the book which helped her open more or less the same pages she closed after reading the book. Nothing like in her habit. That made me confirm that the book develops its memory of the last page reading by a book that guides when the readers open the book in helping start reading from her last left pages.

I have my favorite pen and I am comfortable using it. One day I visited the bank and forgot to take that pen along with me. As I was about to fill out the withdrawal form I realized my pen was missing. A gentleman offered his pen and as I started writing I realized that the pen was not moving with that smoothness that I used to experience with my pen. I was a new user of this pen. I did my signature and the Cashier informed me that your signature matches 40% usually it was more than 50%. That difference made me think of the difference in signature because my usual pen was not with me and a guiding factor was missing. He was kind enough and gave me cash. I remembered the proverb 'Do not milk the other's cow otherwise it will hurt you by kicking with her leg.'

Rubber is a natural product and has a memory of retaining the actual position after stretching. It tries to come back to its original shape. If rubber is stretched for a long duration of time it adopts and earlier memory is lost by a new one. We call it has no elasticity. Similarly, spring-loaded mechanism-like shock absorbers have a fresh memory

of coming back to the original shape in which it is designed but over time memory faded and adopts the new open and we say spring / or oil viscosity has lost its character.

I was sitting at the dinner table and it is in my habit of taking extra spicy taste in my food by sprinkling salt and pepper over served food. As I started taking out from the dining table bottle I realized as much what I needed. I looked deeply at the opening of the bottle and I found the number of holes is covered with salt and pepper that allows that much for releasing what is my requirement. If I go to a restaurant and do the same way it will either be less or more not what I need.

The top players have a fascination with playing with a specific racket while playing tennis. It is not that the always player plays best but sometimes that racket guides the player in correcting their actions and helps in winning the game. It is the skill of the player but in some crucial places where the possibility of committing mistakes players can lose the winning match that the racket silently helps. Racket learns the habits of players during practicing sessions over time and helps in winning the match by guiding him at crucial times for specific return shots. Commercial companies are marketing sports shoes by saying memory sole for athletes that helps in faster running. It may be a marketing gimmick but I appreciated the idea of the memory sole of the shoe. It is the skill of the athlete but the combination with sports goods 'memory that gives a different edge over competitors. Similarly, foam mattress manufacturing companies are marketing memory pillow and mattresses that memorizes the users sleeping habits and act accordingly in the future which helps in better sleep. A guest sleeping over a mattress who has different sleeping habits will be guided by earlier users' habits and the clash will surface with

whom mattresses are not familiar and guests may get disturbed sleep because it has a memory with the same usual user.

I was in the bathroom and realized every device was guiding me with its memory for a bath. As I opened the tap it turned to what I usually expect from the tap for releasing water. Even my soap cake size which kept changing with my daily use was guiding me to hold that much pressure in my hand otherwise it would slip out of my hand. When I brush it appears to me that I am brushing randomly and under my command. Sometimes I realize that brush has guided me in not reaching that particular area you did for brushing and feel satisfied by cleaning.

Shoe biting is the best example where a new shoe tries to adapt to the users and later on, guide them for smooth walking. I was a student and had a reading table and chair in the library of the school where I usually sit. If I found someone occupying the same seat and I had no choice but to sit on another chair table, realized some kind of uneasiness in my studies that I never felt sitting in the same usual place. People called it the familiarity of the environment that helps in faster learning but table and chair memorized my habits and I quickly settled for studies which I never enjoyed in a new sitting place.

A person was standing and suddenly fell and his leg bone was fractured. The people who took him to the hospital explained to the doctor that he was standing and no accident but still he fell. The doctor informed them that 'his bones were not strong enough to bear his weight and because of its first bone was fractured then he fell.' It was bone that might have signaled him earlier but he was ignoring it Result a fracture of bone.

A salesman of second-hand vehicles was emphasizing in his every sentence to the buyers that this is a single-hand driven vehicle. His selling point was too many hands spoil the vehicle. It surprised me that the vehicle adopts better in single-hand drive because it adopts the behavior of the driver and guide in better driving. It reminded me of the drawing of water from a well by pulling the rope with the help of rope and bucket leaving a mark over time of use on a wooden pulley. If it is used by a particular hand pulley mark helps in comfortable drawing. It makes lots of noise when various people come and draw the water with its style. Many users make jumbled grooves due to rope pressure on a pulley that is not similar to a single user, which in turn creates difficulty for drawing and generates heavy noise when it is at work.

It is great honor that Guest Editor Dr. Sharmistha Banerjee, Assistant Professor , Department of Design & Associated Professor Centre for Disaster Management and Research , Indian Institute of Technology Guwahati has accepted our invitation and with the help of SSI lab (Sustainability and social Innovation lab) has focused this special issue on `sustainability through social innovation`

Lambert Academic publication for celebration of the 150th special issue by publishing a book by compiling editorials "Design For All, Drivers of Design" in two sets Drivers of Design Drivers of Design Volume-II was translated into eight different languages from ENGLISH to French, German, Italian, Russian, Dutch, and Portuguese. Kindly click the following link for the book. "Morebooks", one of the largest online bookstores. Here's the link to it:

<https://www.morebooks.de/store/gb/book/design-forall/isbn/978-613-9-83306-1>

Second Volume :

http://www.morebooks.shop/bookprice_offer_74414a1df61c3d2ea8bf46ae7e3c0cf31769f261?locale=gb&cy=EUR

Enjoy reading, be happy, and work for the betterment of society.

With Regards

Dr. Sunil Bhatia

Design For All Institute of India

www.designforall.in

dr_subha@yahoo.com

Tel 91-11-27853470®



Forthcoming Issues

September 2024 Vol-19 No-9



Steinar Valade-Amland.

He is market economist, and after more than 30 years of professional practice, I have accumulated extensive and valuable experience from a wide range of industries and managerial roles within marketing and sales, communication, PR and advocacy - leading to the design industry as an account director and later CEO of one of Denmark's leading brand design agencies, culminating in the role of spokesperson for the Danish design community, heading Danish Designers - parallel with holding numerous honorary positions.

My primary role today is helping organisations and management teams to establish the best possible baseline for business development and change processes - through stakeholder engagement and moderated processes, through organisational learning and co-creation. I'm rather agnostic when it comes to models and methods, but design thinking and processes inspired by design methodologies are part of my DNA after 30 years in and closely connected to the industry.

He authored numerous articles and book contributions, amongst others with 15 articles to the Bloomsbury Encyclopaedia of Design, out in 2015.

His latest book, DESIGN: A BUSINESS CASE - Thinking, Leading, and Managing by Design written together with Brigitte Borja de Mozota, is now out in English, Hindi and Korean.

October 2024 Vol-19 No-10



Dr. Bijaya K. Shrestha received Doctoral in Urban Engineering from the University of Tokyo, Japan (1995-'98), Master in Urban Design from the University of Hong Kong, Hong Kong (1993-'95) and Bachelor in Architecture from the University of Roorkee (now Indian Institute of Technology), India (1983-'88). Dr. Shrestha has got

working experiences of more than two decades. He had already served to the Department of Housing and Urban Development, Ministry of Housing and Physical Planning, Government of Nepal, United Nations Centre for Regional Development (UNCRD), Japan and various architectural schools in Nepal before taking the present job at Town Development Fund (TDF). He has initiated a new master program in Urban Design and Conservation at Khwopa Engineering College, Purbanchal University, where he served two years as Head of Post-graduate Department of Urban Design and Conservation.

Dr. Shrestha is the recipient of numerous gold medals for his excellent academic performance and decorated by 'Calcutta Convention National Award 2006' by Indian Society for Technical Education for his best paper at the 35th ISTE Annual convention and National Seminar on Disaster – Prediction, Prevention and Management. He is also member of numerous professional bodies and life member of various alumni associations. He has already contributed more than five dozen of papers, published in various forms: book chapter, international journals, conference proceedings, local magazines and journals including in local newspapers. Moreover, he has been invited in numerous international conferences for presentation of his research findings. Finally, his field of expertise includes sustainable urban development, disaster management, housing, local government capacity building and development control. He will focus on universal design concept in Nepal

November 2024 Vol-19 No-11

Dr Sandeep Sankat , Associate Professor, Head Department of Architecture, School of Planning and Architecture, Bhopal.

Dr. Sandeep Sankat Associate Professor, School of Planning and Architecture, Bhopal (PhD, M. Ekistics, B.Arch.) Dr. Sandeep Sankat is an Associate Professor in the Department of Architecture, School of Planning and Architecture, Bhopal (M.P.) India. Before this, he was a senior lecturer in F/O Architecture and Ekistics, Jamia Millia Islamia, New Delhi. Beginning his career in the mid-nineties he practiced as an Architect at his own office "Design Innovations" in Indore, Madhya Pradesh, India. His specializations are in Architecture, Ekistics, Human Centric Design, Universal Design, Inclusive Design, Enabling Environments and Elderly and Built-Environment. He did his PhD in the area of Elderly and Built-Environment on the topic "Creating Inclusive Living Environments in Urban Residences for Indian Elderly", from the School of Planning and Architecture, Bhopal, Masters in Ekistics from Faculty of Architecture and Ekistics, Jamia Millia Islamia, New Delhi and Bachelors of Architecture from Madhav Institute of Technology and Science, Gwalior, (M.P.).

For his proposal for the concerns towards the success of "Sugamya Bharat Abhiyaan" through Universal Design Education, he received Erasmus + Global mobility funding in 2016 and is an Erasmus Fellow. He has been awarded the prestigious National "NCPEDP MPHASIS Award 2016" for his work in accessibility and disability studies and Universal Design. Recently he has been awarded with the national "Design Educators Award 2023" for teaching Universal Design. He has been awarded at various platforms for his concerns and work in the area of Universal Design and Accessibility. He has published research papers in journals and conference proceedings focused on accessibility and disability studies. He has secured first position and distinction in the Bachelors and Masters Courses. He has been a recipient of Gold Medal for the Masters Course of Ekistics from F/O of Architecture and Ekistics, Jamia Millia Islamia, New Delhi. Awarded, for the design of accessible toilet (designed following Universal Design Principles) in the category "The Urban Individual Toilet" in the San- Sadhan Hackathon organized by the Department of Empowerment of Persons with Disabilities (Divyangjan) and Ministry of Jal Shakti in association with Atal Innovation Mission, Niti Aayog, Bill & Melinda Gates Foundation.

He has also represented SPA, Bhopal on various administrative posts, including, Dean Academics, Dean Student Affairs, Controller of Examinations etc. And at present he is Head of the Department at the Department



Vishakha Verma

Assistant Professor, School of Planning and Architecture, Bhopal

Vishakha Verma is an Assistant Professor in the Department of Architecture at the School of Planning and Architecture, Bhopal, MP. She began her career with hands-on experience in architectural and landscape projects across pan India including her hometown, Dewas, Madhya Pradesh, before moving into academia. She previously held a faculty position at the National Institute of Technology, Hamirpur, Himachal Pradesh, for two years.

She holds a Master of Architecture with a specialization in sustainable architecture. Her Post graduation thesis was titled as Restorative Environment and Well Being in a Hospital through Landscape Design- A case of M.Y Hospital, Indore MP. Vishakha's research interests include User Centric Design, Built Environment and Human Behavior, Biophilic Architecture, Architecture and Well-Being, Climate Responsive Architecture, Inclusive Environment, Neuroarchitecture, Healing Architecture, aiming to enhance user experience and create healthier, more livable environments. She is equipped with materials like mud and bamboo and strives to explore such more sustainable materials.

She supports the idea that the resources we have are not inherited from our forefathers but borrowed from future generations. Therefore, it is our responsibility to use them wisely and, as a designer, to create built environments that foster inclusion for diverse user groups.

December 2024 Vol-19 No-12



Yuka Takahashi

Designer, specialized in industrial design and applied art.

New Books



Sunil Bhatia

Design for All. Volume-II

Drivers of Design



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Sunil Bhatia

Design for All

Drivers of Design

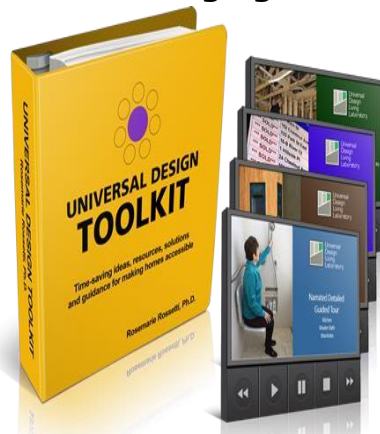
Expression of gratitude to unknown, unsung, unacknowledged, unnamed and selfless millions of heroes who have contributed immensely in making our society worth living, their design of comb, kite, fireworks, glass, mirror even thread concept have revolutionized the thought process of human minds and prepared blueprint of future. Modern people may take for granted but its beyond imagination the hardships and how these innovative ideas could strike their minds. Discovery of fire was possible because of its presence in nature but management of fire through man made designs was a significant attempt of thinking beyond survival and no

doubt this contributed in establishing our supremacy over other living beings. Somewhere in journey of progress we lost the legacy of ancestors in shaping minds of future generations and completely ignored their philosophy and established a society that was beyond their imagination. I gilded up such drivers that have contributed in our progress and continue guiding but we failed to recognize its role and functions. Even tears, confusion in designing products was marvelous attempt and design of ladder and many more helped in sustainable, inclusive growth.

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it is available on www.morebooks.de one of the largest online bookstores. Here's the link to it:
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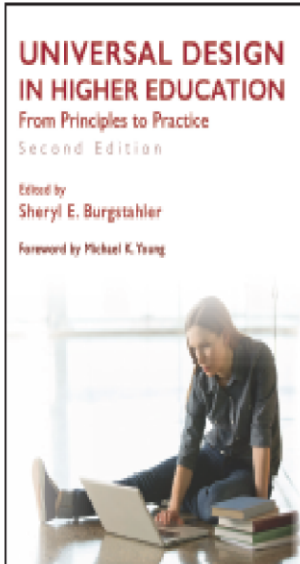
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UNIVERSAL DESIGN IN HIGHER EDUCATION

From Principles to Practice, Second Edition

EDITED BY SHERYL E. BURGSTAHLER • FOREWORD BY MICHAEL K. YOUNG

This second edition of the classic *Universal Design in Higher Education* is a comprehensive, up-to-the-minute guide for creating fully accessible college and university programs. The second edition has been thoroughly revised and expanded, and it addresses major recent changes in universities and colleges, the law, and technology.

As larger numbers of people with disabilities attend postsecondary educational institutions, there have been increased efforts to make the full array of classes, services, and programs accessible to all students. This revised edition provides both a full survey of those measures and practical guidance for schools as they work to turn the goal of universal accessibility into a reality. As such, it makes an indispensable contribution to the growing body of literature on special education and universal design. This book will be of particular value to university and college administrators, and to special education researchers, teachers, and activists.

SHERYL E. BURGSTAHLER is an affiliate professor in the College of Education at the University of Washington in Seattle, and founder and director of the university's Disabilities, Opportunities, Internetworking, and Technology (DO-IT) and Access Technology Centers.

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“Sheryl Burgstahler has assembled a great set of chapters and authors on universal design in higher education. It’s a must-have book for all universities, as it covers universal design of instruction, physical spaces, student services, technology, and provides examples of best practices.”

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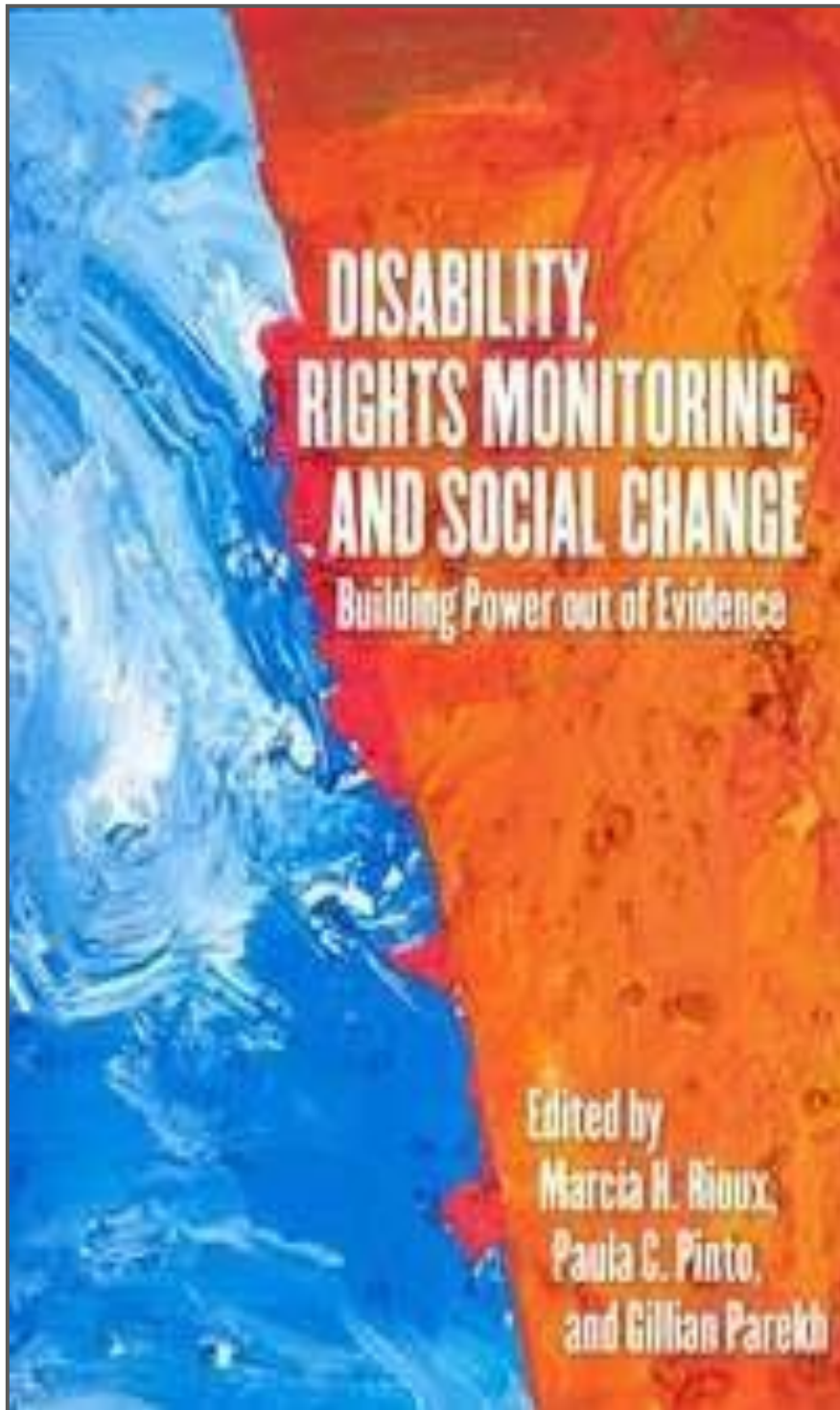
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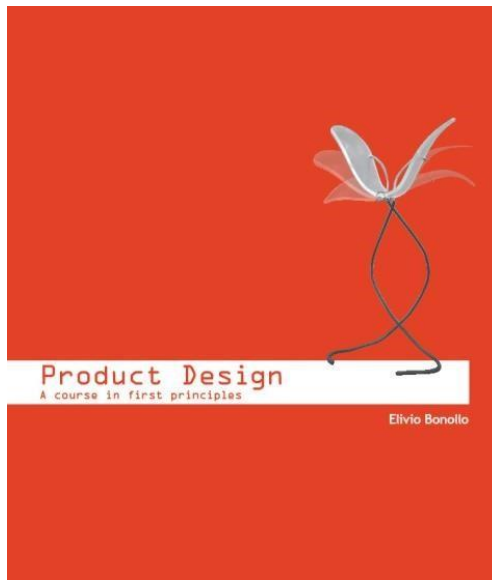
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New Update: ELIVIO BONOLLO (2015/16) PRODUCT DESIGN: A COURSE IN
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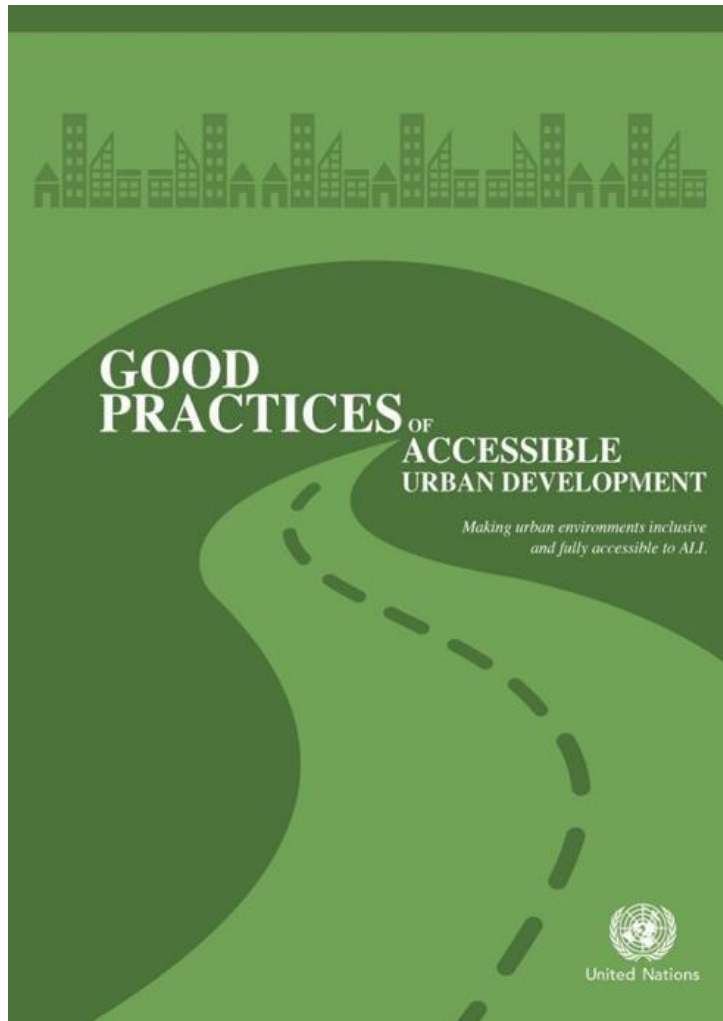
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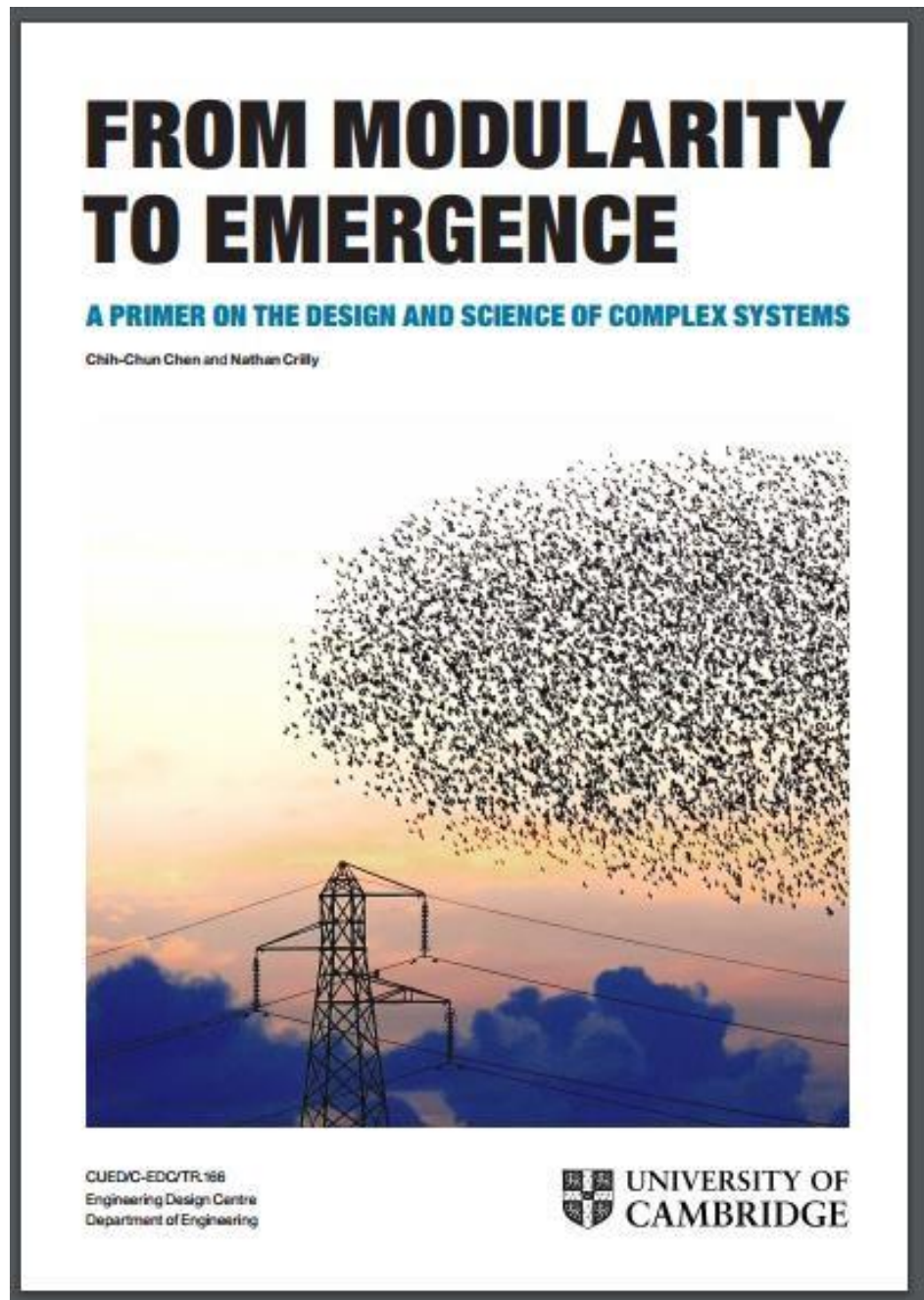
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In light of the forthcoming United Nations Conference on Housing and Sustainable Urban Development (HABITAT III) and the imminent launch of the New Urban Agenda, DESA in collaboration with the Essl Foundation (Zero Project) and others have prepared a new publication entitled: “Good practices of accessible urban development”.

The publication provides case studies of innovative practices and policies in housing and built environments, as well as transportation, public spaces and public services, including information and communication technology (ICT) based services.

The publication concludes with strategies and innovations for promoting accessible urban development. The advance unedited text is available at:
http://www.un.org/disabilities/documents/desa/good_practices_urban_dev.pdf



Dr Chih-Chun Chen and Dr Nathan Crilly of the Cambridge University Engineering Design Centre Design Practice Group have released a free, downloadable book, A Primer on the Design and Science of Complex Systems.

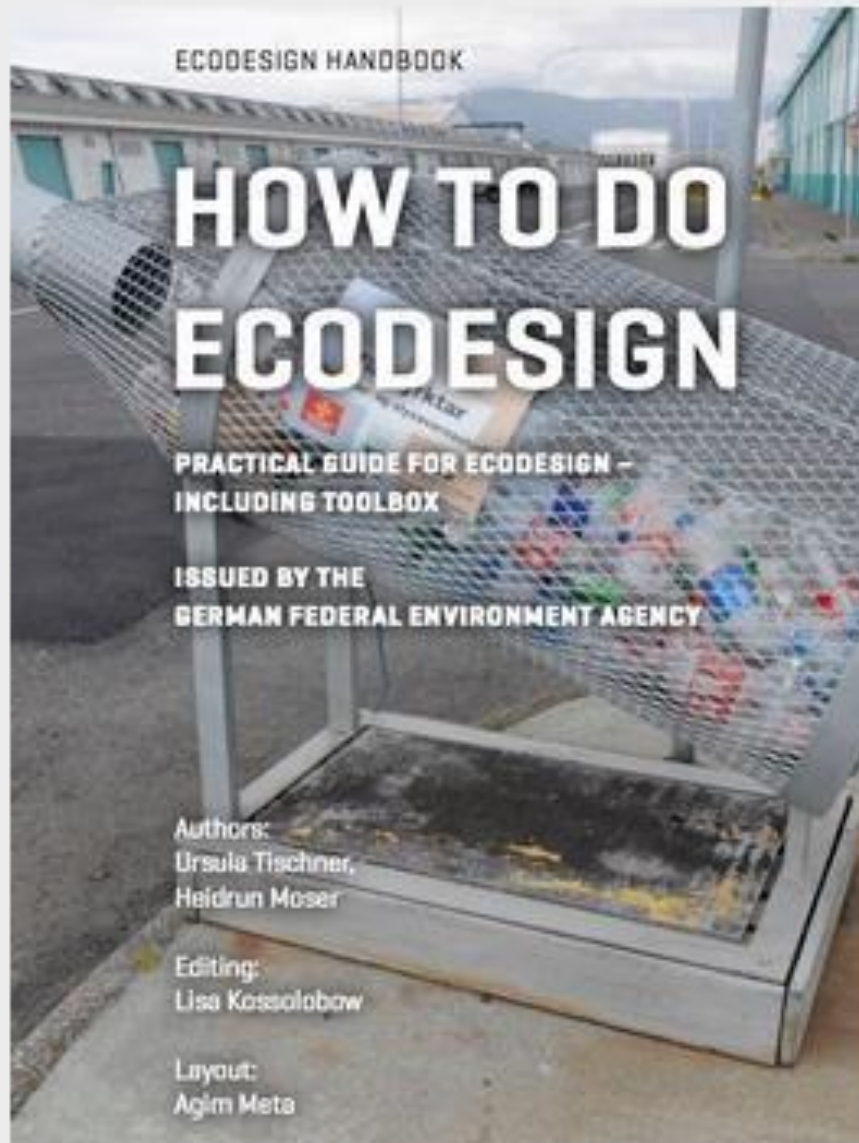
This project is funded by the UK Engineering and Physical Sciences Research Council (EP/K008196/1).

The book is available at URL: <http://complexityprimer.eng.cam.ac.uk>

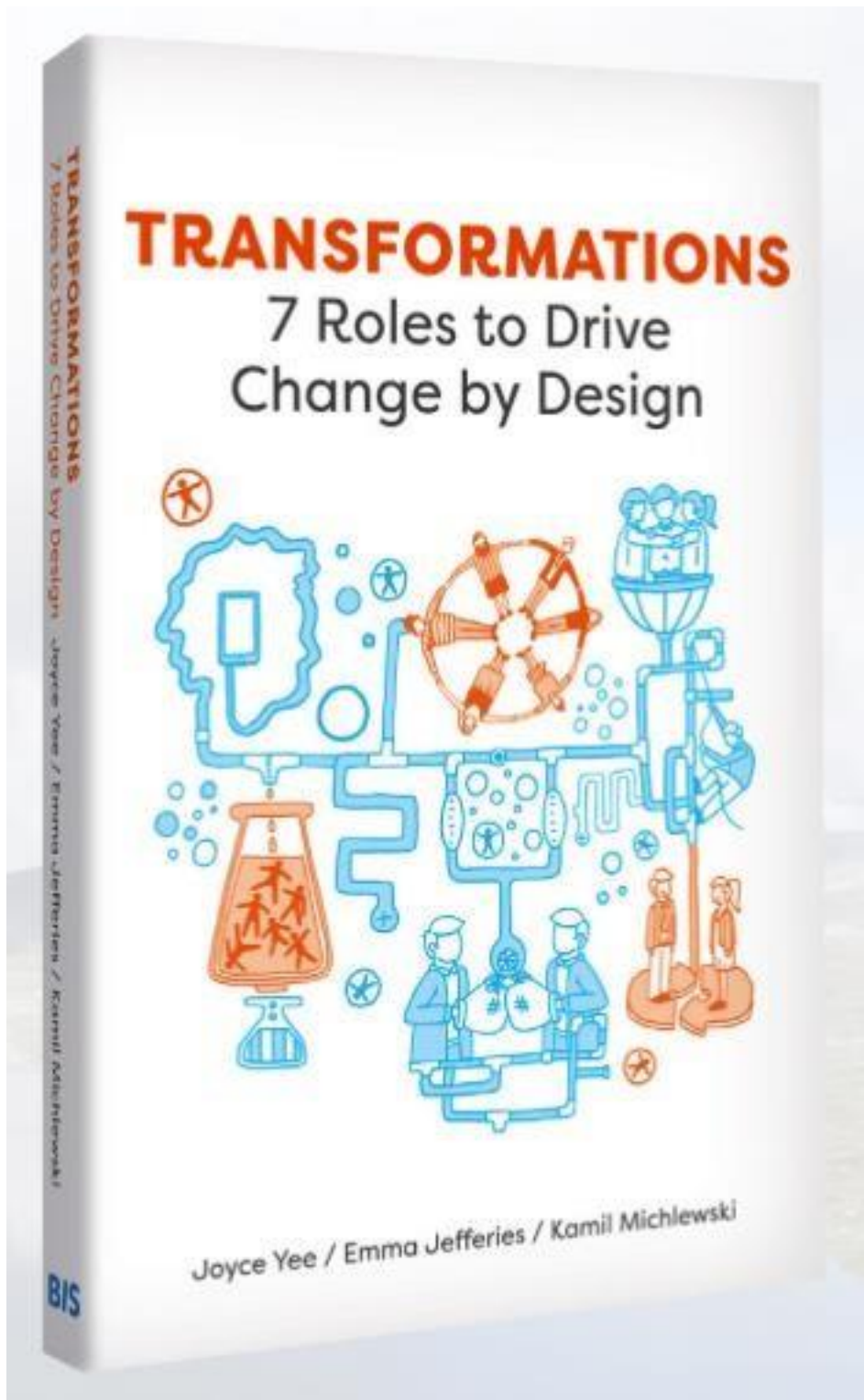
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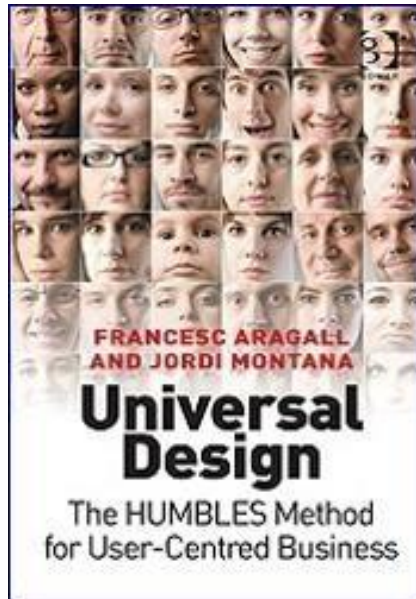
Amar Arnason and Sigurjón Baldur Hafsteinsson

DEATH AND GOVERNMENTALITY

Neo-liberalism, grief and the nation form



Universal Design: The HUMBLES Method for User-Centred Business



“Universal Design: The HUMBLES Method for User-Centred Business”, written by Francesc Aragall and Jordi Montaña and published by Gower, provides an innovative method to support businesses wishing to increase the number of satisfied users and clients and enhance their reputation by adapting their products and services to the diversity of their actual and potential customers, taking into account their needs, wishes and expectations.

The HUMBLES method (© Aragall) consists of a progressive, seven-phase approach for implementing Design for All within a business. By incorporating the user’s point of view, it enables companies to evaluate their business strategies in order to improve provide an improved, more customer-oriented experience, and there by gain a competitive advantage in the marketplace. As well as a comprehensive guide to the method, the book provides case studies of multinational business which have successfully incorporated Design for All into their working practices.

According to Sandro Rossell, President of FC Barcelona, who in company with other leading business professionals endorsed the publication, it is “required reading for those who wish to understand how universal design is the only way to connect a brand to the widest possible public, increasing client loyalty and enhancing company prestige”. To purchase the book, visit either the [Design for All Foundation website](#)

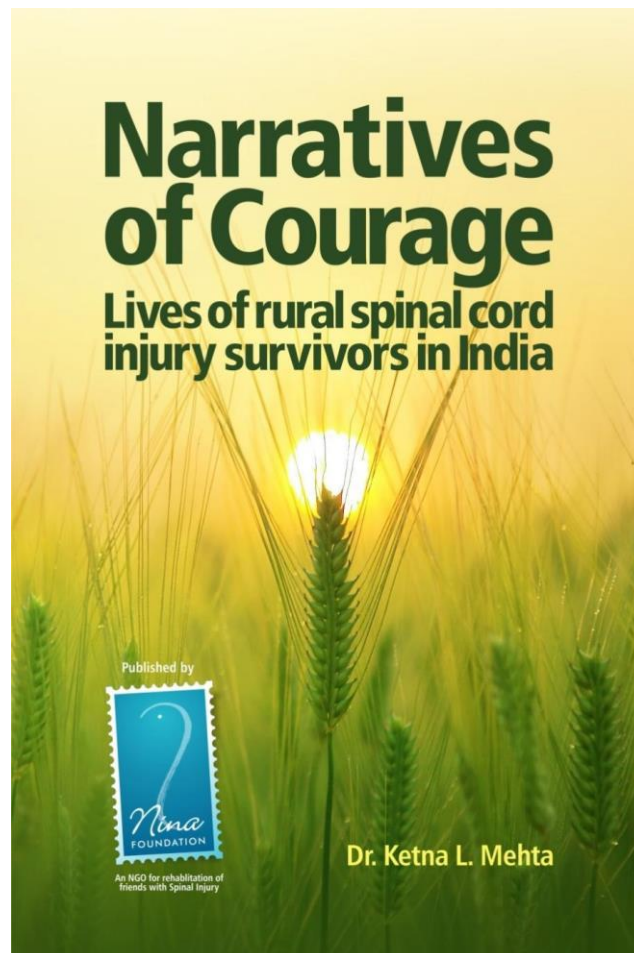
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Case Studies in Applied Behavior Analysis for Individuals with Disabilities *(Second Edition)*

Keith Storey, Ph.D., BCBA-D
Linda Haymes, Ph.D., BCBA-D

This book responds to a critical need for highly qualified personnel who will become exemplary professionals because of their advanced knowledge, skills, and experiences in working with students and adults that have varying disabilities, including Autism Spectrum Disorders (ASD). Since Board Certification for behavior analysts was introduced, there has been an expansion of training programs in Applied Behavior Analysis to meet the demands from school districts, health insurers, and families. In spite of these developments, a case studies book has not been available that uses the Behavior Analyst Certification Board Task List, Fifth Edition (BACB) guidelines for educating individuals receiving their BCBA, or for those in the field such as teachers, and service providers. The goal of this book is to fill that need. In this newly revised second edition, eighteen case studies are provided—case studies with complete analysis, case studies with partial analysis, and case studies without analysis. The format, readability, and detailed description of instructional methodology makes this text a valued resource for instructors and behavior analysts responsible for improving the skills of people with disabilities.

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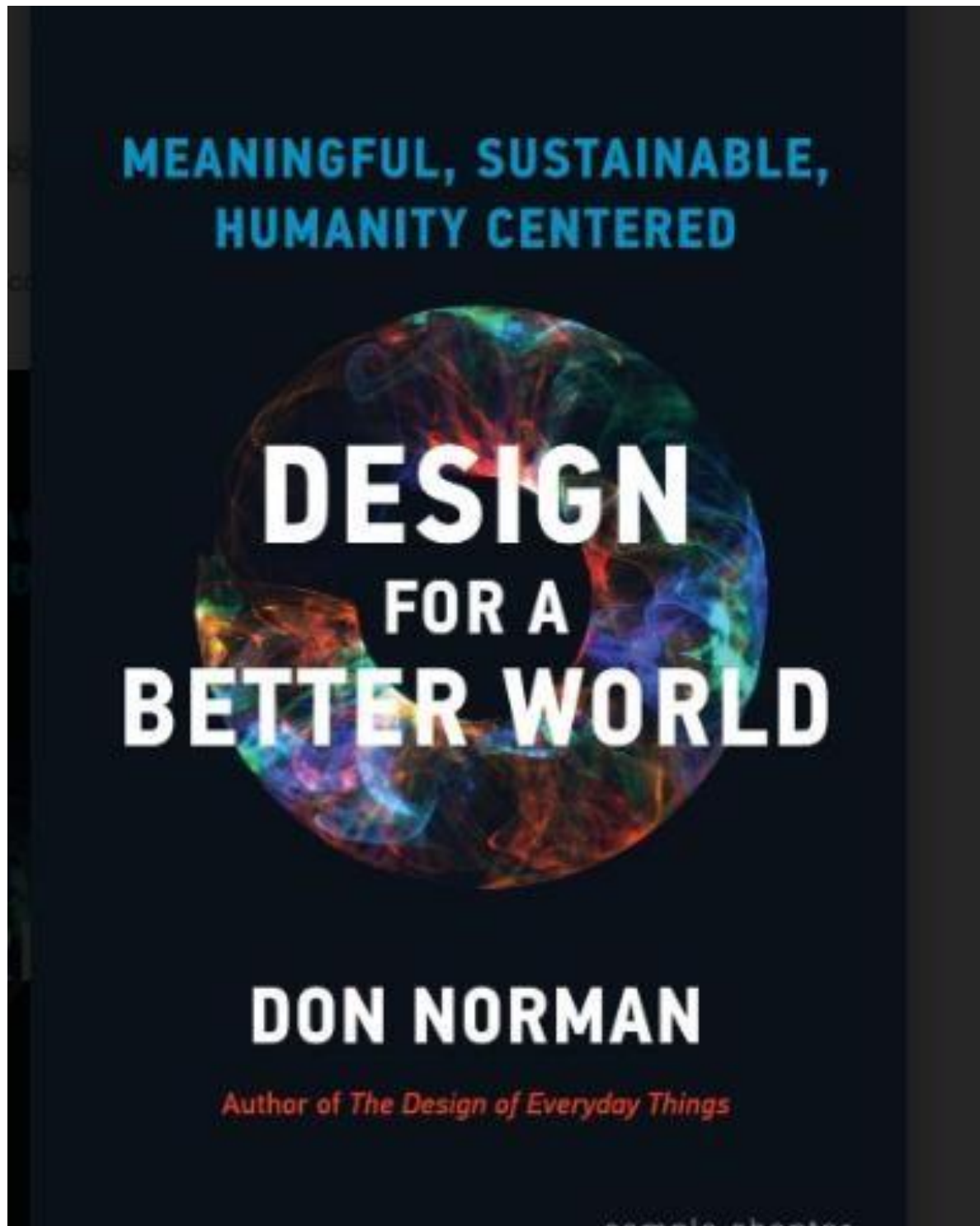


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News

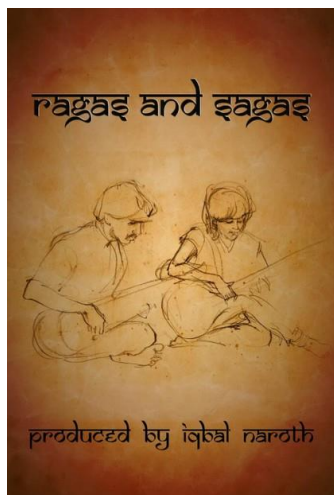
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The sound of healing



MESMERISED and moved by its soul-satisfying attributes, a Durban architect with a deep association with music plans to increase awareness around the art form's unifying traits and healing powers with a movie he's making.

Iqbal Naroth, 68, is producing a short film that he hopes will feature at the 2025 Durban International Film Festival.



A sketch of Iqbal Naroth strumming the sarod and his wife Nona playing the sitar. Picture: Supplied

He hopes the 20-minute movie titled Ragas and Sagas: Power of Music will also be snapped up for showings at next year's Delhi and London Film Festivals.

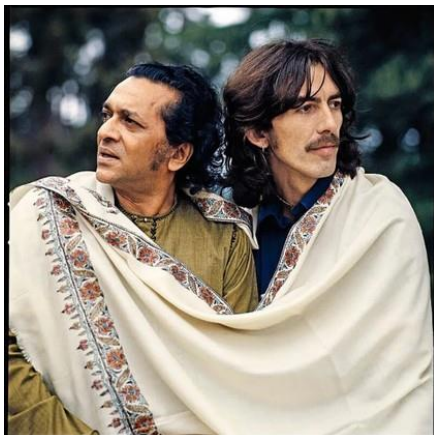
Ragas refers to Indian music and sagas to stories, and the movie will have descriptions for the visually impaired and script for the hearing impaired.



Dedicated music man Iqbal Naroth strumming on a sarod, a classical Indian music instrument. He is making a movie about the healing powers of music. Picture: Mervyn Naidoo

To illustrate music's healing properties, which is a prominent theme in the movie, he provides instances in which music improved the condition of people with medical challenges.

Another point of focus in the film was how music brought people together regardless of race or religion.



Ravi Shankar taught George Harrison from the British Band The Beatles how to play the sitar during their collaboration in the 1960s.

Naroth used the landmark collaboration between legendary Indian sitarist and composer Ravi Shankar and George Harrison, from the British band The Beatles, which resulted in a blending of musical traditions, as an example.

In reflecting on the timeless legacy of music, the movie references the impact it had in the days of King Akbar in the 13th century.

Naroth's experiences in learning Indian classical music and how it helped him overcome his own physical and mental challenges, by finding meaning to life after a motorbike accident left him paralysed from the neck downwards in 2003, is brought to the fore.

He regained his rhythm and zest for life largely through his attachment to the ancient sarod.

The sarod is a stringed Indian classical instrument that is held and played like a guitar, but requires precise picking at its strings to coax its "soul-piercing sounds".

Naroth, who is the only known sarod player in South Africa, said: "My daily practice helped me regain fine muscle control as my fingers deftly navigated the fretboard and executed complex strumming patterns with my right hand. The physical conditioning required to play the sarod has been instrumental in my rehabilitation."

Naroth credits the melodic aspects of the sarod for keeping his mind sharp, stirring his creativity and improvisation, complementing his physical therapy.

"I was rehabilitating without realising it."

Apart from his dedication to sarod, life after the accident saw Naroth indulging in western music having learnt to play the bass guitar.

He is a member of the Laminated Rotis, a band playing classical jazz. They appeared at various Splashy Fen Music Festivals and are a fixture on the local music scene.



Iqbal Naroth at the 2010 Splashy Fen Music Festival. Picture: Supplied

Naroth's architecture operations in Durban have also flourished. His company is responsible for the architecture of prominent Durban buildings like the Ahmed Al Kadi Private Hospital and the Point Road Family Court in recent years.

Naroth is a proponent of the universal design concept, which entails creating buildings for people with various abilities and disabilities.

He gives talks and has lectured on architecture locally and in India.

His formative years forged his connection with music.

"I attended the St Anthony's Roman Catholic school in Durban. There, we sang hymns every morning to piano music. During my mosque attendance, qawwali songs were sung. I heard bhajans (devotional music) when I went to the temple. Although I am a Muslim, I grew up in a Hindu home when a Hindu family adopted me."

Naroth said it all had a great influence on him as did the music from The Beatles, Miriam Makeba, Cliff Richards, and Elvis Presley.

***A Portrait of a Genius*, a Ravi Shankar album, was one of the first vinyl albums his father bought, was played repeatedly at his home and triggered his appreciation for Indian classical music.**

He was chuffed to know that Harrison was exposed to Indian classical music while in the womb, which laid the groundwork for his eventual connection with the Indian culture.

After matric, Naroth moved to London in 1974 having landed the opportunity to study towards a TV technician qualification.

But it was a ruse to beat the local system. Once there, he enrolled at the Merton Technical College for architecture.

“London is a hotbed for music and I studied tabla playing at a local college.”

While living and working in London, a friend introduced him to the sarod in the 1980s.

He enjoyed the music played on a sarod in an album, so Naroth contacted the Indian artist, Amjad Ali Khan, whose telephone number was on the cover.

He travelled to India to learn more about playing the sarod from Khan who became his teacher and mentor (ustad).

Under Khan’s tutelage, Naroth dedicated himself to mastering the intricacies of the sarod.

Naroth returned to South Africa with his wife Nona and young son Cazir to practise as an architect in 1988.

He was also an accomplished motorbiker and in 2002 became the Natal champion in the quad bike class, while his son took the honours in the motorbike section.

Naroth was riding in the Swazi 500 off-road race when he had his accident.

“It took me two years to recover.”

Gym work and music therapy got Naroth moving again. He is still able to ride quad bikes and he drives a specially adapted car.

He also appreciated Nona’s support.

“Nona is my rock. Her grit and confidence in me pushed me to strive for excellence, even when the road ahead seemed uncertain.”

Naroth wants his movie to tell the world about music's transformative power, able to transcend physical limitations and cultural boundaries.

The movie will show footage of a wheelchair-bound 96-year-old Russian woman, a former ballerina who had a stroke, doing dance moves to *Swan Lake*.

While doing his Masters in Universal Design, Naroth learnt how his supervisor's mom, a singer, lost her memory after a stroke.

"Her therapy was singing and in six months later she got her memory back."

Her story is included in the movie.

Naroth conducts workshops at retirement homes, exposing groups of residents to music therapy. He plans to feature some of the people who were uplifted by his music in his movie.

"Physiotherapists use certain pitches of sound as a form of treatment. Just as certain music pitches can break glass, there are music frequencies that have healing powers. Google might not back what I'm saying, but I believe it works."

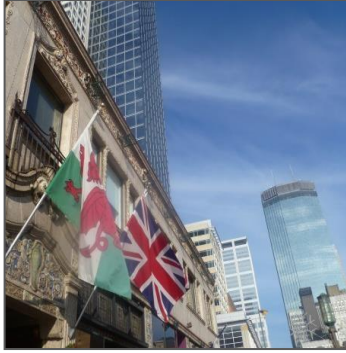
Naroth said everyone had "beat" in them.

"Ragas and Sagas celebrates the universal language of music. It has no language, sex or age barriers and you don't have to play music to be a musician, you can be one by listening."

In a recording, Khan said: "Iqbal is so passionately involved with music. He does not only understand Indian classical music but he enjoys all kinds of music genres, which is important because a human should be able to enjoy all kinds of music. That is very necessary and important.

"Nowadays, the medical world is taking the help of music therapy seriously."

(courtesy: IOL)



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The illustration depicts a vibrant, inclusive community scene. In the foreground, a road features a dedicated bicycle lane with a white arrow and bicycle icon, and a scooter lane with a white arrow and scooter icon. A person is riding a bicycle, and another is on a scooter. A bus is stopped at a bus stop, with a person in a wheelchair and others waiting. A person is pushing a stroller, and another is using a cane. A car is parked on the right. In the background, there are green hills, trees, a park bench, and a house. A city skyline is visible in the distance.



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Chief-Editor:



**Dr.Sunil Kumar Bhatia Faculty Member,
13, Lodhi Institutional Area, Lodhi Road, New Delhi-
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Editor:



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