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Metadesign as a strategy for the evolution of outdoor metal furniture

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Abstract

Outdoor metal furniture has permanently been an interesting topic in facility planning and design. **Metadesign** means the active participation of end users in the furniture development process, by providing information about their requirements, drawing on their experience with furniture and its problems. This research contributes an understanding of the desirable properties of a successful metadesign system, in relation to the evolution of outdoor metal furniture through three aspects:

First: Fundamental constituents of metadesign for outdoor metal furniture

A fundamental objective of metadesign is to create socio-technical environments that empower users to engage actively in the continuous development of products. Metadesign is a design paradigm that includes end users as active members of the design team.

Second: Applying metadesign to outdoor metal furniture

(Human-computer interaction) HCI experts, software designers, and users acting as developers, each through his or her (software shaping workshop) SSW, can access, test, and modify the furniture product. They can also exchange the results of these activities to converge to a common design for outdoor metal furniture evolution.

Third: Parametric design strategies for outdoor metal furniture

Parametric design explores the connection between advanced computational design techniques, and the engagement of reality in the production of outdoor metal furniture. Exploring contemporary modes of digital design to production contributes to the setting up of a flexible design strategy responding, to the needs of customers nowadays. The goal is to rethink the relationship between design and environment, and engage them in a dialog, through the production of outdoor metal furniture.

Keywords

Metadesign - collaborative design - characterizes design - participatory design - computational structures - parametric design.

Introduction

Outdoor metal furniture is a type of furniture that uses metal parts in its construction. There are various types of metal that can be used, such as iron, aluminum, and stainless steel. Cast Iron is used mainly for outdoor finishing due to its hardness, heaviness and general tough composition. Stainless steel is used very extensively for most modern furniture. It has a high tensile strength, allowing it to be applied using hollow tubes, sheets and hinges reducing weight and increasing user accessibility. Aluminum is a light and corrosion resistant metal, and to take advantage of these qualities, it is heavily utilized for stamped and cast furniture, especially in the category of molded chairs. Types of outdoor metal furniture are:

1. Street furniture is a collective term for objects and pieces of equipment installed on streets and roads for various purposes.⁽²⁴⁾ It includes benches, traffic barriers, bollards, post boxes, phone boxes, streetlamps, traffic lights, traffic signs, bus stops, tram stops, taxi stands, public lavatories, fountains, watering troughs, and waste receptacles.

2. Park Furniture plays an important role in society. Park furniture is similar to street furniture but located in a park. It serves as an essential function to these outdoor areas providing visitors and park users with furniture that can be used for sitting through chairs and benches, eating and drinking through tables, as well as fountains and general maintenance like lights, bandstands, picnic tables, bike racks, bin enclosures, bollards, sheltered furniture, signs and tree guards.

3. Garden furniture includes umbrellas, chaises longues and couches. Current accessories of garden furniture include items like birdbaths, plant stands, planter boxes and trellises to add detail to an outdoor space.

Metal furniture is a perfect choice for outdoor use because it lasts a really long time. Durability is the main advantage of outdoor metal furniture; since it is treated for rust and heat resistance, it doesn't need much maintenance, and gets better-looking as the years go by.

Metadesign (or meta-design) is an emerging conceptual framework aimed at defining and creating social, economic and technical infrastructures in which new forms of collaborative design can take place. It consists of a series of practical design-related tools for achieving this. As a methodology, its aim is to nurture emergence of the previously unthinkable as possibilities or prospects through the collaboration of designers within interdisciplinarity metadesign teams. Inspired by the way living systems work, this new field aims to help improve the way we feed, clothe, shelter, assemble, communicate and live together.⁽²⁵⁾

Metadesign refers to the objectives, techniques and processes for creating socio-technical environments that empower end-users to contribute to the continuous development of their systems during use.^(3:35)

Meta-designers create socio-technical environments that provide the tools for other people (consumers and designers) to express their creativity and shape the environment to fit their emergent needs. In addition to creating technological artifacts, meta-designers create the necessary conditions,

both social and technical, to facilitate and encourage expansive participation in design.^(4:22)

The notion of metadesign has been applied in industrial design. These applications have focused differently on the concepts associated with metadesign, ranging from processes of high-order design to participation and co-evolution. The idea of reflexive thinking about design has been commonly translated in the application field as the “design of a design process”. In furniture design, in particular, metadesign has primarily been connected to the idea of working with computational structures on a higher level of design. Because a computational object has a discrete structure, parts of the object can be easily accessed, modified and substituted by other parts, it is not fixed and it can be generated and manipulated without actually drawing it. Metadesign is used to mean the construction of a template that makes a product “that thing” without actually designing it.^(7:14)

Metadesign provides a conceptual framework that enhances and supports creativity and cognition for outdoor metal furniture in communities. Metadesign environments allow stakeholders to act as designers, making it possible to deal with new requirements as they emerge during the development of outdoor metal furniture, and thereby contributing to the integration of problem framing and problem solving as an important source for creativity. Metadesign is composed of a few well-defined procedural shape building blocks. It can generate a large variety of shapes and forms that covers most of the design space of outdoor metal furniture.

Research question

What is the effect of the application of metadesign inspired guidelines and end user participation on the evolution of outdoor metal furniture during design activities?

Objective

This paper aims to provide a framework to facilitate participatory co-design between end users and furniture designers using HCI, for the evolution of outdoor metal furniture.

Hypothesis

Metadesign can provide the foundation for social creativity, and try to create a shared understanding among all stakeholders that leads to new insights and new ideas for outdoor metal furniture, through creating new media environments in which stakeholders can act as designers and be more than users.

Research methodology

The Quasi-Experimental Method has been followed to explore the effect of metadesign inspired guidelines and participation on design and providing end users with the tools necessary to evolve outdoor metal furniture.

1- Fundamental constituents of metadesign for outdoor metal furniture

Whereas, in essence, design is a planned, predictive task, metadesign encompasses a collaborative process, ‘a shared design endeavour aimed at sustaining emergence, evolution and adaptation’^(7:21). Here an opportunistic process of ‘cultivation’ follows a process of ‘seeding’. The Greek word ‘meta’ originally meant ‘beside’ or ‘after’. In its common use, today, it also implies change or transformation. It therefore implies transcendence or

comprehensiveness.^(10:2) Metadesign can be defined as a “mode of integrating systems and setting actions in order to create environments in which people may cultivate creative conversations and take control of their cultural and aesthetic production”^(7:12).

Those who facilitate metadesign teams invite participants to integrate their individual

identity through several stages of development to be able to ‘think-for’, ‘thinkwith’ and to ‘think-as’ the team.^(23:2)

We define this process as moving from ‘me’ to ‘we’, through cycles of individual and collective action and reflection. (See figure.1).

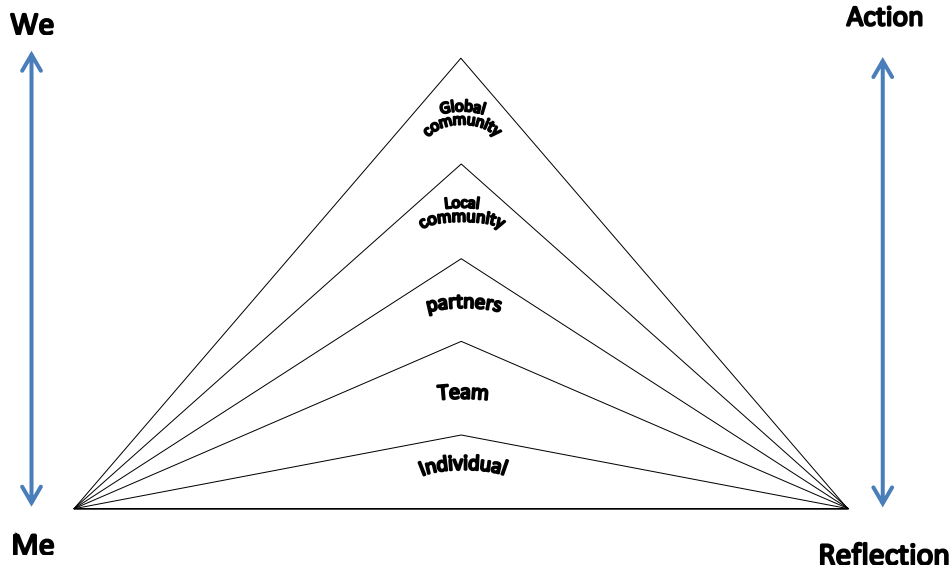


Figure (1)

A nested diagram of the metadesign process

The figure is situating the individual designer within a dynamic set of interrelationships with other stakeholders involved in or influenced by the process. On the left hand side is a continuum charting the journey from ‘me’ to ‘we.’ The continuum on the right represents an ongoing process of action and reflection. "In this sense, metadesign can be described as being ‘co-creative and co-evolutionary, encouraging an unselfconscious (or spontaneous) culture of design”.^(10:2) Some described this" beyond goal-orientated design process beautifully as

‘shared imaginative living – end-in-itself’".^(11:2)

Metadesign can be understood as a set of four "conceptual tools"⁽²⁵⁾:

1. Levels of Abstraction (the ability to understand the structure and limits of abstractions, and instrumental thinking)
2. Diagrams and Topology (the use of diagrammatic thinking and design, sustained by topological understanding)

3. Procedural Design (the creation of realities through the use of procedures)
4. Emergence (the absence of absolute control, and the ability to take advantage of unintended and unforeseen results)

The idea of metadesign proposed originates inside a linguistic inheritance and intellectual debate calling for a democratization of the creative process of invention and leading to a strong sense of design as a “change of place, order, or nature” matching ideas of design as improvisation, modification, and evolution.^(7:22) Metadesign supports improvisation and change to fit the new needs and opportunities that arise during the presentation of outdoor metal furniture. In doing so, metadesign addresses critical design challenges, including:

1. Coping with ill-defined problems: Complex design problems are ill-defined^(15:141), because they are not understood well enough to be described in sufficient detail, they cannot be specified accurately in advance.
2. Supporting reflective practitioners: Characterizing design as a reflective conversation with the materials of the design situation.^(17:2) Designers gradually build their understanding of a design problem and its solution by thinking about what they are doing while doing it, in such a way as to influence further “doing”. Being able to create and arrange over time the materials of the design situation is crucial to reveal new opportunities and envision emergent possibilities.
3. Design as a Collaborative Process: Complex design problems require

more knowledge than any single person can possess, and the knowledge relevant to a problem is often distributed among stakeholders with different perspectives and backgrounds.^(16:238) Bringing together individuals with different knowledge, abilities, and motivations is critical to generating more creative and sustainable solutions.

The key guidelines for the metadesign of socio-technical systems are: providing building blocks, under-designing for emergent behavior, establishing cultures of participation, sharing control, promoting mutual learning and the support of knowledge exchange, and structure communication, to support reflection on practice in the evolution of outdoor metal furniture.

Metadesign suggests that designers of outdoor metal furniture must give up control to users and that users may play the role of consumers or designers depending on context. Metadesign situates design within the context of problem solving, while supporting the inherent improvisatory, evolutionary, and participatory nature of human design. Metadesign seeks to understand user needs through creating a space for stakeholders to shape and form a design of outdoor metal furniture. Furniture designers must anticipate as much as possible, future scenarios of use and future needs of end-users in order to continuously evolving outdoor metal furniture.

2- Applying Metadesign to outdoor metal furniture

Outdoor metal furniture has a direct unique relationship to Urban Planning and Architecture. But it takes some initial

exploration to uncover and understand the essence of the relationship and its inner working within every place. There is no doubt that by any definition outdoor metal furniture has two aspects: art and science/technology. In this context, it seems that outdoor metal furniture designer has to know about both. This is not to say that individual designer of furniture need to be experts in both, nor equally versed in both. It is to say, however, that both are necessary to create and realize outdoor metal furniture.

In the course of the design process, between an idea and a manufactured product, design teams rely on representations in order to bring the idea forward. More strongly stated, the only tools designers use are representations, whether they be narratives, sketches, physical prototypes, CAD models, or purely numeric representations used for optimization. Thus, a product's success may be considered to depend on the effective management and implementation of representation.^(2:119)

The human-computer interaction community has promoted user-centered design,^(12:48) thus playing a Positive role in design, participatory design, by promoting a more active involvement of end users throughout the outdoor metal furniture design process. More specifically, End-user development leads to transfer to end users part of the activities that are traditionally performed by designers group namely, not only adaptation and extension by means of end-user but also interaction design, system prototyping, customization, and maintenance.^(1:481) The software environments are where professional or non-professional which are interested to developing furniture find all and only the

objects and tools necessary to form outdoor metal furniture.

The designers (developers) of SSWs are organized according to a three-level hierarchy^(5:3):

1. At the metadesign level: SSWs used by software designers to create system workshops for domain experts.
2. At the design level: domain experts use system workshops to cooperate in the design, implementation, and validation of application workshops for end users.
3. At the use level: end users carry out their tasks through application workshops created at the design level and customized to their needs, culture, and skills.

"With respect to the software shaping workshop methodology, the approach proposed here deepens the activities to be carried out in the metadesign phase. Particularly, a metadesign team, including not only software designers, but also specialists and domain experts, defines at first the conceptual model of the software environments devoted to end users. This activity should be carried out through participatory design techniques",^(19:119) such as meetings among all stakeholders to perform task and scenario-based analysis, or mock-up development. Metaphor and interaction style of the environments for end users are thus defined, they will strongly depend on domain characteristics and users' habits. This is a way to have more control on their activity and avoid the creation of unusable products. Meta-model represents a domain-dependent class of software environments for end users. Usability of the resulting environments is achieved through a

metadesign activity, carried out through user-centered and participatory methods.

Metadesign can use design and production approaches that enable lay people to take a greater amount of control over outdoor metal furniture. Designing this kind of furniture has been relatively fixed historically because of constraints and economic implications of mass production. The complexities of the production process have also helped reinforce a division between “designer” and “users”. This new type of design thinking welcomes flexibility, in lieu of fixity, in the designed elements of outdoor metal furniture. The distinct line separating designer and consumer blurs as a result of this process. Metadesign focuses on the “design of general structures and processes, rather than on fixed objects.”^(7:24) This approach allows lay people access to tools that can be used to evolve outdoor metal furniture solutions within a framework provided by an original designer. The effect of this would be variety and continual evolution in product outcome. When translated into a furniture design realm this approach has specific implications for the role of the designer. "In lieu of designing forms, the designer now provides working tools to lay people. Parametric thinking is a way to connect furniture to this emerging digital realm. Parametric properties will be established by design professionals to provide the framework and constraints for individual objects of outdoor metal furniture. Once these parameters are established, the furniture design becomes morphologically diverse but still has boundaries or limits that ensure its manufacturability."^(9:415)

There are numerous programs (software) strategies that can be developed and used

that are helping design and manufacturing processes evolve from the standardized product approach, wherein success is determined by uncovering specific user needs, to a parameterized approach that invests less in specific user needs and more in tools that users are given to arrive at a product that is desirable.

Toolkits for User Innovation are “design tools that enable users to develop new product innovations for themselves”. These Toolkits allow users to “create a preliminary design, simulate or prototype it, evaluate its functioning in their own Virtual environment and then iteratively improve it until satisfied.”^(8:822) The application of Toolkits or their equivalent in the furniture realm represents a transition from a form-centered approach to a design approach that favors the generation of operational structures that allow individual lay users to transform the elements of outdoor metal furniture, within a set of manufacturing constraints, to arrive at a desired customized product.

Metadesign provides flexible, modifiable outdoor metal furniture during design activities by end users designers. Metadesign systems are inherently continuous – design never stops – and participatory – users contribute to design the outdoor metal furniture in an ongoing co-design process. Metadesign is based primarily on recent technological trends; it seeks to further our understanding of the value of user participation, as well as the effect of idea generation on outdoor metal furniture. More generally, a practical understanding of Metadesign describes it as a technology tool supporting end-user customization, in the field of outdoor metal furniture.

3- Parametric design strategies for outdoor metal furniture

Parametric design is a process based on algorithmic thinking that enables the expression of parameters and rules that, together, define, encode and clarify the relationship between design intent and design response. ^(22:215) Parametric design is a paradigm in design where the relationship between elements are used to manipulate and inform the design of complex geometries and structures. Parametric design has always formed part of the design process. Parametric modeling systems can be divided into two main types of systems:

1. Propagation based systems where you compute from known to unknowns with a dataflow model.
2. Constraint systems which solve sets of continuous and discrete constraints.

Form-finding is one of the strategies implementing a propagation based system. The idea behind form-finding is to optimize certain design goals against a set of design constraints. ^(21:3)

Parametric definition is the process through which a parametric design problem is formally identified and described by means of structures (structure is temporally regarded as the process of organizing) that aid designers in the development of computational synthesis tools. The description of the problem should explicitly reflect the structure and relations that originate the design problem. Therefore, the research proposes the definition phase as a three-folded activity that accounts the processes of:

1. Exploring the parameters required for the representation of a given conceptual design.
2. Structuring it so that the problem can be divided in smaller chunks.
3. Developing a meta-model that captures the structure, components, parameters and relations on which the instantiation process can take place to result in full descriptions of the design object of outdoor metal furniture. Figure (2) illustrates the design definition processes.

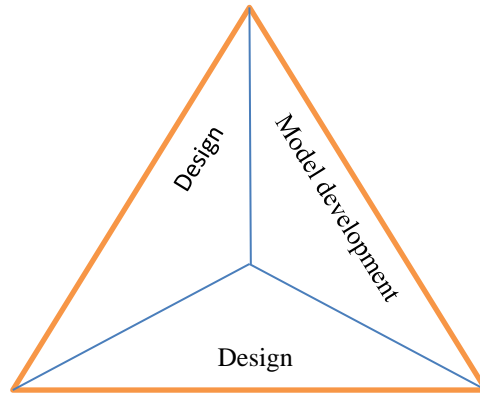


Figure (2)

Design definition of parametric design problems

The purpose of designing is to transform a function into a design description so that the design object being described is capable of producing those functions. Design descriptions allow representing objects elements and their relationships. This is usually done by means of drawings, mathematics and texts.^(6:28) This implies that design involves the process of exploring the entities as well as the relations required for representing a design of outdoor metal furniture.

The Function-Behaviour-Structure (FBS) modeling and an analysis based information flow classification serve therefore as theoretical background for determining the set of entities and relations that:

- Define the topology and dimensions of the furniture design
- Describe furniture's surrounding environment.
- Allow assessing the behavior of the outdoor metal furniture relative to a given function.

FBS modeling allows the representation of a design by distinguishing three levels of object representation:^(20:352)

1. Function is related to the perception designers have on an object structure.
2. Behavior is related to the sequential change of states the object goes through for delivering the required function.
3. Structure is related to entities, relations among entities and the attributes of entities for physical representation of the design object.

By using these three design object representation levels, FBS modeling allows linking a design function to an eventual form or structure that fulfills the required function. To do so, an intended Function is related to Behavior that allows the Function to exist by a human specified mapping. Behavior is related to the response of a Structure for producing the required function by Fundamental Principles, also regarded as laws of physics.

Objects structure of outdoor metal furniture design can be described by three properties:

1. Vocabulary of elements.
2. Description of the elements.
3. Configuration of the elements.

These properties should be represented by a meta-model suited for computational synthesis. Vocabulary of elements is the end result of a conceptual design phase, and is, therefore, known when performing a design definition activity. Configurations can be inferred from an FBS representation of the conceptual design. They emerge from the behavioral representation of the design object and can be translated into two types of relations:

1. Topology relations expressing the connectedness of the elements.
2. Element constraints, also regarded as physical coherence constraints, derive generally from a behavior common to all design objects. This behavior draws from the fact that the activity of designing is carried out with the expectation that the designed outdoor metal furniture will operate in the natural world and the social world.

The information flow around an analysis technique can be categorized into three groups:^(18:4)

1. Embodiment regards the set of parameters describing the design object elements, topology and properties.
2. Scenario is related to the set of entities describing the flow of energy, mass or information the embodiment is exposed to.
3. Performance determines how the embodiment behaves under a certain scenario.

These entities, later on regarded as parameters, are constraints to assure physical integrity and avoid physical impossibilities.

Synthesis is the process where embodiment parameters are specified aiming at meeting a group of performance parameters under the presence of a given scenario. Design rules have an inverted effect to analysis, since scenario and/or performance parameters allow instantiating embodiment parameters. Having described these concepts, it can be summarized that:

- The groups of parameters describing the elements of a Structure are: embodiment parameters, scenario parameters and performance parameters.
- Analysis techniques allow quantifying the accomplishment of the design object expected behaviors.
- Design rules, when existing, allow using scenario and performance knowledge to make statements of the embodiment.

Industrial production techniques have evolved considerably. “Flexible Manufacturing System for Mass Customization Manufacturing” defines three types of manufacturing concepts:^(14:376)

1. The first type: known as a standardized product, has predefined attributes, giving the user no choice except whether or not to use the furniture.
2. The second type: known as a configured product, allows users to choose from limited options which the designer has specified. The configured product indicates a trend toward mass customization but limits the extent of that customization for cost purposes.

3. The third type: Is called a parameterized product, and the process to arrive at this product outcome is referred to as additive manufacturing. This product is built using parameters and as such allows the user to significantly modify its features.

The parameterized product is mass-customizable, which defines mass customization as a “strategy that seeks to exploit the need to support greater product variety and individualization”^(13:223).

Metadesign emerges as a result of new capacities brought about by advanced technologies and digitalization. Unquestionably, parametric design techniques offer the potential for manifold variations and iterations of forms and qualities to be produced economically. This suggests that the parametric in "outdoor metal furniture" design has worked to predominantly simplify the complicated, allowing designers to further their collective desire for an excess of control throughout the design process.

Parametric tools are algorithmically based, and therefore offer increased computational control over design geometry during design activity. Software systems must have features that permit users to create customizations and extensions for outdoor metal furniture.

Discussions & Conclusions

Metadesign offers an innovative way of generating new design solutions for outdoor metal furniture. This paper provides a comprehensive understanding of the fundamental constituents of metadesign by using the following techniques: HCI, SSWs, and the application of Toolkits, which

support the strategies of parametric design that plays an important role in the generation of creative and evolutionary designs.

Using a metadesign strategy will enhance the outdoor metal furniture designer's marvelous insight into and control of design theory, design principles, his sense of space and the ability for the creation of forms that combine the foregoing into a tasteful, attractive, and functional entity. The function of design and designers is to provide new directions and perspectives - new schemes to solving problems for outdoor metal furniture.

Metadesign is not simply a new design methodology; it is a cultural development exploring the new design of outdoor metal furniture engendered by information technologies with the aim to expand the creative process of emergence and invention. Metadesign supports new modes of human interaction and sustain an expansion of the creative process; it can be seen as a form of cultural strategy that represents a constructive mode of design for the outdoor metal furniture.

Metadesign characterizes activities, processes, and objectives to create new media and environments that allow users to act as designers and be creative in outdoor metal furniture design. End users do perform their activity as competent practitioners. They exhibit a kind of knowing in practice for outdoor metal furniture design. Metadesign is founded on the observation that design problems in the real world require open systems that users can modify and evolve which contributes to the evolution of outdoor metal furniture. Technological advances afforded increased computer processing power and speed and

can yield increasingly powerful models of outdoor metal furniture.

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ملخص البحث

مضمون ميتاديزاين تعني خلق أنظمة وإجراءات توفر بيانات للمشاركة النشطة للمستخدمين النهائيين، وذلك بالسماح لهم بتعديل الأثاث المعدنية الخارجية عن طريق تطبيقات الكترونية، تهدف إلى توفير المعلومات، الأشكال، والوظائف التي يصيغها أصحاب المصلحة بناءً على خبراتهم الاستخدامية والمشاكل الملموسة لهم. هذا البحث يساهم في فهم الخصائص المرغوبة من نظام ميتاديزاين الناجح فيما يتعلق بتطوير تلك الأثاث من خلال ثلاثة جوانب:-

أولاً: مقومات الميتاديزاين الأساسية للأثاث المعدنية الخارجية

الهدف الأساسي للميتاديزاين هو خلق بيئات اجتماعية- تقنية تعمل على تمكين المستخدمين للانخراط بفاعلية في التطوير المستمر للمنتجات. ميتاديزاين تعتبر نموذج التصميم الذي يشمل المستخدمين النهائيين كأعضاء عاملين في فريق التصميم.

ثانياً: تطبيق ميتاديزاين على الأثاث المعدني الخارجي

يقوم كل من الخبراء في مجال تفاعل الإنسان مع الكمبيوتر، مصممي البرمجيات، والمستخدمين النهائيين بدور في تطوير الأثاث المعدنية الخارجية عن طريق مواد برمجية مجهزة على شكل ورش عمل مهمتها صياغة وتشكيل التصميمات المقترحة واختبارها وتعديلها، على أن يتم تبادل نتائج هذه الأنشطة لتتلاقى على خواص تصميم مشترك لتلك الأثاث.

ثالثاً: استراتيجيات التصميم البارامتري للأثاث المعدنية الخارجية

التصميم البارامتري (الحدودي) يستكشف الصلات بين كل من تقنيات التصميم الحسابية المتقدمة، والارتباط الفعلي في الإنتاج للأثاث المعدنية الخارجية. استكشاف وسائل معاصرة للتصميم الرقمي من أجل الإنتاج تساهم في وضع استراتيجيات مرنة للتصميمات التي بدورها تستجيب لاحتياجات المستخدمين. الهدف هو إعادة التفكير في العلاقة بين التصميم والبيئة عن طريق اشراك جميع أطراف أصحاب المصلحة في حوار غرضه إنتاج نماذج أولية للأثاث المعدنية الخارجية.

وقد خلصت الورقة إلى ان استخدام استراتيجيات الميتاديزاين سوف تعزز القدرة على ابتكار أشكال وهيئات وظيفية وجمالية جديدة لتلك الأثاث.