User experience goals for interactive climate management systems in green houses

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ABSTRACT
This paper presents findings from interpretative phenomenological interviews about the UX of interactive climate management with six growers and crop consultants. A model of UX of interactive climate management is presented. The findings are reported in a UX target table, which can be the basis for future research on UX at work in this domain.

Keywords
Climate management, interpretative phenomenological analysis, usability, user experience,

1. INTRODUCTION
User experience (UX) researchers have mainly studied the positive emotions related to the voluntary use of computers in non-work contexts [7]. The focus has been on consumers' *initial* usage experiences of mobile phones, e.g. [10] and e-commerce websites, e.g. [12]. Frequently the method used to capture UX has been quantitative in the form of a survey or a scale, see e.g. [5]. In contrast, this empirical work-in-progress paper provides an example of how to capture UX in work contexts and with a qualitative methodology.

It is known that emotions may influence HCI at work [1, 11], that UX is relevant in work situations [6], and that the quality of HCI is also related to designing for positive emotions with interacting with complex systems. However, in addition to considering how emotions influence HCI in work contexts, we argue that the work place itself also restricts, shapes, influences, mediates, and relates to emotional UX At Work.

User experience is defined as a "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service" [8], p. 9, which is influenced by user, system and context. To us, this definition appears to suggest that there is there a single measure „u" of usability, i.e. there is a single, unified concept of usability/user experience that can capture the relation between the human and the computer across the different social, cultural, technical and organizational contexts of an ICT system. However, we believe that this is a question that cannot be answered alone on theoretical grounds, but need to be answered also by empirical studies of user experience in different contexts.

In this paper we focus on what user experience is in a particular work context - that of growers doing climate management in green houses using climate control systems. One reason why this is a good choice for studying UX in work contexts is that there is much exact knowledge about how to control the climate in green houses using climate control computers. However, greenhouses are mostly open systems, plants may exhibit a kind of cognition [3], and green house production is important in many countries in the world [9]. Hence, what is described as growers experience of doing climate management with interactive systems may vary, depending of which of the professional perspectives or parts of the world, which the story is told from. Our aim in this short paper is to raise questions like

- Is there a single unifying meaning of the user experience of interactive climate management?
- What are peoples' (with expertise in the domain) user experience of climate management?
- What is a positive user experience of climate management systems?
- Is the UX of cliumate management similar across the world?

1.1 Related work
Textbooks in UX suggest the use of a UX target table, that is, a spreadsheet-like listing of work roles, user class, UX goal, UX measure and base and target levels [4]. In this paper we propose a research-based target table as the outcome of studying a single work context.

It is possible to view UX in work places as being mainly about positive emotions related to interacting with specialized software and hardware. Thus we assume that UX in interactive climate management depends on:

- Mandatory interaction with climate computer/other hardware
- Organizational culture rules for displaying emotions in grower companies
- Growers preferences for interaction (different versions of systems)

In this paper, we try to relate each individual's UX to these assumptions, and discuss in detail to what degree this is possible.

2. METHOD
To answer the research questions, we used an interpretative phenomenological analysis approach (IPA) [13]. With this idiographic mode of inquiry, the aim is to explore in detail how individuals perceive the particular situation they are facing. Interviews (11 in total) were conducted with greenhouse growers, consultants, researchers, software vendors and greenhouse assemblers ("montører"), all involved in climate management. This sample was carefully chosen to offer multiple perspectives on a shared experience for them, climate management in green houses. Thus climate management phenomena would be experiences of some personal significance to all of the interviewees. In this case the interviewees'

development of their involvement in climate management, how they experienced climate management, and how they made sense of climate management.

2.1.1 Data collection

The interviews were approached from a position of flexible and open-ended inquiry, and the interviewer (the first author) attempted to adopt a stance that was curious and facilitative (rather than, say, challenging and interrogative). IPA usually requires personally-salient accounts of some richness and depth, and so the research had to capture the interviewees' accounts in a way that permitted the researchers to work with a detailed verbatim transcript after the interview. The interviews were semi-structured in order to enter as far as possible into the world of the participant. Follow-up questions were posed, in order to validate the answers that the participants gave. The data were transcribed by a third-party, a native speaker of Danish, who was instructed to do a meaning transcription (leaving out hmms, oehmms, repeated words, etc).

2.1.2 Data analysis

After transcribing the data, the second author worked closely and intensively with the text, annotating it closely ('coding') for insights into the participants' experience and perspective on their world. The analysis of the data was conducted as IPA, supported by the use of Atlas.ti, a qualitative data analysis and research software. The analysis was at every step shared and discussed with the first author. By applying a collective IPA, the researchers attempted to grasp how the participants perceived and made sense of their own world, but at the same time the researchers were also trying to make sense of the participants trying to make sense of their world. Thus, we did in depth qualitative analysis, through careful examination of interview transcripts.

Each interview-transcript was read several times, before actual coding. Each was treated as a single case, as we are focusing on the individual experience of each participant. As the analysis developed, the researchers catalogued the emerging codes, and subsequently began to look for themes in the codes. Coding themes were chosen carefully, as the aim was to make sense of what the participants were saying, but at the same time constantly checking one's own sense-making, against what the person actually said. Themes were recurring patterns of meaning (ideas, thoughts, feelings) throughout the text. We aimed at finding themes that both identified aspects of climate management that mattered to the interviewees, and also carried something of the meaning of that climate management. Themes were eventually grouped under much broader superordinate themes, see figure 1. The final set of themes were then summarised for each individual participants and as a group. The aim was to capture the essence of interactive climate management, both for each group of participants, and across all participants. Thus the final part of the analysis was the narrative account of the meanings inherent in all the participants' experience, illustrating the findings. In this paper, we present only parts of our data, namely findings from interviews three growers and three consultants.

2.1.3 Data reflection

In our IPA, we tried to balance the descriptive phenomenology with some model-based insightful interpretation, in a way that anchored – through quotations - these interpretations in the participants' accounts. We held idiographic focus and considered each participant closely in order not to lose variations. We kept our focus on meaning, and only considered causal relations on the highest level of abstractions. Of course, we wanted to achieve transparency by giving contextual detail about our sample (see table 1), and a clear account of our process. We illustrated key points by verbatim quotes to allow readers to estimate the plausibility and transferability of our study. In later research we will cross validate with other studies of interactive climate management.

3. RESULTS/FINDINGS

The interview participants that we report findings for in this paper were three consultants and three growers, see table 1.

Table 1. Interview participants

Job position	Age	Gender	Years of education	Years of IT experience	Years of climate management experience
Consultant	54	M	17	33	30
Consultant	58	M	17	26	29
Consultant	54	F	17	30	20
Grower	48	M	15	24	24
Grower	53	M	17	34	31
Grower	49	M	16	13	25

3.1 Interactive climate management UX

On the highest level of abstraction, we see the user experience of interactive climate management as being influenced by workplace emotions, work processes and the worker's (user's) personal preference for interaction styles and functions, see figure 1.

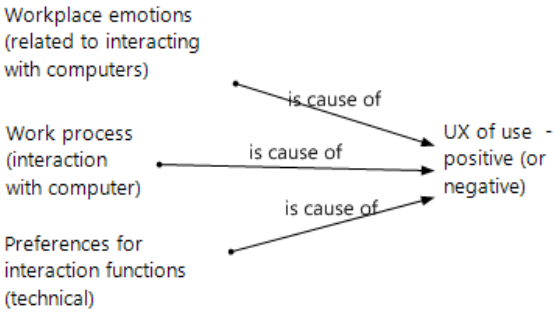

Figure 1. Model of UX of interactive climate management

3.2 Growers' UX

Grower A is a grower, and also sometimes a project leader. He is not so much in direct contact with the climate computer, but he will call some people who will type in the registrations that he is doing (the results of the climate management). Thus, he is collecting knowledge and distributing it to the people who are typing it into the actual climate computer. He will also give some advice on long-term strategies. He finds climate management quite interesting. He prefers to also be on the floor – out in the greenhouse – and is not interested in sitting in the office all day long doing climate management. He uses system

P, which runs on a single pc with windows, located in the administration building, and also Excel spreadsheets to the climate management.

In contrast, **grower B** uses system C, which is a dedicated computer located out in the green house. He talks about the old systems that he used a long time ago, and describes how well they were running. In general he is very optimistic around climate management/computers. He has been involved in some projects as a "guinea pig". He talks about what needs to be improved, e.g. a better dialogue between the developers/providers of the software, and the people who actually uses the system. He feels that some systems has been developed, because they thought it would benefit the growers, but he believes that an overall goal is missing, perhaps a forum could be created, such that the two parties could talk together. According to him, there is a lack of education in the branch, and many growers are not using all of the functions, in the system. Hence the design needs to be more user-centered and the end-users need to be more involved in the process. Many of the programmers/software developers have never sat their foot in a greenhouse. He does believe however, that the Danish developers could create a nice computer, but there is pressure from Dutch companies, because they are the frontrunners in climate computers. When asked whether or not he prefers the old '1200 system' or the new 'system C', he says that he would prefer the 1200. He would even consider to take out the 1200 from a warehouse and use it again in some cases, because it was easy for him to explain to the others, how to use it. It's simple, genius and with lots of functions. He does not care about the old fashion look in the 1200, because back then people had to learn it from scratch including the codes, everyone had to know all the processes in the 1200. Today, nobody knows what's behind e.g. an icon, they are afraid of pressing an icon, they don't know which code lies behind it. He'd rather just get to the point, instead of a lot of fancy graphics.

Grower C is a bit special because he is a grower without a climate computer, so he mainly explains why he does not own a climate computer and also brings forward a sort of "future" perspective, where he reflects on what he would find useful. He does not have a climate computer, thus he sometimes refers to why he does not use a climate computer in his work processes. He has some arguments as to why he has not invested in one, which he mainly sees as a nice complimentary tool, not an essential one. To him, work place emotions related to interaction with computers and his preferences for technical systems in his green houses are tightly interwoven. He is in general quite positive towards climate computers, but he is reluctant to invest in one, because he is turning 50 next year, thus is it worth the investment. He does not see a big enough need for one, because they are "too small". He distinguishes between "us and them", that is, he does compare himself as being smaller compared to the bigger greenhouse owners. However, he does describe several situations, where it would be nice to have one. It seems as though he has reflected upon the topic, because he can come up with specific scenarios where a computer would be useful.

He is skeptical towards a climate computer, as he states that he believes that plants need to be "eye-seen" and checked up on! He is not interested in giving up control 100% to the computer.

3.3 Crop consultant's UX

Crop consultant A is not just a consultant in the industry, but he also has a background in production planning where he does budgets, in relation to production plans. Sometimes the customer needs his "name" in order to get a loan in the bank to buy something for the greenhouses. The overall goal for climate management, according to him, is to save money. He finds climate management interesting – it is exiting to work with the opportunities that are involved. The combination of creating a nice climate for the plants, where they can save a lot of energy, that's a challenge in itself, that he finds fun.

Crop consultant B is focused on the plants. She is in general very positive towards climate computers, meaning that she thinks it is exciting, but most of all it's a very useful tool for climate management. She finds it exciting, interesting, useful, fun, challenging. She says that the young growers are especially interested in learning more about the use of the computer- they are interested and curious (asking questions themselves!). She prefers system P, the windows based system, over system S/C, the dedicated system. She is currently employed by one nursery, where she is allowed to log on to the climate computer from home, and makes adjustments. This is quite special since it is not so common, but it is because she used to be employed there directly. In other places, she would usually go in and look at the set points, graphs, and printouts, and then discuss in cooperation with the owner, if anything need to be adjusted. Usually they will make the changes themselves, unless they ask her to do it. She states, that she thinks that it should be more a more typical way of doing things i.e. that the consultant should have a more direct responsibility. She also says, that she is probably the only consultant who uses the climate computer a lot in her work. This is probably due to competencies, and that most crop consultants, view climate management as difficult, because they are scared of how different things might affect each other. She believes that as a crop consultant, it is not so important to know all the details and technicalities in the computer. It is rather a matter of using the climate computer to determine if the climate that she believes that a plant is thriving most optimally in, is what is being actually realized in the greenhouse. She explains that there are situations where she is walking around in the greenhouse with a grower and detects that e.g. the temperature is too low. The grower will then in some cases say, that it is "the boss" that is doing the adjustments. Thus, in some cases, there is a conflict that one person is doing the climate management, and that gives a set of different frameworks that they are allowed to work within. So the consultant's job is to try and work within those frames, but also to raise her opinion if she can see that e.g. heat savings are affecting the plants. She is also a bit skeptical towards the sensors, she states that you should only trust them to a certain degree, since they only tell you "part of the truth". She would like that the people "on the floor" would learn more about the climate computer and use it more actively. It does not make sense that it is the "boss" who is making the adjustments in the climate computer. She would also like that the interface would be more simple to utilize, because it is a matter of getting the right people "over to the climate computer". She believes that there is a change in the industry, meaning that climate management is not only restrained to a few trusted people. She feels there might be a change with the people she is working with, as more people are entrusted the responsibility. She is also quite positive towards mobile technology such as handheld devices.

Crop consultant C has been in the industry for 30 years and has been in consultancy for 24 years. He does not have many skills within IT, but he has the background knowledge in why certain things are adjusted the way they are – he does not have so much

experience with that (he knows the principles behind it, but not in praxis). He is quite focused on the precise analysis of data, when dealing with climate management. He mostly uses the historical data from the climate computer, but does not do anything on the climate computer. It seems as though his focus is mainly directed towards quality, and what you can do in regards to climate management and production to reach a good quality. Quality is something they need to incorporate in their economic considerations. He would like that two settings were possible on the climate computer: one where you want to produce as much as possible, and one where you want to save as much as possible, with the cheapest resources possible (the economic perspective model-we are not in a hurry). With his background in mind, climate management takes place in the greenhouse. He makes use of some software (that the grower will never use), in order to make the analysis, and from that some things can be adjusted in the climate computer afterwards. He will also suggest some changes that the owner/grower can do, but stresses that in the end it is the greenhouse owner's responsibility-a lot of things can go wrong. He would like to have a more automatically operating system, where you could collect e.g. data from the previous year's production time and obtained quality (as standard), and then get the computer to act more automatically. However, some growers might feel that the computers will get all the power. He says that perhaps it can be a problem that the growers rely too much on "their green fingers", where it is compromising an appropriate climate management. He is very interested in finding key figures for climate managements.

4. DISCUSSION AND CONCLUSION

The interpretations of how growers and consultants experience interactive climate management can be summarized in a UX target table [4], see table 2. The common UX goal is that using interactive climate management systems should be interesting and useful. The growers need to feel like being on the floor of the green house, and that the interactions are easy to explain to colleagues. In contrast, the consultants focus on the plants and on saving money.

Table 2. UX target table

Work role	UX Goal	UX measure	Observed results
Grower(s) interacting with climate computers	Interesting, easy to explain to others, simple, with lots of functions, useful, safe, to the point, feeling of "being-on-the-floor"	Performance in specific scenarios Outcome over time meet company needs	?
Consultant(s) using the computer to analyze and give advice	Interesting, exciting, fun, useful, challenging, save money, focused on plants	Used by crop consultant in their work	?

This study has illustrated a phenomenological, grounded, descriptive approach to finding UX goals in complex work systems.

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6. REFERENCES

1. Bedny, G.Z. and Harris, S.R. "Working sphere/engagement" and the concept of task in activity theory - Discussion. Interacting with Computers, 20 (2). 251-255.

2. Fallman, D., The new good: Exploring the potential of philosophy of technology to contribute to human-computer interaction. in, (Vancouver, BC, 2011), 1051-1060.

3. Garzón, F.C. The quest for cognition in plant neurobiology. Plant Signaling & Behavior, 2 (4). 208-211.

4. Hartson, R. and Pyla, P.S. The UX Book: Process and Guidelines for Ensuring a Quality User Experience. Morgan Kaufmann, 2012.

5. Hassenzahl, M. The Interplay of Beauty, Goodness, and Usability in Interactive Products. Human-Computer Interaction, 19 (4). 319.

6. Hassenzahl, M., Platz, A., Burmester, M. and Lehner, K. Hedonic and ergonomic quality aspects determine a software's appeal. in Proceedings of the CHI 2000 Conference on Human Factors in Computing Systems, ACM Press, New York, 2000, 201-208.

7. Hassenzahl, M. and Tractinsky, N. User experience - A research agenda. Behaviour & Information Technology, 25 (2). 91-97.

8. ISO 9241-210 Ergonomics of human system interaction-Part 210: Human-centred design for interactive systems (formerly known as 13407). International Organization for Standardization (ISO). Switzerland.

9. Kacira, M., SASE, S., Kacira, O., OKUSHIMA, L., ISHII, M., Kowata, H. and Moriyama, H. Status of greenhouse production in Turkey: Focusing on vegetable and floriculture production. 農業気象, 60 (2). 115-122.

10. Karapanos, E., Martens, J.B. and Hassenzahl, M. Accounting for Diversity in Subjective Judgments. Chi2009: Proceedings of the 27th Annual Chi Conference on Human Factors in Computing Systems, Vols 1-4. 639-648 - 2390.

11. Palen, L. and Bødker, S. Don't Get Emotional. Affect and Emotion in Human-Computer Interaction. 12-22.

12. Porat, T. and Tractinsky, N. It's a Pleasure Buying Here: The Effects of Web-Store Design on Consumers' Emotions and Attitudes. Human-Computer Interaction.

13. Smith, J.A., Flowers, P. and Larkin, M. Interpretative phenomenological analysis: Theory, method and research. Sage Publications Ltd, 2009.