How Architects Learn: Training of a Daylight Simulation Tool in Architectural Design Practice

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HOW ARCHITECTS LEARN: TRAINING OF A DAYLIGHT SIMULATION TOOL IN ARCHITECTURAL DESIGN PRACTICE

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Abstract

Software for building performance analysis sees little use in early stage architectural design, yet research applying a practice perspective to tool integration remains limited. To understand how tool learning activities are linked to their perceived usefulness and ease-of-use, we applied interviews and questionnaires during the learning process of a daylight simulation software in a mid-sized architectural office in Sweden. We found that combining learning activities is beneficial, and that members throughout the organisation hierarchy need to learn about the tool capabilities for integration to be successful. These findings can guide training approach focus from ”user” to ”practice”.

Introduction

Building performance analysis tools, including daylight simulation software, are needed to be able to quantify the environmental and social impact of a building as it is being conceived (de Wilde, 2019). As architects claim more responsibility for environmental and social factors of the built environment (Yu et al., 2022), there is a need for tools which are adapted to the architect as a user (Attia et al., 2012), and to architecture as practice (Säwén et al., 2024). However, in current architectural practice, building performance analysis tools mostly see use in later design stages for regulatory compliance (Hensen and Lamberts, 2011, Hollberg and Ruth, 2016, Mahmoud et al., 2020). For tools to be adopted to influence design judgment and decision-making in early stages, a stronger practice perspective needs to be applied during tool development and integration, considering a wider range of actors than just the person operating the tool (Säwén et al., 2024).

A key aspect of practice integration is the learning and adoption process of new tools in organisations like architectural offices. However, there are few studies studying the integration of tools in practice (Purup and Petersen, 2020). Especially, there are no studies which explain tool integration success by linking different training methods and learning activities to how tools are perceived in practice. The Technology Acceptance Model (Davis and Venkatesh, 1996) proposes that the ”perceived usefulness” and ”perceived ease-of-use” of technology are key factors to successful tool integration. The aim of our work is to respond to the following research question, using these concepts to link tool training to improved user perceptions:

- How do different learning activities impact the perceived usefulness and ease-of-use of daylight analysis tools?

We investigate this by tracing the training process of a parametric daylight analysis tool, implemented using Ladybug Tools (Sadeghipour Roudsari and Pak, 2013) and Rhino/Grasshopper (McNeel, 2024), in a mid-sized architectural design office in Sweden (Gustafsson, 2024). The findings of our work are firstly intended to be useful to architectural offices who wish to improve training methods when adopting new tools. Secondly, they are intended for tool developers to adapt training programs to the way that tools are most effectively taken up in practice.

Background

Daylight analysis in architecture

Daylight is a key concern in architectural design as the access to daylight has major effects on human wellbeing including effects on concentration and the circadian rhythm (Ayoub, 2020). Because of its importance, daylight requirements have been defined in many countries including Sweden (Boverket, 2020). The daylight performance of a building is largely governed by a number of geometric and material parameters which are in the architect's control (Wang et al., 2024). This means an architectural model can be readily transposed into a daylight analysis model, and the performance quantified in order to differentiate design options and select a well-performing alternative (Ayoub, 2020). The level of detail of the analysis ranges from the shading angle of the surrounding, to vertical sky component, to daylight factor, to climate-based analysis (Gustafsson, 2024).

Daylight analysis tools have been investigated from several perspectives, including the precision of the algorithm (Ayoub, 2020), use for design optimisation (ElBatran and Ismaeel, 2021), links to machine learning applications (Lorenz et al., 2020), and energy consumption (Mavromatidis et al., 2014). However, these studies largely apply a technological perspective, failing to take into account the reality and complexity of architectural design practice, including processes of tool apprehension and uptake within a given organisation (Säwén et al., 2024). In our study, we apply this practice perspective by studying how different actors in the architectural office react during the learning process of a parametric daylight analysis tool.

Organisational learning in architecture

According to the Technology Acceptance Model, the likelihood of adoption of any given piece of information technology, like a daylight analysis tool, can be explained through the perceived usefulness, and perceived ease-of-use of the technology (Davis and Venkatesh, 1996). Several variables affect these perceptions, including the access to technology training and the implementation environment (Lin et al., 2022). As studies on how training methods affect the willingness to adopt daylight analysis tools in design workflows are lacking, we compare different methods and use these concepts to identify their impact on the perceptions of various actors in architectural design (Gustafsson, 2024). The methods are intended to firstly teach the participants about the analysis, and secondly to operate the tool (Mahmoud et al., 2020). An overview presentation with participants from the entire office was held for the first purpose, an in-depth course with select participants for both purposes, and finally one-to-one sessions applying a problem-based learning approach were held for the second purpose (Banerjee and De Graaff, 1996).

Case study

Our study surveys employees in various positions in the organisation hierarchy using interviews and questionnaires as they are going through learning activities connected to the tool (Gustafsson, 2024). We carried out the study in a mid-sized (around 60 employees) architectural office in Sweden. The principal evidence collection was carried out by the second co-author who, at the time of the study, had been an employee at the office for three years, responsible among other things for the development and application of building performance analysis tools.

The initial motivation for the office to implement the tool in the practice, instead of outsourcing the analysis to external consultants, was threefold (Gustafsson, 2024):

- Reducing the distance between designer and analysis
- Increasing the amount of iterations possible within the project budget
- Allowing selling the analysis as a service, adding value to the proposal

For the purposes of analysis, as shown in Figure 1, the office can be considered to have a hierarchical structure with five layers (Swedish titles in brackets) (Sveriges Arkitekter, 2024):

- Management (delägare)
- Responsible architect (ansvarig arkitekt)
- Project architect (handläggande arkitekt)
- Junior architect (medverkande arkitekt)
- Supporting group (HR, IT, etc.)

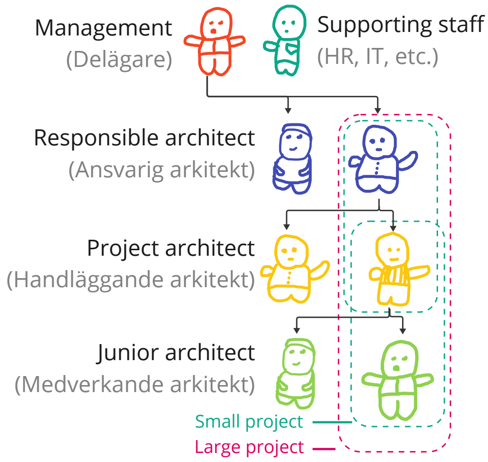

Figure 1: Hierarchy of the office. Swedish titles in gray. Adapted from Gustafsson (2024), with permission.

Daylight analysis tool

The tool used for the learning activities was developed by the second co-author based on Ladybug Tools (Sadeghipour Roudsari and Pak, 2013) and implemented in Grasshopper/Rhino (McNeel, 2024). The components of the tool are shown in Figure 2 (Gustafsson, 2024). Geometric information from Rhino, Revit, AutoCad or Sketchup is adapted in Rhino. The analysis is setup in Grasshopper and carried out in Ladybug Tools, using the validated Radiance engine as the simulation back-end. Finally, results are graphically presented in Rhino.

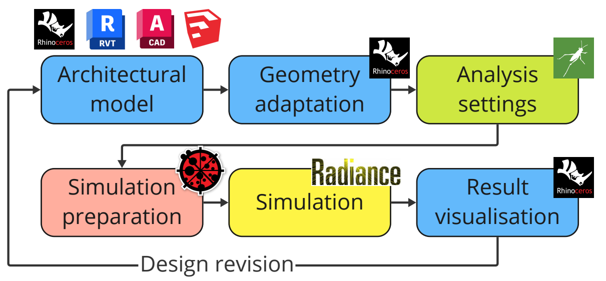

Figure 2: Tool workflow. Adapted from Gustafsson (2024), with permission.

The purpose of the tool is to be used for early-stage decision making as well as building permits. The output of the tool is threefold as shown in Figure 3, firstly a 2D heatmap which shows the daylight factor (DF, [%]), secondly a single value for each room which represents the median DF, and thirdly a border which represents the portion of the modelled rooms in which $DF > 1\%$, which is relevant in relation to Swedish daylight requirements (Boverket, 2020).

Method

An overview of the methodology is provided in Figure 4. The evidence collection included questionnaires in conjunction with experiments, that is, after each learning activity, as well as interviews. The questionnaire results and

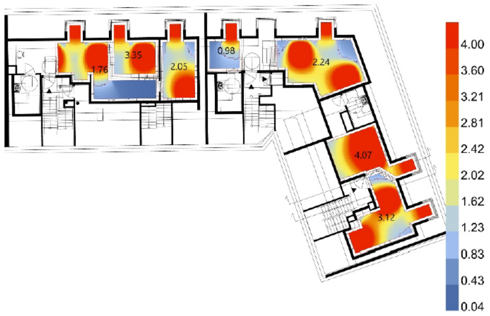

Figure 3: Tool output. From Gustafsson (2024), with permission.

the notes from interviews were coded to identify first- and second-order topics (Gioia et al., 2013). The evidence was analysed using concepts from the Technology Acceptance Model to understand the effect of the learning activities on the perceived ease-of-use and usefulness of tools (Davis and Venkatesh, 1996).

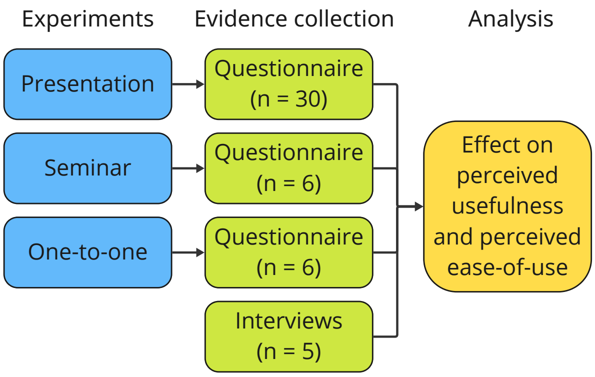

Figure 4: Overview of methodology

Experiments - learning activities

Three experiments were conducted in the form of different learning activities. Firstly a presentation for the whole office, the purpose of which was to increase the knowledge about the analysis method (improving the perceived usefulness of the tool). Secondly, a seminar course with select participants, the purpose of which was both deepening the knowledge about the analysis method and introducing the tool operation (influencing both perceived usefulness and ease-of-use). Thirdly, one-to-one training sessions were held with the course participants, the purpose of which was to increase the knowledge of the tool operation (improving its perceived ease-of-use). Details of the experimental method outlined in the following section are provided by Gustafsson (2024).

Experiment 1 - Presentation

The first learning activity was a presentation held for 30 minutes during the weekly meeting in the office, including participants from all levels of the hierarchy presented in Figure 1. The topics included were:

- Physics of daylight
- Relevance of daylight
- Laws and certifications
- Daylight metrics
- Daylight history
- Analysis tools
- Parameters affecting daylight

Following the presentation, a questionnaire was handed out, as described below.

Experiment 2 - Seminar course

The second learning activity was a seminar course given to six office employees who were intended users of the tool. The participants either volunteered or were recruited by the management. All participants were of the level ”project architect” or ”junior architect” as defined in Figure 1. The course focussed on presenting the theoretical knowledge needed to operate the tool, and lasted two hours including a 15 minute break. The course included the following topics:

- Reference projects
- Physics of daylight
- Relevance of daylight
- Laws and certifications
- History of daylight
- Daylight metrics
- Parameters affecting daylight
- Creating an analysis model
- Tips and tricks

An objective of the course was to highlight the importance of verification in relation to simply accepting the analysis outputs. After the course, the participants were asked to perform a diagnostic test lasting an additional two hours. The test consisted of defining analysis rooms in an existing 3D model of an apartment building, performing a *DF* analysis, and checking against Swedish regulations.

Experiment 3 - One-to-one training

The third learning activity was one-on-one training sessions where the participant applied the tool in real design projects, ”learning the tool by doing” in a problem-based learning approach (Banerjee and De Graaff, 1996). The co-author was present while the participant worked on the problem, allowing questions to be asked and immediate verification of the results. The process starts with an introductory meeting, including:

- Explaining the project
- What analyses are relevant
- The context and input values to use
- A beneficial workflow
- Reference projects

Following this meeting, the instructor is available to answer questions upon request or during regular check-ups. Finally, all produced material is reviewed before delivery.

Evidence collection

Evidence as to how the participants in the experiments responded to the learning activities was collected firstly using self-assessment questionnaires, and secondly using semi-structured interviews. The application of these methods is described in detail by (Gustafsson, 2024), and an overview provided in the following section.

Questionnaires

The first way of responding to our research question: "How do different learning activities impact the perceived usefulness and ease-of-use of daylight analysis tools?" was anonymous self-assessment questionnaires (Ward et al., 2002), thus evaluating the learning experience of the experiment participants. The questionnaire included firstly multi-option questions where the respondent described their experience on a range 1-4 (bad-good) in a variety of topics, and secondly open-reply questions. As Ward et al. (2002) notes, self-assessment may have a low accuracy. Hence, triangulation was achieved through interviews with representative experiment participants (Natow, 2020).

Semi-structured interviews

Triangulation of the questionnaire responses was achieved through five semi-structured interviews (Kallio et al., 2016), one representing each group in the hierarchy of the office shown in Figure 1. The interviews were carried out by the second co-author using the following interview guide:

1. In relation to the diagram shown in Figure 1...
    - ...what position do you have at the office?
2. General - In your position...
    - ...what is relevant for you in a tool?
    - ...what do you need to know about the tool?
    - ...how do you want the tool to work?
3. Specific - Daylight tool - In your position...
    - ...do you feel the tool is relevant?
    - ...do you want to use the tool or teach others?
4. Self-Assessment - to what extent do you feel...
    - ...you know the tool and its intended use?
    - ...the tool is relevant for you?
    - ...you can use the tool by yourself?
    - ...you are able to teach how to use the tool?
5. Experience - how many times...
    - ...have you used this tool before?
    - ...have you used a similar tool before?
6. Credibility - do you...
    - ...believe the tool gives relevant results?
7. Miscellaneous - do you have any...
    - ...suggestions how to improve the tool?
    - ...other thoughts?

The interviews were recorded and transcribed. Coding of the responses was carried out inspired by Gioia et al. (2013), structured into first-order quotes, opinions and figurative expressions (using the respondent's terminology), and second-order themes and topics (as identified through analysis).

Analysis of evidence

The Technology Acceptance Model links the actual implementation of a technological product like a daylight analysis software tool to two factors: the perceived ease-of-use, and the perceived usefulness, of the technology Davis and Venkatesh (1996). These factors support our analysis of the various actors' experience learning the tool investigated in our case study. This allows us to investigate how different learning activities were effective in changing the perception of different actors.

Results and analysis

An overview of the results from the questionnaires and interviews is presented here. For a detailed breakdown of the results, cf. Gustafsson (2024).

Questionnaire survey

Experiment 1 - Presentation

The questionnaire sent out by e-mail immediately after the presentation got 30 responses. The results of the self-assessment questions, where questions of the form "After the presentation, how do you estimate your..." were answered on a scale 1-4, are shown in Table 1.

Table 1: Summary of questionnaire results following experiment 1 - presentation with office. Rating on a scale 1-4 (low-high). Questions were posed in the form: "After the presentation, how do you estimate your..."
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	Question \ rating	1	2	3	4
A1	...motivation to work with daylight?	8%	38%	42%	12%
A2	...motivation to work with daylight has improved?	0%	8%	50%	42%
A3	...general knowledge of daylight has improved?	0%	11%	58%	31%
A4	...knowledge of daylight?	15%	46%	39%	0%
A5	...knowledge of the relevance of daylight?	0%	8%	58%	34%
A6	...knowledge of the relevance of daylight has improved?	4%	8%	42%	46%
A7	...knowledge of the internal daylight tool?	69%	27%	4%	0%
A8	...trust in the internal daylight tool?	0%	8%	54%	38%
A9	...perceived relevance of the presentation?	0%	4%	31%	65%

The presentation appears to have improved the motivation to work with daylight (questions A1-A2). Many respondents felt their general knowledge of daylight had improved but was still limited (questions A3-A4). The respondents felt their knowledge of the relevance of daylight had improved to a good level (questions A5-A6). While the respondents felt they had little knowledge of the internal daylight tool, their trust in the tool was high (questions A7-A8). Almost all respondents felt the presentation was

relevant or highly so (question A9).
The presentation appears to have succeeded in its main aim to improve the understanding about the relevance of daylight analysis in architectural design. Further, it succeeded in improving the motivation to work with daylight (the perceived usefulness). It is not very worrying that the participants felt that their daylight knowledge was still limited based on the short (30 minute) scope of the introductory presentation. Still, the presentation was perceived as relevant and indeed improved the self-assessed knowledge of daylight and its relevance.
It is interesting that although most participants felt they had little to no experience with the internal daylight tool, their trust in the tool was high. Since the presenter was the developer of the tool and the main person responsible for operating the tool currently, this indicates that the credibility of the tool and its outputs are largely linked to the perceived competence of the tool developer, and by extension, its operator.
Open-text questions were also asked. Firstly, question (A10): "What motivates you to work with daylight?" to which the following categories could be identified:

- Understanding: human experience of light
- Independence: not having to rely on others
- Importance: necessary to realise projects
- Economy: opportunity to offer service
- Quality: improved architectural designs
- Guidance: use to drive design, not validate it

Secondly, question (A11): "How could the presentation be improved?" which received the following responses:

- Time: ranging from "too short" to "too detailed"
- Reference projects: good and bad, real projects
- Graphics: improved fidelity and visibility
- Design tool: how to use in practice to design
- Economy: reframe specialist analysis as service offer
- Reference documents: literature for further reading
- Relevance: good introductory presentation

Experiment 2 - seminar course

For the participants in the seminar course, the same questionnaire was sent out before and after it. The responses are summarised in Table 2.
As shown by the responses to questions B1-B4, the course was successful in improving the knowledge both about daylight itself and its relevance, whereas according to questions B5-B6, the credibility of the tool remained mostly constant. Questions B7-B10 show that the perceived knowledge of the tool, both in terms of operating and explaining it, improved greatly through the course. However, according to the responses to questions B11-B12, the motivation to implement daylight analysis in workflows was unaffected.
This shows that the course approach was successful in improving the knowledge of daylight phenomena and their relevance (the perceived usefulness), as well as the confidence in performing daylight analysis using the tool (the perceived ease-of-use). The limited effect on the perceived credibility of the tool is interesting - the confidence was quite good at the outset, but two potential changes are imaginable: the improved knowledge of the tool might either reduce the perceived credibility as the awareness of tool limitations is improved; or it might increase the credibility as the awareness of the possibilities of the tool is improved. The results here point vaguely to the second mechanism, but the limited sample size limits the opportunity to draw conclusions.

Table 2: Summary of questionnaire results preceding and following experiment 2 - seminar course. Rating on a scale 1-4 (low-high) in number of respondents (n = 6). Questions were posed in the form: "How do you estimate your...".

	Question \ rating	1	2	3	4
	...knowledge about daylight...				
B1	...*before* the course?	2	4	0	0
B2	...*after* the course?	0	1	5	0
	...knowledge about the relevance of daylight analysis...				
B3	...*before* the course?	0	1	5	0
B4	...*after* the course?	0	0	2	4
	...confidence that the results are credible...				
B5	...*before* the course?	0	1	4	1
B6	...*after* the course?	0	1	3	2
	...knowledge of the internal daylight analysis tool...				
B7	...*before* the course?	4	0	2	0
B8	...*after* the course?	0	2	3	1
	...ability to teach the tool...				
B9	...*before* the course?	4	1	1	0
B10	...*after* the course?	0	2	3	1
	...motivation to work with daylight analysis...				
B11	...*before* the course?	0	0	3	3
B12	...*after* the course?	0	0	3	3

An open-ended question was posed about the motivation to work with daylight. Three main topics could be found among the responses:

- Quality: improving the design
- Influence: ability to affect decisions
- Independence: not relying on external consultants

A second open-ended question was asked about suggestion for improvements to the course. Three topics can be highlighted:

- Manual: availability of a reference document
- Terminology: providing clear definitions
- Learning goals: clear expectations

Experiment 3 - one-to-one training

The six participants in the one-to-one training sessions responded to a questionnaire sent out after their conclusion. Six responded to questions C1-C6, and five to questions C7-C10. The responses are summarised in Table 3.
Following the one-to-one sessions, most participants feel their knowledge of daylight is good, and of the relevance of daylight is excellent (questions C1-C2). The participants have good confidence in the credibility of the tool output (C3). The knowledge of the tool and the ability to teach it

Table 3: Summary of questionnaire results following experiment 3 - one-to-one training. Rating on a scale 1-4 (low-high) in number of respondents (n = 6, questions C1-C6; n = 5, questions C7-C10)). Questions were posed in the form: "After the one-to-one training, how do you estimate your...".

	Question \ rating	1	2	3	4
C1	...knowledge about daylight?	0	1	5	0
C2	...knowledge about the relevance of daylight?	0	0	2	4
C3	...confidence that the results are credible?	0	1	3	2
C4	...knowledge of the internal daylight tool?	0	2	3	1
C5	...ability to teach other users?	0	2	3	1
C6	...motivation to work with daylight analysis?	0	0	3	3
C7	...increased knowledge regarding the internal daylight tool?	0	0	0	5
C8	...increased knowledge regarding the relevance of daylight?	0	1	2	2
C9	...increased knowledge regarding working with daylight?	0	0	2	3
C10	...increased motivation to work with daylight?	0	0	3	2

can be considered acceptable (C4-C5), and the motivation to work with daylight is high (C6). The participants feel the sessions improved their knowledge of the tool, their knowledge of working with daylight, its relevance, as well as their motivation (C7-C10).

In summary, the most important goal of the one-to-one sessions was fulfilled, namely improving the ability to operate the tool (the perceived ease-of-use). In comparison to the course, the training had less effect on the perceived knowledge about daylight and its relevance - possibly because the training sessions were preceded by the seminar course. The responses were mixed to the question if the sessions improved the motivation to work with daylight - some felt the increased knowledge improved their motivation and the sense that it analysis can affect the design outcomes, while others were already highly motivated, stating for example that "analysis is always fun". None of the participants felt their motivation was reduced through participating in the course, which indicates potential to integrate quantitative analysis tools in design practice.

In terms of suggested improvements, the learning barriers were perceived as high, and "learning by doing" while slowly increasing the difficulty was proposed. The tool was also perceived as unclear.

Interview study

Five interviews were conducted with representatives from each layer of the hierarchy presented in Figure 1. A summary of the second-order topics discussed, with first-order example quotes, and analysis in terms of perceived usefulness and ease-of-use, is presented in Table 4.

A trend can be seen where practitioners "higher" in the hierarchy are more concerned with aspects of perceived usefulness in terms of selling more services, supporting the design, and reducing the cost of integration; whereas those intended to operate the tool are more concerned with aspects improving the perceived ease-of-use, like the availability of a manual and personal support.

Several respondents bring up the need for key personnel who can act like a "champion user" (Markham and Aiman-Smith, 2001). This is a person who knows both the analysis method and how to operate the related tool, and can thus push for its increased use and teach other users. This person can help the responsible architect figure out the time consumption and competence needed to perform tasks (I2); they can be the person who has the deep knowledge about the analysis (I3); and they can be the person to support junior personnel when they get stuck (I4).

Discussion

While it is obvious that tool training leads to improved user perceptions, we break this perception down into "perceived usefulness" and "perceived ease-of-use", and investigate how these perceptions change among different practitioners in an organisations when exposed to different training methods and learning activities.

Our first finding is that several activities should be combined for successful tool integration. This is firstly in order to motivate the intended users by teaching them about the relevance of applying the analysis, improving perceived usefulness; and secondly in order to teach the operation of the tool and how to troubleshoot and interpret the results, improving the perceived ease-of-use. As found by Lin et al. (2022), the availability of training is a key aspect to tool adoption, yet is a significant cost both in terms of time and money. Our results offer insights into what training activities to prioritise at what stage of tool adoption.

Our second finding is that practitioners on all levels of the office hierarchy need to see both how tools are relevant, and how they should be operated. This ranges from the highest management, who need to be aware of how the tool can add to the service offered to the client, to the support staff like IT department, who need to know how licenses and installations work and what people in the organisation are responsible for carrying out work using the tool. This includes the importance of the "champion users" Markham and Aiman-Smith (2001) who act as early tool adopters and proponents, and guide other users as the tool is being integrated. This finding stands in contrast to most of the existing literature on tool integration in architectural design practice, which emphasises the experience of the single user, and not their relation to other actors in the design practice (Säwén et al., 2024).

These findings indicate that the Technology Acceptance Model (Davis and Venkatesh, 1996) offers meaningful concepts to achieve a fine-grained understanding of the impact of training methods on perceptions on tools which can

Table 4: *Summary of responses in interviews with one representative from each of the levels of the office hierarchy. The responses are exemplified through the second-order topics that emerged from our analysis, and example first-order quotes representing the topics.*

Perceived usefulness	*Perceived ease-of-use*
I1: Management	
Service offering: "Use as a design tool as well as something which you are able to sell extra"	**Communication:** "You can see and understand it. Like a pen and pencil, you just understand"
Empower architect: "Otherwise another consultant can get power over our topics. E.g. facades etc."	**Intuitive:** "Not like Outlook, which is menu based"
Design support: "To know how to get a daylight study I think we can handle, but use as a design tool puts more requirements"	**Functionality:** "Energy would be good but think it exceeds our mental barrier"
Cost: "Time, internal knowledge, money"	**Availability:** "Who can use it? Do we have it?"
I2: Responsible architect	
Playfulness: "If a tool is easy and playful, it creates lust to learn. It helps you to sketch and design"	**Time consumption:** "I do not actually need to know how to do something, just how long time it takes and how advanced it is"
Credibility: "I believe in our results, less in velux, it is a bit cowboy style"	**Learnability:** "We have limited time and tight budgets, don't have time for learning new tools but would use it on actual projects"
Avoiding mistakes: "If you have understanding about accessibility, you make less mistakes connected to it"	**Shared knowledge:** "If it is software used for design and to help us in the everyday process it is good if everyone can use it"
I3: Project architect	
Benchmarking: "You don't need to know specific standards and laws, you need to know how to look it up within a specific project"	**Support:** "Both the responsible and the one who does the work have to have someone to ask"
Champions: "One person at the office who knows everything, other people only know what they need"	**Learnability:** "It should be so simple so anyone can do daylight. I don't have time to learn new tools"
Tracking design: "If you could reduce the risk the original idea goes lost in later stages it would be super"	**Time consumption:** "Better to have it internally at the office. Faster. Externally it is often more expensive and only retrospect"
I4: Junior architect	
Relevance: "You have to keep yourself relevant, [by learning] within the working environment"	**Transparency:** "Possibility to learn more about how the logic behind the tool works, to be able keep developing this tool and new tools."
Credibility: "I trust you and your knowledge, and therefore the credibility of the tool"	**Support:** "Someone I can ask when I get stuck"
Communication: "It is not common for responsible architect to know Rhino or Revit, they ask me to show the 3D model on the screen"	**Manual:** "I need to know how the program works, how to use it. How to solve errors and fix eventual problems"
I5: Support group	
Robustness: "It should be several people who are able to use every tool. Robustness within the company"	**Competence:** "I need to understand who knows what where; I'm like a spider connecting people from different strings"
	Availability: "I need to be able to install it"

influence the success of technology adoption.

It should be noted that the evidence has been collected in one mid-sized practice in Sweden only, and that experiments in other organisations and contexts are needed to add further nuances to the influence of learning activities on tool integration. We also note that the learning activities were only investigated in terms of their impact on perceptions, and that follow-up studies in the same practice would be required to investigate the actual uptake of the daylight analysis tool.

Conclusion

In a questionnaire and interview study, we surveyed the learning activities of a daylight simulation tool in a Swedish architectural design practice. In investigating how learning activities impact the perceived usefulness and ease-of-use of the tool, we found that a combination of activities is needed as each activity impacts different tool perceptions for different practitioners. We further found that different learning activities need to introduced for practitioners of different levels in the office hierarchy, and that training focus should not be limited to the tool operator but to all actors affected by tool integration. We intend to support the development of training programs for building performance analysis, and offer a practice perspective on tool integration which goes from the scope of the single user to the success in the entire organisation. Eventually, the adoption of simulation tools can lead to better design outcomes in terms of daylight performance.

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