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An architectural viewpoint to user-centred work environment research to support spatial understanding in a transdisciplinary context through ecosystem-based approach

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Abstract

Purpose – This paper aims to build on the presumption that defining the spatial solution of the activity-based office environment through user-centred interdisciplinary dialog would strengthen understanding of interdependencies between the environment and the worker. Secondly, this presumption also contributes to the idea that the shared and clarified concepts of a spatial solution through location-specific structuring, would support the research outcomes in being communicated to the design practice, and further improve the work environment design in the future. Thirdly, this supposition is that understanding, documenting and communicating of the interdependencies between the environment and the worker would contribute to increased interdisciplinary understanding, ultimately benefitting the end-user, the worker.

Design/methodology/approach – The driver of this conceptual paper is to encourage understanding across disciplinary boundaries and communication of work environment research results for implementation in design practice. The authors introduce an ecosystem-based approach to discuss the spatial solutions of activity-based office work environments. This approach is motivated by a need to understand the contradictory findings in former knowledge work environment research, such as ambiguities with shared concepts concerning interdisciplinary spatial discourse and shortcomings with user-centred methodologies in architectural design research. The transdisciplinarity forms the methodological framework of this paper, and it is reflected in relation to the design research approach Research by Design (RbD). RbD considers the professional designer's viewpoint, which includes creative knowledge production, carrying out the operations of research in a real-life context with interdisciplinary interactions together with the worker's user-experience.

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Findings – The research outcome is the proposal of an activity-based office ecosystem-based approach, in which the physical environment is structured into two entities: *architectural envelope* and *interior orchestration*. In this twofold approach, both qualitative and quantitative contents are meant to be seen as part of the time-location-based framework of an office space. This integrative approach is intended to support the process of searching for understanding and unity of knowledge across disciplinary boundaries. The twofold structuring also has an essential role in supporting methodological choices and the communication of the research outcomes both between disciplines and to design practice. The twofold model also has a role in engaging users as participants and evidence providers in the design or research processes.

Originality/value – The location-specific ecosystem-based approach of the physical work environment compiles of a twofold entity *architectural envelope* and *interior orchestration*. This approach supports affordance-based thinking, understanding the ecosystem's complexity and underpins spatial documentation. Furthermore, this location-specific ecosystem-based approach enables communication of the research outcomes to the design practice and participation actions with the users.

Keywords Knowledge work environment, Location-specific approach, Time-location based approach, Affordance of the physical environment, Ecosystem-based approach, User-centred design knowledge, Transdisciplinary approach, Boundary object, Research by design

Paper type Research paper

1. Rationale

Admist today's pressures for workspace design, it is still difficult to build offices that are compatible with the humans working in them. Although the physical environment is the core substance in architecture, very little interest has been paid to the influence of the architectural environment in the field of architecture (Bodin Danielson, 2010). Architectural design does not have an established approach to produce or integrate user experience to the architectural design processes. The creative knowledge is the determining feature in the profession of architecture (Cohen *et al.*, 2005; Saks, 2012), where experiences in three-dimensional spaces have an important role in design work. However, the design guidelines are technical and normative in their nature, where the user experience is not one of the factors to consider in general (BS ISO 17772–1:2017, 2017; national guidelines: RT 103253, ARK18, 2020; RT 10–11192, SIS12, 2015) or in relation to current office design guidelines (e.g. national guidelines: RT 95–11151, 2014; RT 95–11152, 2014; RT 95–11153, 2014). On the other hand, work environment research is conducting topical studies about environmental satisfaction (Colenberg *et al.*, 2020; Brunia *et al.*, 2016) indicating user experience in office spaces that architects have designed. Unfortunately, the produced research outcomes from multiple fields do not reach designing architects or other involved designers and, thereby, novel scientific knowledge is not harnessed to improve the forthcoming office spaces and workers' user-experiences. Albeit the problem is architecture-oriented, we consider it important to recognise the possible challenges that designing architects might encounter when aiming to deploy the work environment research outcomes. We, as architect design researchers, confront similar situations when operating in an interdisciplinary context.

Combining creative knowledge and user-centredness is recognised in architectural design research, although the user experience orientation is not explicitly present in architectural design guidelines. The architectural design research approach called Research by Design (RbD) (Dunin-Woyseth and Nielsen, 2004; Sevaldson, 2010; Verbeke, 2013) recognises the transdisciplinary research approach where the user-orientation is an essential feature side by side with interdisciplinarity. RbD has the attempt to retain both, (a) the designerly way of thinking, i.e. keeping the creative knowledge as a determining feature of the architect profession or when an architect is acting as a design researcher and (b) recognising users as evidence-providers. Although the approach of RbD is rather

architect-centred by reason of retaining the creative aspect, the recognition of the transdisciplinary nature of the context contains the possibility to have a more user-oriented (if not user-centred) approach than in the architectural design profession.

In work environment research at present, the new ways of working and increased time- and location-independent work (van Yperen *et al.*, 2014) have directed the development of knowledge work environments towards more flexible settings, referred to as activity-based offices (Appel-Meulenbroek *et al.*, 2011), flex-offices (Bodin Danielsson *et al.*, 2014) or activity-based flexible offices (Wohlers *et al.*, 2017) (later in the text: activity-based offices). Activity-based offices are open-office environments with additional half-open and enclosed workspaces, where the workers choose workstations or workspaces that best suit their current work tasks and subjective preferences (Appel-Meulenbroek *et al.*, 2011; Bodin Danielsson *et al.*, 2014; Wohlers *et al.*, 2017). In the work environment research, the following terminology is recognised: "workstation" refers to a setup for an individual user; "workspace" refers to an open, half-open or enclosed part of an office with single or multiple workstations; and "work environment" refers to a setting, such as an office, consisting of multiple workspaces. However, we have understood the use of the terminology is not always be uniform in work environment research and the meaning of the used concepts may vary (Colenberg *et al.*, 2020).

Worker's environmental satisfaction is an indicator of user experience. In work environment research, environmental satisfaction indicates how well the environment meets worker's wishes and needs concerning work itself, social working environment, physical working environment or interactions between these aspects (Van der Voordt, 2004). Architect designers or design researchers do not have the knowledge or the methodology to study workers' environmental satisfaction. Therefore, we are interested in understanding how the work environment as a physical space is approached in research concerning environmental satisfaction. We have understood that in work environment research the physical work environment is present in discussions through employees' sense of privacy and social interaction that are supported or hindered by the level of openness or division of space (Brunia *et al.*, 2016; Hoendervanger *et al.*, 2018). The arrangements of interior design elements and ambient factors create unique combinations affecting a workers' environmental satisfaction in their work environment (De Been and Beijer, 2014; Brunia *et al.*, 2016; Bodin Danielsson, 2019; Colenberg *et al.*, 2020). The *person-environment fit* (Edwards *et al.*, 1998; Kristof-Brown *et al.*, 2005) is one of the key concepts indicating compatibility between a worker and one's work environment. From the architectural design point of view, the concept of person-environment fit seems to be intertwined with the physical knowledge work environment's three-dimensional spatial design solution; however, in work environment research, the emphasis is on social-organisational work environment context (Yu, 2016), leaving the physical work environment with less attention.

The research concerning environmental satisfaction is often conducted in medium-size or large organisations using mainly quantitative methods to produce reliable and generalisable knowledge. Usually, the only visual document of the company premises is the furnished floor plan; however, it is not always presented when reporting the research outcomes. (Brunia *et al.*, 2016; Hoendervanger *et al.*, 2016) In addition to a furnished floor plan, the documentation might include photographs providing documentation of the three-dimensional space, e.g. concerning interviewees' workspace preferences and non-preferences (Babapour Chafi *et al.*, 2020). In studies conducted in small-size organisations, the qualitative methods were also emphasised; however, then a lack of generalizability was reported (Rolfö, 2018).

For architects, the two-dimensional visual documentation of the office spaces concerning a worker's environmental satisfaction is insufficient to understand the reported features (e.g. atmospheric aspects), as the three-dimensional properties of a space cannot be deduced from a two-dimensional furnished floor plan. From an architectural point of view, to understand a worker's environmental satisfaction in a spatial context, it is essential to know the location where the worker is using and experiencing the three-dimensional office space. The generalisable knowledge about environmental satisfaction produced with quantitative methods seem to lose the connection between the worker and one's specific location in the workspace. For architects, it would be interesting to study in detail the reasons related to a specific space affecting the compatibility between the worker and one's work environment, if e.g. the worker's workstation preferences would be available to study in a three-dimensionally documented space. We see great potential to study environmental satisfaction with work environment researchers where the *location* in a three-dimensional office space is one of the studied factors. Therefore, we will propose an ecosystem-based approach aiming to indicate the interdependencies within the spatial design context when studying a worker's compatibility with one's work environment in a user-centred interdisciplinary framework.

2. Challenges and methods of advancing spatial understanding

Work environment research involves knowledge produced by different disciplines (Colenberg *et al.*, 2020) and even developing into a multi-disciplinary field (Appel-Meulenbroek *et al.*, 2018). The causal relationship between physical office environments and employee outcomes are seen as systemically complex and often challenging to explain and, therefore, interdisciplinary framework is seen as relevant, even necessary (Van der Voordt, 2004; Ruohomäki *et al.*, 2015; Appel-Meulenbroek, *et al.*, 2018). In architectural design research, the definition or interpretation of transdisciplinarity seems to be one of the key issues affecting how RbD is understood in relation to the other disciplines. Transdisciplinarity, as such, is considered to belong to RbD (Dunin-Woyseth and Nielsen, 2004; Sevaldson, 2010; Verbeke, 2013), at least in an implicit way, *considering architecture, by its nature, as transdisciplinary* (Doucet and Janssens, 2011). In this interpretation of transdisciplinarity, architecture has a two-fold nature as a *discipline*, which refers to the theoretical contents with interdisciplinary features, and, on the other hand, as a *profession,* which refers to the practical design contents of architecture (Doucet and Janssens, 2011). Instead, we (Herneoja *et al.*, 2015) are more carefully following the original idea of transdisciplinarity containing the four core elements: *participatory research approach*, *life-world problems, search for unity of knowledge beyond disciplines* and *transcending contents*, i.e. integration of disciplinary paradigms (Nowotny *et al.*, 2006/2001; Hirsch Hadorn *et al.*, 2008, pp. 437–439). We find the original definition to be more relevant as to evolve further, including the genuine interaction with other disciplines and questions arising from real-world problems (e.g. aspects concerning the design and realisation of buildings/spaces and interaction with society) together with user-centredness (participatory research approach), while also retaining the designerly way of knowledge production (Herneoja *et al.*, 2015).

The transdisciplinary approach opens the discussion, how to also engage the professionals (e.g. designers) being involved with the practical knowledge, in addition to the researchers as academic knowledge producers and users as evidence providers. The enabling conditions for actions concerning work environments combining all actors can be reflected through the boundary object theory (Star and Griesemer, 1989; Carlile, 2002). The use of boundary objects is described (Carlile, 2002; Carlile, 2004) as a means of representing, learning about and transforming knowledge to resolve the consequences that

exist at a given boundary. Together with this interpretation, the original definition (Star and Griesemer, 1989) provides additional understanding for the direction of transdisciplinary design research (Rönkkö and Herneoja, 2021). Boundary objects are considered to have different meanings in different social worlds, but their structure is common enough to more than one world to make them recognisable, a means of translation (Star and Griesemer, 1989). In a work environment context, the *social worlds* can be interpreted referring to researchers from different disciplines, professionals (e.g. designers) from different fields and users engaged in the design or research processes as participants. The ecosystem-based approach is brought to the design research context as an attempt to recognise the complexity of the work environment as a physical space affecting the worker's environmental satisfaction and to integrate it as part of the discourse of work environment research and practice.

In general, ecosystem is currently used to mean something (such as a network of businesses) considered to resemble an ecological ecosystem, especially because of its *complex interdependent parts* (ecosystem. 2020). The concept of environment may be understood either as non-physical (Tsujimoto *et al.*, 2018) or also including the physical aspect. Therefore, we looked at the original definition of ecosystem in biology, where both living and non-living components were included (Molles, 1999, p. 482; Smith and Smith, 2012, G-5). We propose that the *physical environment* as such and in detail would also be included in the ecosystem-based approach as *one of the complex interdependent parts* to support the holistic understanding and to hinder the fragmented way of discussing the spatial content. The ecosystem-based approach would also support the transdisciplinary way of conducting research familiar to RbD (Dunin-Woyseth and Nielsen, 2004; Sevaldson, 2010; Verbeke, 2013) and, thereby, make visible and engage the design practice in addition to the interdisciplinary research orientation.

The interest towards a holistic understanding of the work environment is not, as such, novel. Recently, Babapour Chafi *et al.* (2020) proposed the use of artefact ecology in the context of understanding workspace preferences. This was based on digital artefact ecology by Forlizzi (2008). The artefact ecology recognises the physical structure (placement, seating arrangement and openness) of an office environment (Bødker and Klokmose, 2011). Babapour Chafi *et al.* (2020) used the concept to focus on a worker's preferences in the interior design scale. We share their interest in understanding worker's preferences and non-preferences in a spatial context; however, our interest is even in a more holistic understanding of the three-dimensional physical environment together with its technical solutions, including the aspects of design practises.

In our intervention-based research (Markkanen *et al.*, 2022; Herneoja *et al.*, 2015), we applied RbD with the genuine transdisciplinary approach engaging interdisciplinary research knowledge, practical design knowledge and user-based evidence. The idea of intervention, in general, refers to the *act of interfering with the outcome or course, especially of a condition or process* (as to prevent harm or improve functioning) (Intervention, 2020). In the greater picture, the aim of *intervention-based research* in architecture is to *study real-world environments through change* to capture a holistic overview to find better solutions for users and search for a working theory for designers. Therefore, it is noteworthy to recognise that *intervention-based research* in architecture usually requires the *spatial design phase* when the intended *change* is designed based on the data from the analysis phase. In the *design phase* of *intervention-based research, the* researcher and professional designer share the same aims and methods. From the ecosystem-based point of view, the intervention-based research aims to understand the *interdependencies* between the *physical environment* and the *worker* in one's own spatial context through making temporary

changes to the spatial arrangement. Thereby, we are aiming to not only understand the *interdependencies* between the *physical environment* and the *worker* but also *locate* these interdependencies in the spatial context.

In the design process of our RbD approach, we considered the complex and holistic nature of the office environment. Therefore, a user's insider perspective of one's work environment is crucial. However, when using participatory design (PD) methodology in our interventions (Markkanen *et al.*, 2022), we recognised that Service Design (SD) methods could be useful to support both architectural design processes and to gain new knowledge on knowledge work environment design processes.

The *changes* in the operational environment, focusing on user-oriented design solutions and the worker's subjective experience, are the core interest of the SD approach. In our research approach, the focus is on the success of the spatial design process in fulfilling the compatibility between the worker and one's work environment. SD has emerged in the past decade and gained ground in a variety of fields in interface design, industrial design and business development (Miettinen, 2017). SD applies PD methodology to engage users in the design process. In the core of PD is mutual learning, where both the user and the participants of the study, as well as designers and researchers, inform and learn from each other about the context of the use. A systematic approach to PD (as described by Bratteteig *et al.*, 2013) divides the process into:

- a real-life problem situation;
- information that will help us understand organisational practices and identify the needs and wishes of participants; and
- testing and evaluation.

The guiding principles of the SD – user-centred approach, co-creation, visualising, evidencing and holistic approach of the design case (Stickdorn and Schneider, 2011) – meet the general approach of PD, but it is more focused on the user and the producer (in this study – the *designer*) from the position of space-as-a-service. Thereby, the design process would also be more thoroughly integrated to the extended understanding of the worker's relationship to one's physical environment. In the ecosystem-based context, using SD methods, in addition to aiming to deepen the understanding of the *interdependencies* between the *physical environment* and the *worker*, we are also interested in how the *gained knowledge could be communicated to the design practice*.

Through our interventions (Markkanen *et al.*, 2022), that the concept of *affordance* would deepen our understanding of the possible *interdependencies* between the *physical environment* and the *worker* from the *action* point of view. An affordance-based approach would also the prevent fragmented way of discussing interior design through separate pieces of furniture and other non-fixed elements or solutions. The concept of affordance (Gibson, 1977; Norman, 2013) refers to the latent action possibilities that the environment offers the individual. To understand whether the nature of affordance is positive or negative, our architectural design knowledge alone does not offer the explanations. For architects, a relevant shared concept, in addition to a more general concept *person-environment fit,* would be the *need-supply fit* (Kristof-Brown *et al.*, 2005; Gerdenitsch *et al.*, 2018) by recognising the affordance of the physical environment. In the ecosystem context, it would be important to know *not only how* the worker uses one's physical environment but also, more precisely, *where* and *when it takes place.*

At present, a worker's current location during one's workday is possible to track with the aid of context-aware mobile methods (Markkanen *et al.*, 2019), to reflect the physical

environment's affordance to the worker more precisely. We have found combinations of smartphones and Bluetooth beacons to be useful when we combined location data and the experience sampling method (ESM) in the context of work environments. In the light of current knowledge, RbD, PD and SD methods, together with the context-aware mobile methods, offer grounds for a user-centred understanding of the *interdependencies* between the *physical environment* and the *worker* valuable also *to the design practice*.

3. Location-specific structuring of the spatial solution

The location-specific physical representation of the ecosystem-based approach is presented in the two-fold structuring to *architectural envelope* and *interior orchestration*, to form the context of understanding, documenting and communicating the complexity of the interdependent parts of the physical work environment. The structuring of the representation follows the designers' working processes and contents to support the knowledge transfer from research to practice. This location-specific physical twofold structuring is also an attempt to integrate the design knowledge approaches to the work environment research to mitigate the fragmented ways of discussing spatial entities and to form a platform for qualitative enriched concepts to find their physical representations in interdisciplinary discourse.

The ambient factors of the knowledge work environment considered in this paper are acoustic quality, architectural privacy, lighting and indoor air quality (e.g. temperature and humidity). They contribute to the concept of indoor environmental quality (IEQ) approached as a measurable technical quality (e.g. BS ISO 17772–1:2017). From the user-centred point of view, the ambient factors of a three-dimensional physical environment are intertwined to influence the worker's experience of the work environment. Therefore, it is not relevant to draw demarcation lines between contents of architectural features or technical systems, or by the responsibilities of different design fields (e.g. architectural, interior, lighting, acoustic, HVAC).

On the other hand, spatial architecture, visual and acoustic privacy, lighting, acoustics, communication landscape, furniture comfort and architectural aesthetics are important to work environments (Vischer, 2008; Vischer and Wifi, 2017), but they do not as such align with all designers' ways of approaching the spatial solution. The national standards exist in the field of architectural and interior design (RT 103253, ARK18, 2020; RT 10–11192, SIS12, 2015; RT 95–11151, 2014; RT 95–11152, 2014; RT 95–11153, 2014) about the procedures and contents in design processes familiar to designers in their professional work. However, in these documents the content of the work environment is discussed using practical concepts, but not in qualitative manner as in the knowledge work environment research outcomes. Therefore, to support the engagement of the design knowledge to the work environment research, we suggest that the *physical environment* would be considered to consist of a *twofold entity*, fixed environment and non-fixed interior design solution featuring the design procedures from professional design fields. The fixed environment that we call *architectural envelope* (Figure 1), in general, consists of the architectural design solution and lighting, acoustic and HVAC solutions. The non-fixed environment that we call the *interior orchestration* (Figure 2) consists of the non-fixed interior design solution. The aim of this division is to approach designers' way of operating and structuring their working processes. The proposed approach forms the context to study how the worker is experiencing one's work environment and, on the other hand, integrate the latest research outcomes of work environment research to practice to improve the physical work environment and, thereby (hopefully), affect the worker's environmental satisfaction in a positive way.

Architectural design solution (e.g. Ching & Binggeli, 2018)
- size and shape of floorplan, height and form of three-dimensional volume, e.g. affecting acoustics in the space
- material qualities such as surface texture and colour, e.g. affecting lighting needed in the space
- shape, size and location of doorways, e.g. affecting circulation in space
- shape, size, position and direction of window openings, e.g. affecting qualities of natural light entering space

Lighting design solution (e.g. BS ISO 17772-1:2017; Vischer, 2008; Markkanen *et al.,* 2017)
- lighting fixtures, lighting design and adaptive lighting control systems (occupancy and daylight detection), e.g. affecting how architectural space and its materials, textures and colours are experienced

Acoustic solution (Virjonen *et al*., 2007 & 2009; Hongisto *et al.*, 2016)
- location and amount of sound-absorbing panels, sound masking systems, sound-absorbing floorings and their capacity and relation to architectural space, e.g. shape of floor plan, form of volume and floor, wall and ceiling materials
- (sound-absorbing furniture and mobile sound-insulating phone booths and workspaces are considered to belong to the qualities of Interior orchestration due to their non-fixed nature)

HVAC solution (e.g. BS ISO 17772-1:2017)
- heating, ventilation and air conditioning and their relation to architectural space

Figure 1.
Material qualities and solutions of architectural envelope

(e.g. Ching & Binggeli, 2018)

Furniture
- within an architectural envelope, e.g. chairs, tables and storage units

Non-fixed Lighting fixtures
- not included in the architectural envelope, e.g. freestanding on a floor or task lighting attached to a table

Non-fixed Acoustic solution
- acoustic panels not included in the architectural envelope, e.g. freestanding, attached to furniture or suspended from a ceiling
- sound-absorbing furniture and mobile sound-insulating phone booths and workspaces

Other non-fixed elements
- textiles, e.g. curtains, non-fixed carpets
- greenery
- other interior elements not being part of the architectural envelope

Figure 2.
Material qualities and solutions of interior orchestration

Some remarks concerning practical interrelations between *architectural envelope* and *interior orchestration*. Structuring the physical environment to *architectural envelope* and *interior orchestration* refers to the design processes of the physical work environment. The relationship between these two is understood here sequentially, with the interior designed inside the existing *architectural envelope*. *Interior orchestration* is more temporary than an *architectural envelope*, but still dependent on it. For example, the arrangement of furniture may be changed but the overall physical solution of the *architectural envelope* and the technical systems and solutions integrated to it are mostly fixed. However, the design decisions impacting the *architectural envelope* sets the conditions both spatially and technically for designing the *interior orchestration*. The *architectural envelope* and *interior orchestration* also form the structuring for the documentation of the physical environment. The documentation plays an important role as the research data and outcomes gathered are communicated across disciplinary boundaries, as well as in ultimately communicating the research findings to design practice benefitting the worker's experience of the work environment.

3.1 Defining architectural envelope and its qualities

Building envelope is a technical term, the origin of which is considered to be the physical separator between the conditioned and unconditioned environment of a building, including the resistance to air, water, heat (Cleveland and Morris, 2009), light and noise transfer (Syed, 2012). Here, the conditioned environment refers to interior and unconditioned environments to exterior spaces. In the definition of a building envelope, Straube and Burnett (2005) includes the finish to meet desired aesthetics on the inside and outside, in addition to material and structural aspects (Straube and Burnett, 2005). The finish is understood here as the architectural features of the building envelope. In our case, as not all spaces of the physical work environment are bordered with outside structures (the border between the conditioned and unconditioned environment), if the office is not the size of a whole floor level, the concept of a building envelope, as such, would be too broad. As discussed earlier, although the dividing interior walls are missing, the space is still bordered by the interior or exterior walls or both (they may be farther apart or outside the focus area) or only with exterior walls. Therefore, instead of the concept building envelope, we apply the concept of *architectural envelope* (Figure 1) comprising the idea of a closed space with technical solutions and architectural features as in a building envelope, but focusing on the interior part of the envelope that does not necessarily require an outer border structure.

However, the *architectural envelope* contents are more focused on studies of architectonic and technical solutions, they may either facilitate or hinder the *interior orchestration* solutions. The design decisions taken concerning the *architectural envelope* greatly affect the affordances interior designers designing work environments may offer to the worker. For example, the chosen lighting design solution (a fixed part of the *architectural envelope*) may either support or prevent the worker adjusting the lighting fixture above their workstation and thereby influence the level of personalisation of their workstation (the workstation belonging to the *interior orchestration*). Therefore, we consider it important to identify the interdependencies existing in design processes between these two entities (*architectural envelope* and *interior orchestration*), and we believe it is also key that these are taken into account in the work environment researchers' interdisciplinary interactions.

The wishes and needs of the worker are the focus of attention when studying environmental satisfaction. Location and time anchor a worker's environmental satisfaction to a specific place and moment in the work environment and, thereby, enabling architects to study in detail the physical work environment that the worker is experiencing. The location

dimension is present in design decisions impacting the *architectural envelope* setting the conditions both spatially and technically for designing the *interior orchestration*.

3.2 Defining interior orchestration and its qualities

In general, the first dictionary meaning of the verb *orchestrate* refers to music (orchestrate.2020), to arrange or score (music) for an orchestral performance. The second, general meaning of the verb *orchestrate* is to plan or coordinate the elements of (a situation) to produce a desired effect, especially surreptitiously (orchestrate.2020). The noun *orchestration* is broadly used in different disciplines for specific purposes, e.g. *classroom orchestration* referring to how a teacher manages, in real time, multi-layered activities in a multi-constraints' context (Dillenbourg, 2013), where the classroom as a space is implicitly present as a context. An example of *orchestration of the shopping experience* in mall spaces refers, i.e. to the role of place in the retailer-consumer interaction (Faurholt Csaba and Askegaard, 1999), where the physical features (such as space and wall fixture units) are explicitly presented in relation to the user's experience in the shopping context. Interior design process, as such, has been compared to orchestration and interior designer to a visiting conductor to a symphony's performance (Dohr and Portillo, 2011). Dohr and Portillo (2011) also mentioned the *interior orchestration* but did not define the concept any further. In a non-academic practical design field, *interior orchestration* has been used to refer to organising an interior renovation from the design phase to the implementation or just as a synonym for organising furniture in an interior space.

In general, in a work environment context *interior orchestration* would refer to interior design contents that facilitate employees' activities in relation to their workstation, workspaces or work environment and other activities (e.g. recovering) during the workday. Regardless of the material dimension and way of structuring the material qualities of *interior orchestration* (Figure 2), we are *not* considering the interior design, as such, to be an *interior orchestration*. We propose, *interior orchestration* refers to researcher's (or professional designer's) intentional design action based on the user-centred evidence-informed data to design a workspace interior by using material features and solutions to be integrated to the *architectural envelope*. And further, the *intention* is, thereby, *to facilitate the functions* of the work environment (e.g. collaboration or concentration) and *to harness* the provided *affordance* to the benefit of a worker's environmental satisfaction. The concept of *interior orchestration* is intended to support affordance-based thinking to avoid the fragmented way of discussing the interior through furniture and other non-fixed elements or solutions. The individual piece of furniture (table or chair), textile (curtain or carpet) or non-fixed lighting fixture (freestanding on the floor or task lighting attached to the table) might not be important as such, but together they provide relevant affordance to support workers' experience of a satisfactory work environment. As stated earlier, in the ecosystem context concerning affordance, it is important to focus not only on how the worker uses their physical environment but also, more precisely, where and when it takes place. From the affordance-based thinking point of view, *interior orchestration* must be inspected in its location in relation to the *architectural envelop*e to also understand if the architectural design, lighting, acoustic and HVAC solution have consequences for the affordance provided. For example, the shape and orientation of the space, together with the location of the windows, might affect how the natural light enters the space; is it causing glare for the worker at their workstation or are they able to experience the natural light as a pleasant and positive feature in the work environment.

4. Conclusion

We built this paper upon the presumption that to understand a worker's environmental satisfaction in a spatial context, it is important to know where and when the worker is using and experiencing the three-dimensional office space. This was a bold overture considering that architects, as designers, have deficiencies in integrating user experience to their design work. Neither architect designers nor design researchers have the established knowledge or methodology to study the environmental satisfaction of workers. However, the identified challenges by the work environment researchers in explaining causal and systemically complex relationships between physical office environments and employee outcomes encouraged us (architect design researchers) to enter the discussion. In general, the work environment research findings have been highly interesting. However, we have also had difficulties in understanding the qualitatively enriched concepts in a spatial context, the fragmented ways of discussing spatial entities and the two-dimensional floor plan-based documentation. We were not content only to exploit the work environment research outcomes to our spatial intervention-based research. Instead, we were interested in searching for a holistic approach to cooperate within an interdisciplinary context with work environment researchers to advance our shared understanding. We already had experience of conducting intervention-based research to study real-world environments through change to capture a holistic overview to find better design solutions for users. Therefore, our concern was also the discontinuity in knowledge transfer of the work environment research outcomes to the architectural design practice to improve the physical office spaces that are not, at present, very compatible with the worker.

Based on this knowledge and experience, we identified a need for a location-specific ecosystem-based approach for holistic transdisciplinary understanding of the physical work environment compiled of a twofold entity, *architectural envelope* and *interior orchestration*. This approach forms the context of understanding, documenting and communicating the knowledge concerning the complexity of the interdependent parts of the physical work environment. The twofold division is to imitate designers' way of operating and structuring their working processes to better engage the design professionals involved with the practical knowledge, together with the researchers as academic knowledge producers and the users as evidence providers.

In work environment research, environmental satisfaction indicates how well the environment meets a worker's wishes and needs. Space and time connection enables architects to study in detail the physical space the worker is experiencing. The design decisions an architect makes are location-based, setting the *interior orchestration* for the spatial and technical framework. The *interior orchestration* is intended to support affordance-based thinking, focusing not only on how the worker is using the physical environment but also where and when it takes place. This approach avoids the fragmented way of discussing the interior. *Interior orchestration* facilitates the functions of the work environment and harnesses the provided affordance to the benefit of a worker's environmental satisfaction. When sharing the findings in the interdisciplinary context with the other researchers, also documenting the time-location dimension is relevant.

The time-location-based approach may also open new kinds of possibilities to integrate qualitative and quantitative data to advance understanding of the physical environment's affordance to the worker more precisely. For example, combining the tracking data concerning the worker's location during the workday with data collected by context-aware mobile methods or with any other dataset brought to a time-location-based grid provides a novel way to study environmental satisfaction in the physical office space context.

There are limitations in the use of the activity-based office ecosystem model. One of the greatest challenges is the success of genuine communication (in multiple levels) between disciplines in practice. For example, the idea that the twofold model would support to clarify the ambiguous contents in spatial discourse and further structure the qualitatively enriched spatial concepts is understandably challenging, if the interdisciplinary research group does not include an architect or interior design researcher. Also, the broad variety of methods and methodological approaches within interdisciplinary research consortium interactions is highly demanding, not to mention the combined ethical and GDPR requirements. In addition, the intervention-based research carried out on the premises of an operating enterprise is full of risks. However, despite these known risks and shortcomings, we are still highly motivated to aim for further understanding about interdependencies between the environment and worker. In our own interdisciplinary research projects, we are, step-by-step, proceeding towards the direction proposed in the ecosystem thinking model.

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