INNOVATION IN WOODWORKING INDUSTRY AND ENGINEERING DESIGN, 1/2021 (19): 68–73

OPPORTUNITIES FOR PRODUCT SERVICE SYSTEM DESIGN IN THE PROCESS OF TRANSITION TO A CIRCULAR ECONOMY

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ABSTRACT

This paper combines literature on Circular Economy, Business Innovation and Product Service System Design (PSSD) to outline different opportunities on the application of PSSD in the process of transition to a new economic model. Moving to a closed-loop industrial model would naturally introduce new opportunities for development of PSS because of the essential principles of the Circular Economy. These would include the ideas of delivering capability rather than ownership, extending product value (remanufacturing), shared ownership, reverse logistics etc. Value for the user and the environment is found in product but mainly in service content and serves as an example for the positive effect PSSs can have in the process of transition to a circular economy model. The argument is supported with case studies that serve to illustrate the potential success of circular services and systems.

Key words: circular economy, circular design, business innovation, systems thinking, service design.

INTRODUCTION

This paper serves to illustrate the opportunities for product service system design (PSSD) to support the process of transformation of our economy. Currently, the linear economic model presents high demands for resources that exceed the globe's environmental capacity. In the face of growing sustainability challenges, pressure on businesses to decouple environmental impacts from economic performance is rising. Further, global trends such as urbanisation, unemployment, environmental consciousness and technological leaps will accelerate the transition towards a preserving economic model. (Ellen MacArthur Foundation, 2015). While the idea of the linear economy is based on a system of take-make-waste, the Cirular Economy (CE) represents a closed loop system, which cycles and cascades resources between industries (as feedstock) to unlock multiple value streams. (Prendeville & Bocken, 2017).

The notion of a CE has attracted increased scientific attention in recent years and the implementation of CE in business context started to gain popularity and speed after the EU issued the report 'Closing the loop' in 2015. The idea to close the industrial loop with sustainable PSS has become a widely accepted transformational tool driven by economic and environmental interests. The concept is presented widely in literature also as "functional service economy" or "performance economy" (Stahel, 2006) and the "Cradle to Cradle"® design philosophy (McDonough & Braungart, 2002).

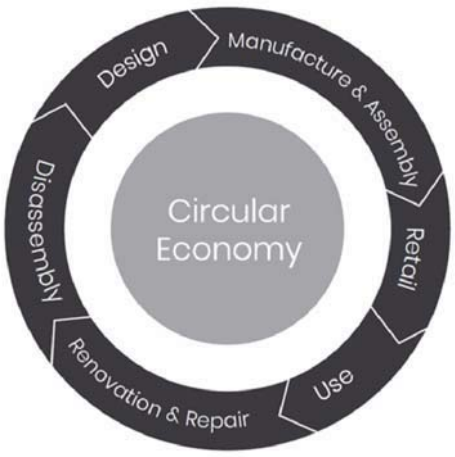

Figure 1: Circular Economy Process flow, inspired from WRAP (http://www.wrap.org.uk/).

Among the drivers for fast transition to this new industrial model is the work of Ellen MacArthur Foundation which characterises the concept of a CE as restorative and regenerative by design and an economy that aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. It is conceived as a continuous positive development cycle that preserves and enhances natural capital (Ellen MacArthur Foundation, 2015).

One of the main principles that would secure the transition to a CE is "think in systems": all elements in the world (human beings, environment, businesses etc.) should be linked together in a thriving ecosystem (Ellen MacArthur Foundation, 2015). The effectiveness of sustaining these links is believed to be the key element that ensures positive change and resilient closed loops. Thinking in systems is the starting point of many opportunities for designers to accelerate the transition process from the "take-use-dispose" economic model to a closed-loop one.

Although a challenging task, as it requires a new way of thinking and doing business (Bocken et al., 2015), the shift is motivated by promises of improved economic growth, substantial net material cost savings, creation of employment opportunities and increased innovation.

EMERGING OPPORTUNITIES FOR PSSD IN CIRCULAR BUSINESS INNOVATION

Product service systems (PSS) are integrated bundles of products and services which aim at creating customer utility and generating value (Pendeville & Bocken, 2017) and promise strategic methods to battle "wicked problems" such as the economic and environmental crises. Design of PSS (PSSD) analyses the links between resources and stakeholders in the system and involves solving problems through a service response, which unlocks value for each stakeholder in a value chain.

In the process of the author's research, it became evident that a structure for outlining opportunities for circular PSS should be based on user-centered business innovation models (rather than classification of PSS) and the shift from "customers" to "users" or even "co-creators". Former research suggests that PSS are perceived to have failed to translate into business action (Tukker, 2015), the goal of the paper is to present up-to-date re-

sults in the field and motivate circular practices for future business transformation. Building on Bocken et al., (2016), the structure follows six main areas of business innovation with a core PSS that propose the strategy to slow resource loops or even close them.

Access and performance model

The service offering is access (capability) to satisfy user's needs rather than the ownership of a product. Its advantage is that it introduces economic incentives for slowing resource loops (reduced costs), both with manufacturers and users. Depending on the case study the environmental impact of each PSS varies and needs to be evaluated individually. This category is quite broad as the PSS offerings vary widely and include the already established mobility sharing systems (Share Now), the office document management systems (Xerox), online subscription platforms for renting fashion garments (Rent The Runway) etc. An interesting case is the Singapore-based company Kaer which offers air-conditioning as a service (ACaaS). The provider takes responsibility for both the design and installation of the air-con system thereby avoiding over-specification and the operation which ensures the system runs more effectively. The challenge for service designers in the current strategy is to understand better how customer value is perceived since this model often provokes questions regarding privacy and a feeling of lack of control (Antikainen et al., 2019).

Extending product value

This model is based on exploiting residual value of products which return to the phase of manufacturing at the end of their life. The reverse-logistic strategy also includes collection of products between distinct business entities. The opportunities for PSS development that already prove to be effective include third parties introducing affordable "as new" products which have been given "a second chance" through remanufacturing or repair. On a larger scale, the leader in consumer goods sector is CoreCentric whose practices prove that repair programmes reduce the need for product replacements, while the redistribution networks create deep-value secondary markets and new sales channels. The same innovation in a different market is Trove which manages the return and resale programmes of trusted outdoor equipment brands such as Patagonia and Rei (USA).

Classic long life model

This is the business model focused on delivering long product life, supported by design and repair and maintenance services. New technologies and tools such as Internet of Things (IoT) trigger innovation and the design of PSS with real time monitoring, seamless diagnostics and improved customer experience. The heavy machinery manufacturer Caterpillar gathers data for the condition of its products with a new connected service called "Product Link". Similar is the offering behind HP's Instant Ink. It is an IoT enabled "pay-per-print" model in which the printer sends information about the cartridge condition so in need of replacement a new one is sent automatically per mail free of charge. The existing cartridge is recycled and flows back in the industrial loop.

Encourage efficiency

This strategy includes solutions that reduce end-user consumption through principles such as durability, upgradability, service, warrantees and repairability as well as showing non-consumerist approach to marketing and sales. The role of PSSD in this aspect is the design of customer experience as a fundamental part of the closed resource

loop. Perhaps one of the brightest examples in the large-scale consumer goods production is the outdoor brand Patagonia (USA). The ethical company educates and engages its customers in various activities for environmental protection and recycling, repairing their garments and non-consumerism. One of their radical initiatives, Worn Wear Program, repairs damaged clothes and offers an online resale platform for its customers' old clothes. Patagonia creates value for customers with radical innovations and the history of the company proves the importance of building trust in order to maintain profit even in moments of economic crisis.

Extending resource value

This close-loop strategy exploits the residual value of resources rather than products (sourcing of otherwise 'wasted' materials). Even though local examples of cooperation are in abundance, the challenge remains in operations from larger scales. InterFace's NetWorksTM is a program that sources fishing nets from coastal areas to clean up oceans and beaches while creating financial opportunities for people in impoverished communities in Southeast Asia. The social innovation project involves recycling of the nets into a polymer yarn that is later used as resource input for industries such as carpet manufacturing. This strategy serves as a great example of how we can design PSS that also have broader social and environmental impact.

Industrial symbiosis

The industrial symbiosis is a similar solution, concerned with using residual outputs from one process as feedstock for another, which benefits from the geographical proximity of businesses. The design of the PSS focuses on close partnership and quicker resource exchange with lower carbon footprint. AHLMA is an apparel brand from Brazil which is designed around the idea of external input: the company offers the possibility for its customers to co-create the next season collection and sources over 80% of raw materials from leftover fabric resulting from other textile companies' mismanagement. Despite their start-up size, AHLMA applies an open source approach, expanding their influence by making all design and pattern codes available on their website.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The research uncovered multiple opportunities for PSSD that support circular business model innovation by uncovering strategic as well as operational synergies. In most cases, there was a challenge to divide PSS and group them with innovation strategies because of the multifunctional nature of the PSS. The obstacles, however, serve as a proof of the value PSS offer in areas outside of performance in industry. While the given examples of PSSD ultimately represent provision of a service, theoretically, the companies exemplified here focused on user experiences, interactions and value to foster mutually beneficial relationships. By adopting new circular principles while "thinking in systems", businesses would consequently improve the level of customer interaction, satisfaction and loyalty.

While the paper serves to motivate research and application of PSSD in the process of transition to CE, the research also unveiled several challenges that lay before designers and businesses. An important aspect is understanding the user's role in the transition to a CE, focusing on the shift from "customers" to "users", as well as how design for behaviour change strategies could be implemented in this context (Wastling et al., 2018). It is widely believed that lack of ownership

with the user would present challenges for maintaining the system because of misuse or damaging behaviours. Moreover, another barrier to circular business models is the capital required to cover running costs, such as managing a reverse logistics network (Rizos et al., 2016), therefore it may also be desirable to encourage user behaviour that would reduce these operating costs. A step in this direction has been made by the collaborative work of Ellen McArthur Foundation and IDEO with their Circular Design Guide (2016). It represents an online tool for designers to use human-centred thinking into the design of circular products and services, encouraging them to appreciate how the user fits within the system.

As far as the concept of CE is concerned, there appear to be even more obstacles that confront business innovation strategies. It is widely believed that with the advancement of technology it may not be possible to make new products from materials extracted from old products and recycling on its own requires substantial amount of energy. Moreno, Braithwaite and Cooper (2014) build on the CE and establish a new PSS-oriented model, taking into account the more sceptical views over the desirability and viability of a completely circular flow. The Overarching Framework shown in Fig.2 focuses on the interlinks between the different stages and proposes routes to more material-efficient business opportunities and illustrates how reductions can be achieved through the different life stages of a product to ensure minimal environmental impact. The objective of the overarching framework is to present different industry sectors with realistic methods but also taking into consideration user behaviour (Moreno, Braithwaite and Cooper, 2014).

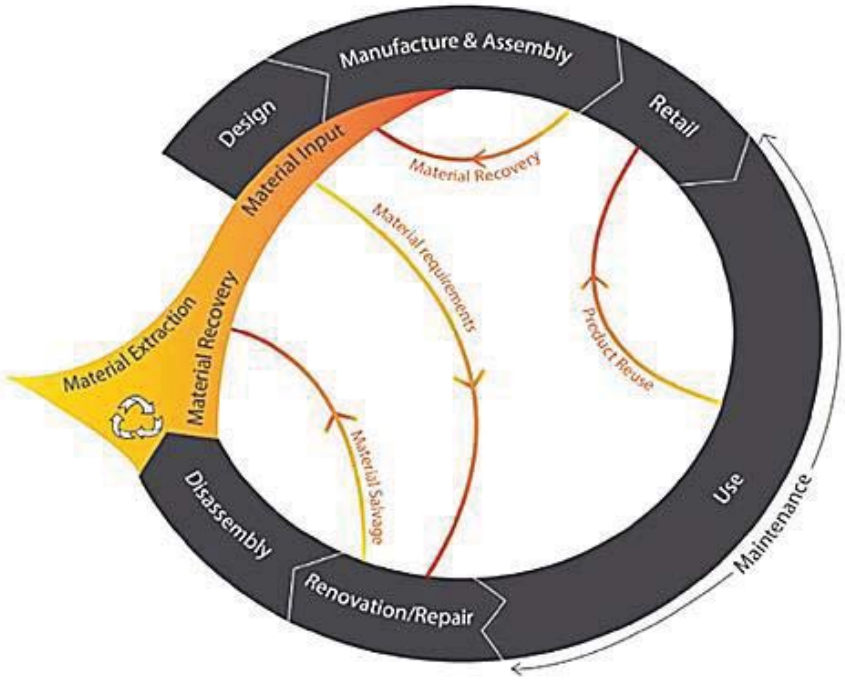

Figure 2: The Overarching Framework from Moreno, Braithwaite and Cooper (2014).

Even though challenges of adopting a closed-loop economic model exist, research in the field shows that PSS create economic incentives to slow resources and materials flowing through the economy and thus accelerate the process of transition to a CE. Opportunities for business innovation are in abundance and tools such as the Circular Design Guide and the Overarching Framework may reduce the pressure for designers and businesses in the existing challenge.

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INNOVATION IN WOODWORKING INDUSTRY AND ENGINEERING DESIGN, 1/2021 (19): 74–80

PROJECT ASSIGNMENT AND PHASES OF IMPLEMENTATION IN INTERIOR DESIGN – THEORY AND PRACTICE

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ABSTRACT

During the direct work in teaching interior design of residential and public objects with students in the specialty "Engineering Design" at the University of Forestry, in Sofia, Bulgaria it was found that they have particular difficulties in applying the design methodology in practical briefs and work. For this reason, the present work was made. The report clarifies the stages of project assignment implementing, which accompanied by the basic concepts in the design assignment theory and practice in Bulgaria gives the key to the successful creation of a harmonious interior composition, both in public and in residential buildings.

Key words: interior, project, design, project assignment.

INTRODUCTION

Project assignment composing is a process in which information about a task is collected, analyzed, and clearly indicated to provide a basis for design. It defines the task before seeking a solution.

A project assignment is an analysis of tasks, while design is their synthesis.

It involves gathering information about the specific needs of the client, architectural's site data, as well as identifying more general human factors issues, often related to social and cultural influences.

The overall assignment includes a wide range of information. In addition to the above, the assignment defines the site requirements, the design phases and the required design parts.

The design task for the initial phase serves as a reference for each subsequent phase, together with the project from the previous phase of project designing. (Ordinance № 4 of May 21, 2001 on the Scope and Contents of Investment Projects).

ASSIGNMENT COMPOUNDING

There are several assignment methods, all of which can be used to establish the guidance and information that the design process may be based on. For residential projects and small public ones, a project assignment may consist only a few sentences, indicating the goals of the project and a list of required spaces and furniture. In many large projects, such as corporate headquarters, the assignment can be quite voluminous, containing very detailed information about the current and future needs of the organization. If an assignment has not yet been completed, it is the responsibility of the interior designer to determine how much information is needed before the project begins and to collect and analyze that information.

Raycheva points to a four-phase process of interior designing (Raycheva R., 1998):

1. Design assignment. The terms of reference are drawn up by the contracting authority (investor), or by the contractor when the investor assigns it.

It includes:

- Data on the architectural object (drawings required such as layouts,

sections, or drawn photographs of the object);
- List of the main activities and functional purpose of the premises;
- Number and occupation of workers or residents of the site, as well as their age composition, gender, preferences, etc.;
- Style features and preferences for the character of the interior.

2. Conceptual design of the idea.

Based on the terms of reference and some additional data, the designer begins his work, whose material expression is the idea's conceptual design. It is also developed in variants, subject to evaluation, validation, adjustments by the investor.

The conceptual design necessarily includes arrangement, elevations and perspective images.

3. Technical (working) project. This is the next stage in the realization of the author's idea. Here, an accurate arrangement is made of selected samples, which is given a specification of units, prices and supplier. Architectural details (cornices, flooring, joinery, etc.) are given. All furniture is drawn in layouts, sections and characteristic details. Possible contractors are indicated.
4. Designer's supervision (author's control). This stage takes place during the construction and repair work, in the manufacture of the furniture and in their installation. Often, designer's supervision and control is also an opinion about replacing defective or expensive material with another, resolving problems „on the moment ", and more.

- Delchev outlines the following steps in the methodology of design (Delchev S., 1993):

1. Preliminary design study;
2. Preliminary design project;
3. Working design project.

According to him, failure to comply with this design sequence has a negative impact on the final result.

- Angelova describes five stages in design, namely:
  1. Pre-project's study;
  2. Analysis;
  3. Concept development;
  4. Proposal for final project;
  5. Implementation (Angelova D., 2019).
- The architects Tikholov and Grozev (Grozev O., K. Tikholov, 1993) systematize the following main design phases:
  1. Study phase,
  2. Drawing up a functional diagram,
  3. Development of an interior solution, including:
     a) Development of spatial composition,
     b) Space Grading,
     c) The relationship between the elements of the volume composition,
     d) Sizing of interior spaces,
     e) Means and methods for achieving a uniform interior appearance.
  4. Design of furniture elements.
- W. M. Penia and St. A. Parshall's book "Problem-solving" describes a design method that uses a five-step process. (W. Penia, St. Parshall, 2001). The five-step process involves defining goals, gathering and analyzing facts, discovering and testing concepts, identifying needs and setting a task.

1. *Setting Goals*: Goals (long-term goals to be achieved) show what the client wants to achieve and why.
2. *Fact-gathering and analysis:* The facts describe the existing conditions and requirements of the task. There are always many facts; part of the designer's job is not only to collect them, but also to organize them in useful way.
3. *Concept Finding and Testing:* Writing a project assignment should develop abstract ideas that are functional solutions to the client's assigned tasks without identifying the physical means that could be used to solve them.
4. *Identifying needs:* This step in the research process balances the customer's desires with the available budget or sets a budget based on goals and needs. During this step, "desires" must be separated from "needs."
5. *Assignment:* The previous four steps are a prelude that clearly describes the essence of the assignment. Defining it is a bridge between the job and the design process. The assignment agreed by the client and the designer describes the most important aspects of the task and serves as a basis for design and criteria by which the decision can be evaluated.

There are slight differences in the theoretical concepts discussed so far regarding the phases of interior design in Bulgaria, Europe and worldwide.

However, are there clearly regulated legal prerequisites and restrictions related to interior design and furnishing in Bulgaria?

While the Spatial Development Act and Ordinance № 7 For Rules and Norms for Development of The Separate Kinds Of Territories And Development Zones defines the rules and regulations for the design of residential and public buildings in Bulgaria, only Ordinance № 4 Of May 21, 2001 On The Scope And Contents Of Investment Projects of Ministry of Regional Development and Public Works distinguishes the part “Interior and Furnishing” as a separate independent part of a project. It can be made at newly designed sites or as a standalone project for furnishing existing objects with or without changing their purpose.

The interior and furnishings part provide solutions for:

1. the main function of the individual rooms and spaces and their interconnections in order to satisfy the compositional, technological, physiological, ergonomic, acoustic, security and other requirements;
2. the design of the floor, walls and ceiling of the premises, as well as of additional created partitions for partial separation of the spaces;
3. the location of the movable and fixed elements of the furniture;
4. the location of the artificial lighting fixtures in relation to the general spatial layout;
5. the inclusion in the interior of works of fine and decorative arts.

There are no clearly defined legal constraints on what kind of specialists may or may not be involved in the implementation of interior projects.

However, when completed, they must include:

1. drawing of the basic functional and architectural solutions with the arrangement of the elements of the interior;

2. a drawing of the ceilings showing the main and additional processing, lighting, etc.;
3. elevations, showing the basic and additional processing and the design of the elements of the installation systems;
4. color solutions and materials;
5. drawings of characteristic decorative, artistic and other elements of cultural and historical value from the interior of buildings - real cultural values;
6. characteristic details of the interior on an appropriate scale.

All of the above is accompanied by an explanatory note that describes:

1. the main function of the premises and the spaces and the connections between them;
2. the main elements that are used to build the interior;
3. the solutions adopted to satisfy the basic functional, compositional, technological, physiological, ergonomic, acoustic, security and other requirements;
4. the materials used and the manner of their processing;
5. justification of the works of art and applied arts included in the interior.

When designing an interior in Bulgaria we could meet all of the above approaches for finding a solution and preparing a project - individually or in combination, chosen according to the personal vision of the designer and the investor.

Regardless of the design method used and the complexity of the project, the entire design process must be accompanied by the preparation and completion of some type of written document that stores the information collected and the conclusions drawn from the analysis. This document must be reviewed and approved by the client before starting the project, as any incorrect design information will result in a project that may not meet the client's needs.

Although the exact format of the functional program will vary depending on the size and complexity of the assignment, each plan must include at least the following information:

- Outline of long-term and short-term goals. This may include results-oriented goals such as "increasing sales by updating the store's image" and functional goals such as "improving traffic and personal interaction between departments."
- List of customer requirements. It should include the number of people who will use the space, as well as information on the types of activities they participate in, the necessary neighborhoods between people and activities, as well as the specific furnishings and equipment that each person requires. In addition, special needs for lighting, acoustic separation, flexibility in the use of space should be noted.
- List of required premises and their floor space. This information is basic and serves as a starting point for an architectural solution. This type of list should also include the need for secondary spaces such as corridors, closets, and other spaces that are not listed but needed to make the space functional.

INFORMATION GATHERING

There are various methods of collecting the necessary information to complete the planning and preparation for design, applicable to both residential and public interior design. Each has its own advantages and disad-

vantages. In most cases, two or more methods are used together for a project. Before being discussed individually, the following lists provide comprehensive detailed information on the specific information that may be required for a project. Of course, different types of projects will use different items from this list.

Checklist of required information

It is advisable, before proceeding with information collecting, to draw up an indicative list in order not to miss the analysis of certain information which may be relevant at a particular moment. This list could include the following:

1. Goals and objectives

- Main goal – creating a brand new or adapted existing interior space,
- Functional goals – such as achieving more space, adapting an existing room to accommodate more (or fewer) occupants, working more efficiently, or changing the workflow,
- Aesthetic goals - a change in the style of the interior, a change connected with fashion trends.

2. Requirements of residents or employees

If the project concerns a residential interior:

- number of inhabitants, is there a change expected in the near future that needs to be taken into account,
- user characteristics: age, gender, special needs (right-handed or left-handed, physical disabilities, etc.),
- personal preferences: colors, special interests, etc.,

If the project concerns a public interior:

- the location of the workspace or functional area (eg, North side service areas, corner office for managers).
- individual information about employees or occupants: by name, title or position,
- number and function of groups, if not individual employees,
- a description of the position of the employee,

3. Activity requirements

- type of principal, additional or incidental activity,
- the nature of the activity, when it is performed and how often it is performed,
- whether the activity is carried out independently, in small groups or in large groups,
- whether the activity shares space with other activities,
- special requirements for the activity: lighting, acoustics, heating or cooling, ventilation,
- other special requirements (security, environmental friendliness, sustainability).

4. Furniture and equipment

- the types of furniture or equipment needed, whether existing furniture will be used or new ones purchased, sizes,
- necessary style, color, quality level, ergonomic needs, etc.,
- types and requirements of communication equipment, audiovisual equipment, electrical installations, mechanical requirements of the equipment: cooling, ventilation, etc.,
- the types and sizes of astorage: libraries, shelves, drawers, cabinets, etc.,
- personal or shared furniture and equipment,
- space required for accessories.

5. Functional connections

- the necessary contacts between the persons,
- necessary movement of objects, equipment or documents,
- connection level: mandatory, preferred or insignificant,
- necessary zoning of related activities, departments or functional groups,
- External links required: visitors, service, visibility, delivery, etc.

6. Requirements for premises or areas listed by area of activity and space

- premises defined by the fields of activity: people and equipment, requirements for them.

7. Time and budget requirements

- total budget allocated to the budget for possible reconstruction or construction, furnishing costs, equipment costs, taxes, unforeseen expenses, etc., by project type,
- life-cycle cost analysis,
- Transport deadline or phasing-out requirements.

Customer survey

Asking questions to prospective users is one of the most valuable ways to gather information. Properly asked questions can collect non-verbal data about what the user can really think or about his/her attitude to certain aspects of the topics being discussed. The interview technique works in both residential and public interiors.

Interviewing takes time and requires the interviewee to stick to the topic while allowing for some open-ended questions and comments. The interviewer should prepare a list of specific questions or points for which answers are needed. This keeps the process going in the right direction and provides a common basis for comparing interviews and gathering results.

The general topics for which questions may be developed do not differ from those detailed in the checklist description.

Observation

One of the surest ways to gather information is by observing what people are doing instead of listening to what they say. The danger of observation, however, is to come straight to the conclusions without clarifying why people are doing things in this way. For example, some people may have a large number of small appliances on the kitchen counter, not because it is so convenient, but because there is nowhere else to store them. The client may prefer to have storage space in the closet, but the observer may incorrectly conclude that the client likes to have appliances on the counter.

Surveillance is best used to verify information gathered through interviews or questionnaires, or as a way to generate questions to determine the cause of the behavior observed.

Surveillance is also useful in situations where questionnaires or interviews are not possible – for example, to determine how people use a given public space.

Site investigation

Because interior design is done within an architectural space, it is an important part of the job to determine the existing conditions. Whether the building already exists or is still in the planning stages. For existing buildings, architectural surveying is done on site, and special conditions may be noted. If a building is still being designed, the information must be determined by architectural drawings.

CONCLUSION

Clarifying the stages and phases of information gathering and design is a key to team-working in interior design and assists designers and users. In the course of the research, however, the dissonance between the normative regulations and the design practice became obvious. There is a need for discussion and updating of the terms, stages and approaches in the design, as well as of the legal framework in which it is carried out.

During the direct work of the author in teaching interior design of residential and public objects with students in the specialty "Engineering Design" at the University of Forestry, in Sofia, Bulgaria it was found that they have particular difficulties in applying the design methodology in practical briefs and work. For this reason, the present work was made. The report gives the opportunity to become fully acquainted with the basic concepts in the design assignment theory and practice in Bulgaria, the correct use of which is key to the successful creation of a harmonious interior composition, both in public and in residential buildings.

ACKNOWLEDGEMENT

This research was funded by National Scientific Program “Young Scientist and Postdoctoral Students” of Ministry of Education and Science, and The Law of Promotion of Scientific Research and in compliance with the National Strategy for Development of Scientific Research in Republic of Bulgaria.

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UNIVERSITY OF FORESTRY
FACULTY OF FOREST INDUSTRY

INNOVATION IN WOODWORKING INDUSTRY AND ENGINEERING DESIGN

1/2021

INNO vol. IX Sofia

ISSN 1314-6149
e-ISSN 2367-6663

Indexed with and included in CABI

INNOVATION IN WOODWORKING INDUSTRY AND ENGINEERING DESIGN

Science Journal
Vol. 10/p. 1–92
Sofia 1/2021

ISSN 1314-6149
e-ISSN 2367-6663

Edition of
FACULTY OF FOREST INDUSTRY – UNIVERSITY OF FORESTRY – SOFIA

The Scientific Journal is indexed with and included in CABI.

Cover Design: DESISLAVA ANGELOVA

Printed by: INTEL ENTRANCE
Publisher address: UNIVERSITY OF FORESTRY – FACULTY OF FOREST INDUSTRY
Kliment Ohridski Bul., 10, Sofia, 1797, BULGARIA
http://inno.ltu.bg
http://www.scjournal-inno.com/

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