Coexistent Perspectives (ACDC7001)

Research on participatory design for energy sustainability in the community context

6. Design Thinking - From Process to Product

Name: Yiming Ma

Student number: 2200429

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Abstract

As the basic unit of urban and rural residents' lives, the community is the basic unit of urban governance and the basic unit of the goal of "reducing energy demand". With the rapid development of urban renewal, the community has become a key field of practice, and its design process is closely linked to the daily life of residents. In this process, residents are not only stakeholders but also active participants and actors. Public participation in community renewal is an important way to explore the sustainable development of the community.

This paper will adopt the method of case analysis. By focusing on specific cases, such as the design project "Energy Babble", a design project by the University of London's Energy and Co-Design Community and "Co-local", we will explore how designers can promote the sustainable use of energy and the construction of community collaboration in the context of community. And we can analyze the role of designers and participants in the design process by this theory. In addition, based on the theory of participatory design, this paper explores its design process and sustainable practice mode as well as its future development direction and puts forward philosophical thinking on "environment-man-machine" interaction design.

1 Introduction

According to the International Energy Agency's 2019 World Energy Outlook report, with the continuous improvement of people's living standards, the demand for energy consumption is also increasing, which further leads to increasingly serious environmental problems. Therefore, adhering to sustainable lifestyles and translating environmental protection knowledge into concrete actions has become an important part of the global strategy for environmental protection. Reducing energy consumption is one of the major challenges we face today. In order to achieve this goal, various social groups are actively exploring low-carbon energy production and innovative manufacturing methods. However, the significant reduction in energy consumption is expected to be a major source of energy savings, and as a result, "reducing energy demand" has become a key topic in government policy discussions. At the same time, the government has made reducing energy demand a top policy priority in order to address CO2 emissions while ensuring the security and affordability of energy supply.

As the basic unit of urban and rural life, the community is the basic unit of urban governance, as well as the basic unit of the goal of "reducing energy demand", and the basic vehicle for building a resource-saving and environmentally friendly society. Changes in energy consumption depend not only on behavioural changes at the individual level, but also on the joint development of the community and existing emerging technologies (Gaver, Michael, Kerridge and Wilkie, 2015, p. 1115-1124). Low-carbon communities are the cornerstone of achieving future environmental

goals. With the rapid development of urban renewal, the community has become a key practice area, and its design process is closely linked to the daily life of its residents. In this process, residents are not only stakeholders, but also active participants and actors. Public participation in community renewal is an important way to explore sustainable community development. With the improvement of the quality of life, the community residents' demand for the living environment is gradually increasing.

This paper will adopt the method of case study, and through specific cases, such as the design projects "Energy Babble" of ECDC of the University of London and "Co-local", it will deeply explore how designers can promote the sustainable use of energy and the construction of community collaboration in the context of community. The role of designers and participants in the design process will be analyzed. In addition, based on the theory of participatory design, this paper explores its design process and sustainable practice model as well as its future development direction and puts forward philosophical thoughts on "environment-man-machine" interaction design.

2 Theoretical Background

(1) Development background of participatory design

Participatory design originated from the Scandinavian trade union movement. In order to address the problem of workers being deprived of their work rights by new technologies, researchers developed a design method called "language game",

which enables researchers and workers to solve various problems caused by new technologies together (Ehn and Kyng, 2020, p. 169-195). Subsequently, Scandinavians issued the "Scandinavian Challenge", a call for people to develop and use an industrial democratic design approach appropriate to The Times (Bjerknes, Ehn, Kyng and Nygaard, 1987). Participatory design developed in Scandinavia in the 1970s and 1980s. In the late 1980s, participatory design became popular in the United States and developed from a political field into a practical design method. In 1990, the first participatory Design Conference held in Seattle successfully attracted many outstanding masters and practitioners in the design field to participate, in which a large number of participatory theories came into being. Later, at the Participatory Design Conference in 2002, questions about design research were discussed in depth, such as how designers begin the design process, what their goals are, how they use it, and how they end it. The conference was held every two years from 2004 to 2014 to discuss the development mode of participatory design in different social contexts.

There are various definitions of participatory design, but the one that has been recognized as authoritative and accurate by Stanford University is that participatory design is a systematic design method that encourages all stakeholders to participate in the decision-making and design process (Bratteteig and Wagner, 2010, p. 51-60). From the past application, participatory design is not a design method that simply pursues goals, but focuses more on the design process and design steps. Participatory design has greatly improved the initiative of users in the

design process.

At the core of participatory design is the view of the design process as a collaborative practice. Users are not just recipients of the design, but key stakeholders and active participants in the design process. This approach values the implicit knowledge of the user, the experiences and intuitions that are not easily spoken but are essential to the design. In the design process, the externalization and sharing of this tacit knowledge can be promoted through creative interaction and interesting design activities (Muller, Wildman and White, 1993, p. 26-28). The goal of participatory design is not only to solve specific problems, but also to stimulate the creativity and imagination of participants. It encourages users to go beyond the traditional role of feedback or data source and become the leading force in the design process (Schuler and Namioka, 1993). In this way, participatory design can promote deeper community participation and continuous social innovation, bringing solutions that are more suited to the actual needs of the community and lasting social impact.

(2) Theoretical perspectives

Pay attention to the realistic ecological construction of the community

After products enter the consumer market, they tend to inevitably focus on the utilitarian side, but ecological civilization and energy emission reduction are not on the utilitarian side, which leads to a key question: In the current trend of individualism, utilitarianism and modernism, how should we find new paths to conduct deeper research and exploration of energy sustainability, led by design?

On the surface, using human-computer interaction technology to reduce energy demand may seem like a persuasive strategy. Designers can influence a user's energy use by providing real-time feedback, combined with persuasive computing methods to motivate people to reduce their energy consumption. Considering that sensing technology, user feedback, information visualization and home applications are key elements in the field of human-computer interaction, this field seems to have a potentially leading role in promoting energy demand reduction.

However, simple energy demand feedback and resource demand monitoring are not necessarily effective in reducing consumption. First, there is evidence that interventions produce only small and transient effects, and are prone to a "boomerang effect", whereby above-average consumers may reduce their energy use, while below-average consumers increase their energy use (Gaver, Michael, Kerridge and Wilkie, 2015, p. 1115-1124). Second, an instrumentalize designed solely to reduce energy consumption tends to desensitize users to the environmental impact of energy use. When any product can contribute to reducing energy consumption, users will fall back into the situation of focusing on product practicality or efficiency when making a choice.

As the Energy Babble project demonstrates, designers should focus more on the concrete realities of the community, rather than just focusing on technical means to reduce energy demand. Different environments respond differently to different products, and a single technological solution may not be adapted to specific local conditions. It is worth noting that paying attention to the reality of the community not

only includes the environment, energy consumption and carbon emission situation, but also the attitudes and practical actions of the residents of the community towards energy use. Any technical solution that is divorced from reality and overly simplified may become meaningless when faced with practical and effective solutions.

Participatory design based on the masses - focus on the participants

Although participatory design is often mentioned or used by many design teams, most people have certain misunderstandings about it, believing that the purpose of participatory design is to balance the interests of multiple parties to achieve win-win results. In fact, the purpose of participatory design is to stimulate the imagination of participants, that is, participation is not only to solve one thing, but also to trigger re-thinking and conceptual reconstruction through the problems raised by different representatives.

In the field of contemporary design, designers should gradually shift their focus from traditional questionnaires and interviews to a deeper understanding of participants' "sense of participation". This means that the role of the participant in the design process should be seen as more central and active. Their views and feelings are not just used to provide feedback or serve as a source of data, but become integral to the overall design process. For example, from the research analysis of the "Energy Babble" project, it can be seen that participatory design should not be limited to the initial stage of design, but should be throughout the entire design process, even including the unforeseen aspects after the design is

completed. Product design should be closely connected with users' daily lives and naturally integrated into their lifestyles. This design concept encourages the product to become a part of the user's daily activities, rather than just a passive object of use. Users should be able to integrate the product into their lives, making it a medium that stimulates personal thought and community discussion and interaction. Such design can promote a "designer-user-product" ecosystem where each component is connected to each other and together shapes the final form and function of the product.

This participatory design approach not only enhances the usefulness and relevance of the product, but also increases user satisfaction and engagement. It encourages designers to deeply understand the needs and expectations of users and to take these factors into account as important points of consideration during the design process. In this way, a dynamic and mutually reinforcing relationship is formed between designers, users and products to create design solutions that are more personal, meaningful and have a lasting impact.

3 Energy Babble's product research

Energy Babble is an Internet-enabled wireless appliance that collects "environmental" or "energy" related information from the web, from news feeds ranging from Twitter to the national grid, as well as user input via text message, email or built-in microphone (Fig 1). This information is converted into synthetic speech by a text-to-speech system, mixed with advertisements and sound effects,

to form an automated talk-style radio show that plays once an hour and has a built-in microphone for user interaction (Ovalle and Gaver, 2016).

Figure 1. *Energy Babble front and top view*

The product aims to stimulate discussion within the community by tapping into the creative and emotional aspects of energy use, with a view to reducing energy consumption (Gaver, Michael, Kerridge and Wilkie, 2015, p. 1115-1124). It is designed with the idea of participatory design in mind. Through this product, the community can be more actively involved in energy-saving practices. Therefore, a comprehensive design analysis of the product is conducted, including its design conception, materials used and interaction modes, while exploring the role and contribution of professionals in the energy sector in the design process.

(1) The design ontology of the product

In the start-up phase of the project, the goal of the team was not to directly create a tool to reduce energy consumption. Instead, they wanted the device to take shape as they interacted with the community and studied it. Energy Babble was designed to remain mixed, undefined and uncertain throughout the development and rollout phases. When the team first discussed the still-unformed "product," the focus was not on clarifying the specific goals of the system or how participants would be

involved, but rather on an interesting way to expose complex issues to participants and stimulate discussion among community members. Thus, Energy Babble is not only a practical information exchange tool on energy production and conservation, but also a system that intricately portrays and mimics energy topics. It can be seen as a combination of two natures: a product with utility on the one hand, and a research tool for reflection on the other. At its core, it aims to advance the understanding and practice of energy demand reduction.

The creation of Energy Babble is not accidental, but the result of gradual discovery by researchers in the course of goal-oriented exploration. The project was driven by the energy community involved in reducing emissions, including most community members, some representatives of the energy and climate change sector and other interested parties. They work together in workshops as project practitioners, innovators and change agents. In this participatory environment, researchers are aware of the imbalance between daily energy use and environmental goals by building interactions between participants and researchers. They hope to help raise awareness and ideas about how to reduce energy consumption. Before coming up with “Energy Babble”, the team explored a variety of strategies including "Energy tourism", "Sustained activism" and "Energy awareness". After months of development, a balance of community suggestions and product goals resulted in the concept of "Energy Babble": through web searches and input from participants, information is pooled to a central server, where content is organized in a variety of ways, and finally played on a variety of

public and home devices (Boucher, Gaver, Kerridge and Michael, 2018).

However, it is worth exploring the fact that, despite the device's simple and straightforward functionality, which is essentially the product of a speculative design, some volunteers saw a potential commercial value in Babble: it could be used as a marketing tool. Users can voice input their energy products, which can be picked up by other volunteers in the community, raising awareness of the product. So whether the product is a change in design philosophy or not, users will always find a way to make the product serve their practical purpose.

(2) The form in which the product exists -- the material and the way it interacts

The Energy Babble is a combination of two custom-blown glass components fastened to an injection-molded base (Fig 2). The base houses the device's various electronic components, such as a Raspberry Pi microcomputer, various actuators and a mini speaker. The central piece of glass enhances the sound of the speakers beneath it, making it ideal for this function by taking advantage of the acoustical properties of glass (Gaver, Michael, Kerridge and Wilkie, 2015, p. 1115-1124). The only interactive element of the device is a yellow knob that adjusts the volume, and when the knob is adjusted above the lowest setting, it plays a recording explaining the operation of the system. In terms of design, the appliance seems to have started with the exploration of birdhouses and nests, gradually moved to the study of various containers, and then focused on laboratory equipment such as test tubes, beakers and stills. The final design uses a glass cone to symbolize the storage and

release of data, which is not only attractive in a domestic environment but also harmonious with the surrounding environment.

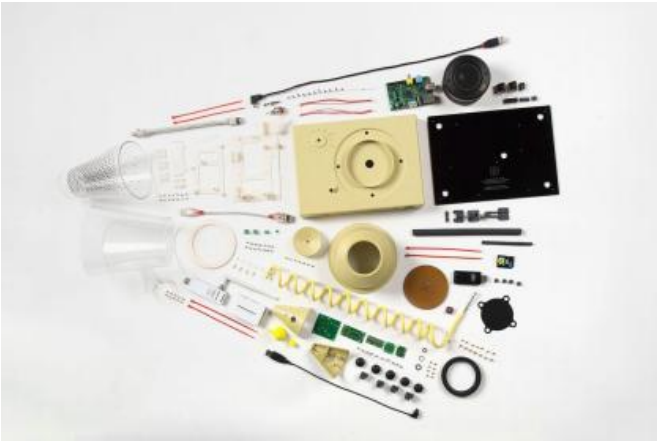

Figure 2. *Rotary button design and use of materials*

Babble has a unique aesthetic that is reflected not only in its exterior design but also in its sound output. The Babble displays both a lovely charm and a touch of vintage. It's shaped like a kitchen mixer or a lab chemistry unit, and the versatility comes from the glass it uses to evoke different feelings. This recombination of materials and design is a subtle critique of contemporary consumer culture, challenging the academic conventions and political status quo of the time. By substituting glass for plastic items common in modern consumerism, Babble offers users the opportunity to explore new uses for glass. Even in the face of seemingly familiar objects, people feel a sense of novelty, and this feeling leads to interesting discussions and reflections in everyday life.

Although the Energy Babble is conceptually a basic audio device, its implementation involves a meticulous evaluation of the intelligibility and aesthetics of existing speech synthesizers. This is to ensure that Babble can produce a

continuous stream similar to a newscast, interspersed with short snippets of music. Moreover, in addition to the audio output, the device's system, servers and control modules also have to work together to achieve its unique indirect playback effect.

The instructions for the operating modules simultaneously clarify how the product interacts (Fig 3). First, it mainly uses audio rather than visual or text as a way to interact with social media, similar to the radio experience. Unlike radio, however, Babble's information is unfiltered and neutral, creating a continuous stream of information that fully engages the listener in the subject matter. Second, it involves the user's contribution to the content and interactive Q&A with the device, which is a key part of Energy Babble's use of participatory design to encourage public engagement.

Participant Input Modules	Details
User Input	Users can enter their own statement through the microphone on the Babble device. Voice recordings are sent to servers, which pass them on to commercial services, perform speech-to-text translation, allow them to be resynthesized for anonymous input and make them consistent with the entire audio ecosystem. Text can also be entered directly via SMS.
Cue Robot	Develop a series of use questions (e.g. "How do you save energy?"), which is occasionally read out by the system to prompt the participant's response.
Markov Algorithm	Runs on content retrieved from URLs and separately on user input to produce a new string of text. Markov's algorithm finds the conversion probabilities of words from the corpus, which can be used to generate new word strings, and the results are often locally reasonable.

Figure 3. *Module input by participants*

While some participants suggested filtering audio content, arguing that too much information could appear cluttered, filtering could introduce utilitarian considerations. The team's insistence on the device's speculative goals prompted participants to shift their focus from Babble's functionality, utility and aesthetics to broader issues,

practices and controversies. This shift underscores the importance of participatory design in facilitating public exploration and discussion of deeper issues.

(3) Participation of energy community members in the exploration of the design process

The research team connected with members of multiple energy communities in the UK and adopted a design-led approach to develop interactions with these community members (Fig 4). This interaction ultimately led to the development of the Energy Babble concept and the exploration of how the concept could be further refined through software development and product design (Gaver, Michael, Kerridge and Wilkie, 2015, p. 1115-1124). The process of the project included initial site surveys of communities across the UK, workshops with participants, exploratory research into the culture, and the development of a series of design manuals (Fig 5).

Figure 4. *Participating in workshop tasks*

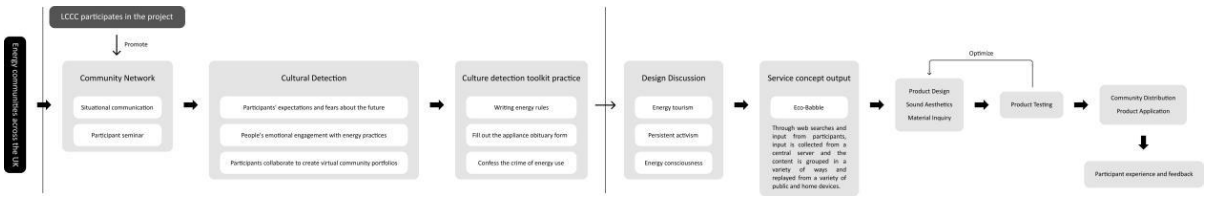

Figure 5. *Participatory design process for this project*

4 “Co-local”

EMERGENT DESIGN STUDIOS '" Co-local "project is a British urban mixed-use design that aims to revitalize vanishing local diversity and character by combining locally-based work environments, production practices and residential layouts (Fig 6). As an integrated development strategy, Co-local taps into the historical, cultural and economic character of its setting, with the aim of creating a work environment that is rooted in the locality, community-driven, sustainable and highly connected. This strong focus on the identity of the location sets the project apart, as it achieves its goals through a collaborative and co-designed approach.

Figure 6. *Design drawing of Co-local*

The collaborative team is active at the intersection of three key functions: work, production and life (Fig 7). The interconnectedness of these functions forms the cornerstone of the shared collaboration and well-being sought by young professionals and emerging industries. Local workers, residents and neighbourhoods demonstrate diversity in flexible work habits, schedules and ways

of communicating. They work in a stimulating and diverse environment, share knowledge and resources with each other, and take advantage of shared amenities and public facilities. At the same time, they are enthusiastic about local production, handicrafts and public cultural affairs.

Figure 7. *Three key functions*

The "Co-local" design concept emphasizes the close connection of cities in terms of transportation, energy and data transmission infrastructure, and focuses on the unique historical, cultural and economic attributes of cities. The heart of the concept is to ensure that architecture and planning are inspired and influenced by a broad group of users, in order to achieve a harmonious integration with the local human environment, thereby promoting sustainable development. This approach requires designers to not only consider technical and functional aspects in the planning process, but also to have a deep understanding of and respect for the local historical context and cultural values to ensure that the design is both functional and reflective of the regional character.

"Co-local" showcases an innovative approach to urban planning, which cleverly

combines the idea of participatory design with the practice of modern urban planning. It focuses on the active participation of community members, and this design philosophy is not only reflected in all stages of project planning, but also in its spatial layout and function. This bottom-up approach gives the project a unique, community-led style. Its design emphasises the multi-use and flexibility of the space, allowing the complex to accommodate a variety of social and cultural events. This not only promotes the practicality of the space, but also enhances its adaptability to the changing needs of the community. The aesthetic elements of modern architecture have been adopted in the specific design, with its clean and smooth lines and the use of modern materials adding visual appeal. At the same time, it reflects the concern for environmental sustainability in the choice of materials and energy, which conforms to the green trend of contemporary urban design. The design of the project also fully considers the coordination with the surrounding environment, whether it is in tone, material selection or overall layout, and strives to form a harmonious dialogue with the environment, which reflects the deep understanding and practice of the "environmentally friendly" urban design concept.

"Co-local" is not only a multi-functional urban space design case, but also a deep reflection and response to the modern urban lifestyle. It demonstrates the key directions of modern urban design in terms of community participation, flexibility, modern aesthetics and sustainable development. Through the concept of participatory design, it makes reasonable use of the functions of each plate, which greatly facilitates the daily life of residents, and at the same time achieves the

sustainable development of community energy, which is conducive to our reflection on the philosophical thinking of interactive design.

The development of the design field has gradually evolved from the initial surface treatment to focus on electronic functions and interactivity, and finally shifted to human behaviour, goals and motivations, which is consistent with the trend of "environment-human-machine interaction". Human-centred design and usability design, as means of measurement and optimization that focus on utility and efficiency, are often seen as universal tools that can meet a variety of needs, relying on continuous data collection and information integration to create intelligent products that seem to know themselves better than the user. This approach not only leads to the emergence of "filter bubbles" that limit the diversity of users' horizons and thinking, but also intensifies user backlash and protests against dissatisfied products.

Information interaction design is increasingly focused on improving the user experience, but sometimes at the expense of broader social issues. Therefore, the current design practice needs to strengthen reflection and exploration, designers should not only focus on efficiency and optimization but should more deeply understand, explore, express and recognize the interrelationship between users, objects and the system they are in, in order to deal with problems more intuitively. It is important to recognize that objects are mediums of expression and not just the embodiment of their function. Users give objects a specific meaning based on their understanding when they interact with them. Function is so closely tied to the

dynamic use of objects that it is difficult for designers to directly define the function of objects and predict how users will understand and use these products. Therefore, the so-called representative user group in the design process is often only an experimental goal. Designers should accept uncertainty in the process of human-object interaction.

Today's designers often rely on the concepts of optimization, practicality, and operability to drive product consumption. However, this approach often ignores the practical functional connotations of the project, as well as the symbolic, cultural and existential nature that the product may have. In fact, the function should cover a broader spectrum, including structural function, physical function, mental function, social function, and cultural existence function (Fig 8). User experience standards and product functionality evaluation should start from these dimensions, focusing not only on the physical structure and utility of the object, but also on the user's emotional response to the object, its social attributes, and its deep-seated cultural symbols.

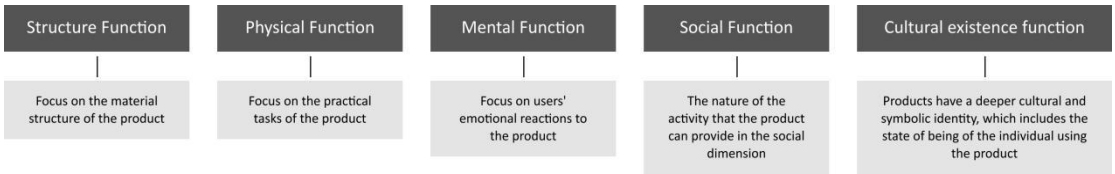

Figure 8. *Five functional attributes*

5 Conclusion

"Energy Babble" and "Co-local" break through the traditional design framework. These projects not only focus on the transformation of the physical environment but

also on the interaction of "environment-human-machine". By analyzing the theory of participatory design, these cases show how designers can explore new ways of energy sustainability and building community collaboration in a community context.

Through the analysis of these cases, participatory design practice not only requires designers to pay attention to the "sense of participation" of community members and the "designer-human-product" engagement at the post-design stage, but also requires designers to critically re-establish the role of interaction design in the service process, instead of superficially analyzing the role of interaction design in the service process. It is also necessary for the designers to rebuild the role of interaction design in the service process in a discursive way, rather than thinking superficially about the dividends brought by the technology, or else they will lose the inquiry into the construction of community ecology and culture itself.

Perhaps in the future of participatory design practice, designers will shift from their traditional roles of modelling or innovation of tangible and physical products and systems to that of facilitators of mass innovation. From being a subjective exporter of products to a medium that connects the public to the products. In this context, designers need to develop design methods and processes, and be prepared to adapt cognitive structures and skills to create a foundation that facilitates user-stakeholder interactions. For example, "workshops," which have become common in recent years, can be considered an extension of participatory design. Researchers from Hunan University and Chiba University have proposed the PDCA model and the SPAR model through participatory practice, and have

summarized the experience of the Changsha Fengquan Gujing Community Design Workshop under the SPAR model from the perspective of the sustainability of the effect, suggesting that the cumulative effect of time and the feedback mechanism of repeated evaluations are the key factors for the success of participatory design in the context of community design. (Shen and Yang, 2018, p. 179-186).

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