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IMPROVING USER EXPERIENCE IN COMPLEX SYSTEMS

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Abstract

Don Norman and Jakob Nielsen define User Experience (UX) as "encompassing all aspects of the end-user's interaction with the company, its services, and its products". The question is, however, is it possible to provide a significantly better UX in an inherently complex environment, such as at a neutron beamline instrument? With this in mind, we decided to ask the professionals at Design Psychology to see what might be achievable for user-facing scientific software at the European Spallation Source.

During a series of short workshops, we looked at general UX principles and how they could be applied to two of our software projects. We learned a number of useful practices and ideas, such as:

- Why UX is more than just the graphical user interface
- The value of creating user personas and mapping their workflow
- How to design for the user's "System 1"

A bad UX may make the user feel like they are fighting against the system rather than working with it. A good UX, however, will unobtrusively help them do what they need to do without fuss or bother. If done well, UX is not a zero-sum game: improvements can be made so novices and experts alike can work more efficiently.

INTRODUCTION

The European Spallation Source (ESS) [1] will be a multi-disciplinary research facility based on a next-generation world-leading neutron spallation source which will allow users from a range of scientific and engineering fields to study their materials at a level not achievable at existing neutron sources. Sweden and Denmark are the joint hosts of the ESS, with the facility itself being constructed in Lund, Sweden and the Data Management and Software Centre (DMSC) being located in Copenhagen, Denmark.

In parallel to the construction of the facility, the DMSC team have been constructing a suite of user-orientated software to assist the users in pursuing their science. This suite provides software for the whole lifetime of the experiment starting from the initial proposal submission, through performing the experiment at the facility, to analysing, storing and cataloguing the data. The software suite consists of both thin-client web applications and more traditional thick-client desktop applications; however, regardless of the technologies used, it is important that the software provides a good User Experience (UX) [2] for both expert and novice users. With this goal in mind, the DMSC asked the UX specialists at Design Psychology [3] to run a series of UX workshops. The first one was a general workshop introducing UX principles and brief examination of existing DMSC software. The second and third workshops were focussed solely on SciCat [4] and NICOS [5], which are two of the more mature applications developed at the DMSC.

The focus of this paper is on the application of UX principles to SciCat and NICOS.

About Design Psychology

Design Psychology extend the classic user centred design process by grounding it in expert knowledge of human psychology. This dual user and human centred design approach enables them to turn descriptive user insights into prescriptive design drivers. This increases the quality of UX design in projects and reduces risk. They work with companies across many business areas to help them realise the business value of improving UX. Their services cover both strategic design and design implementation. In addition, they have a UX laboratory with a diverse testing toolbox than can deliver quantified data to support design decisions.

SCICAT AND NICOS

SciCat is a catalogue for providing users with access to the scientific metadata and raw experiment data for their experiments. It covers the whole life-cycle of the experiment, from the initial proposal, through data collection and analysis to publication and beyond. The project is an open-source collaboration between the Paul Scherrer Institute (PSI) [6] in Switzerland, MAX IV [7] in Sweden and the ESS. The user interface for SciCat is web-based, built using the Angular [8] framework. The user interface is shown in Figure 1.

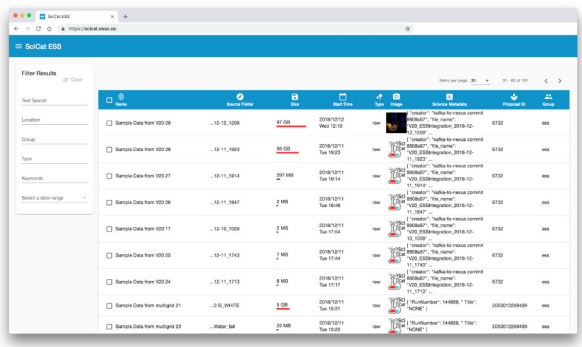

Figure 1: The SciCat user interface prior to the workshops.

NICOS is a network-based experiment control program written for neutron scattering at the Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRMII) [9] in Germany. Though originally developed for FRMII, NICOS is now being used at a number of other facilities including the ESS and SINQ (PSI). NICOS is written in Python and uses

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the Qt framework [10] for its desktop-based user interface. The user interface is shown in Figure 2.

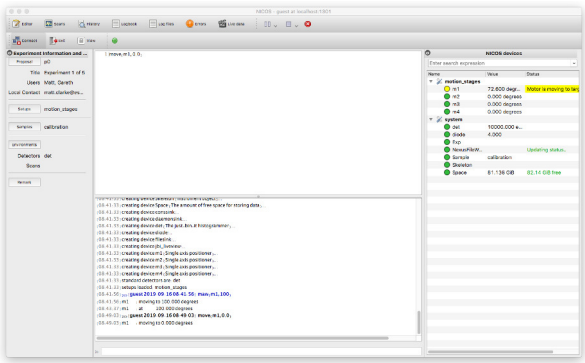

Figure 2: The NICOS user interface prior to the workshops.

USER EXPERIENCE

The UX Value Equation

Design Psychology have produced a pseudo-equation for describing the factors that contribute to the user achieving their end goals called the uxValuEQ™ which is shown in Figure 3.

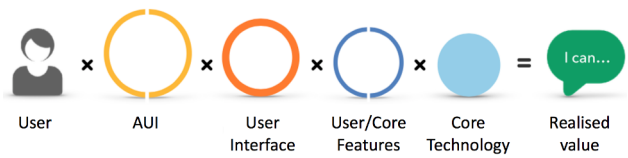

Figure 3: uxValuEQ™ - Design Psychology's user experience value equation.

These factors can be summarised as:

- Core technology - the product that actually does the core task that the user is trying to achieve
- User/core features - features added around the core technology that exposes access to the core technology
- User interface - how the user interacts with the user/core features
- Assisting user interface (AUI) - these represent items that assist the user in using the user interface to achieve the core task

It could be said that the core technology is the basis of the product's business case and the other factors enable the system's value to be realised. As an example, consider the fictional manufacturer of the latest most advanced lawnmower:

- Core technology - the revolutionary new motor than cuts quicker and more accurately than the competitors
- User/core features - the ability to adjust the cut length, motor speed and so on
- User interface - the ergonomically designed handle and the touchscreen for setting the cut length, etc.
- Assisting user interface - the touchscreen has a walk-through animation showing how to change the settings, etc., there is an owner's manual, a how-to video on the web and a customer service hotline

All these factors can have a direct effect on the user's experience of a product, but the user interface and the core technology are perhaps most important. If the core technology is not sufficient to achieve the user's end goal then the product is ultimately worthless no matter how excellent the user experience is. However, if the core technology is sufficient but has a poor user interface then users have to construct their own "mental" user interface. These mental user interfaces often require extensive training to learn and tend to be easily forgotten by occasional users. They can also be incomplete meaning the user is only using a subset of the available functionality and, as a result, may be working inefficiently.

Analysing User Experience

To better understand the UX requirements of a system, Design Psychology recommend breaking down the analysis into four discrete levels as shown in Figure 4. The four layers are described as:

1. The perceptual layer - represents the look and location of the various parts that make up the user interface, i.e. the appearance of the buttons, icons, input fields and other widgets, and the overall aesthetic
2. The interaction layer - represents the basic logic of the user interface in terms of its layout and interaction, i.e. what goes where, what happens when this button is clicked, etc.
3. The workflow layer - represents the high-level tasks or steps the user need to complete to reach their goal, e.g. first log in, search for item, add item to basket and so on
4. The user journey layer - represents the overall narrative of the process the user performs in reaching their goal, including tasks that may lie outside the core process, e.g. collecting their user id card

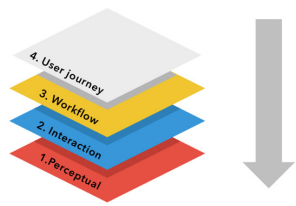

Figure 4: The levels of analysis for understanding the UX requirements of a system.

It can be seen that the layers range from being specific and low level (perceptual level) to representing a more high level view (user journey layer). In analysing the UX requirements for a system it is recommended to start from the user journey and work through the levels in the order shown by the grey arrow in Figure 4.

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ANALYSING SCICAT AND NICOS

This section walks through the process of analysing the UX requirements of both SciCat and NICOS. Most of the work involved was done using wall-mounted sheets of paper, sticky notes, pens and plenty of coffee and biscuits.

User Journey

The first step of mapping the user journey is to identify the users and to create personas for them. Ideally it would be possible to involve actual users for this, but often this is not practical or, as in the case for the ESS, not yet possible. In these situations, it is usually possible to create the personas based on the domain experience of the people present. This was deemed to be a reasonable compromise for these workshops as amongst the participants were people who had either been users or had many years' experience of working with users at other facilities. The following main user types were identified at the NICOS workshop:

- Visiting scientist (consumer) - new/novice user, someone to whom neutrons are just a tool
- Visiting scientist - experienced user, knows more about neutron science, beamlines etc.
- Beamline scientist - expert user
- Technician - maintenance user

Due to time constraints, it was decided to combine the two visiting scientists types into one and use that as the focus for the workshops but with a bias towards the novice user. The persona was developed by considering what might be their goals, their possible pain points and their skill-set. The resulting persona is shown in Figure 5.

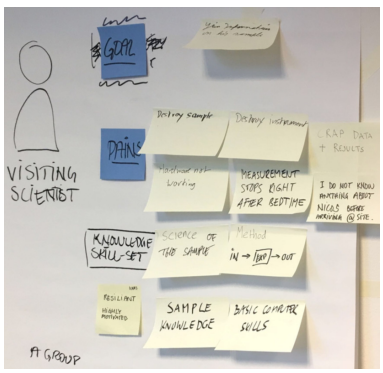

Figure 5: The persona for the visiting scientist.

Given more time it would have been interesting to explore the other user types as well. However, improving UX is not a zero-sum game as it is possible to make improvements for the novice that also improve the experience for the expert.

A similar persona was developed independently at the SciCat workshop - this was not surprising as both SciCat and NICOS are aimed at and used by the same users, but with different goals.

User journeys were constructed in both workshops by identifying the steps which this visiting scientist persona goes through before, during and after their interaction with the software. For example, the user journey produced at the NICOS workshop was:

1. Submitting a proposal
2. Pre-experiment preparations at home
3. Arriving at the facility
4. Arriving at the beamline
5. Planning/preparing the experiment
6. Starting the experiment
7. Monitoring the running experiment
8. Initial data reduction
9. Finishing the experiment
10. Leaving site
11. Data management and analysis back at home

The overall user journey is considered rather than just the steps relevant to the software because it can provide more information about the user which can be used to enrich the definition of the persona and it may also uncover dependencies in the system which affect the UX. The user journey is meant to be very high-level, so it doesn't need to explain in great detail what each stage entails; its purpose is to provide a starting point for developing the workflow.

Workflow

Starting from the user journey, the key steps relating to the user journey and the software were extracted. Each of these steps were then broken down in to the tasks which the user needs to perform to "complete" the step. Some of the tasks themselves could be broken down into further sub-tasks, as shown in Figure 6.

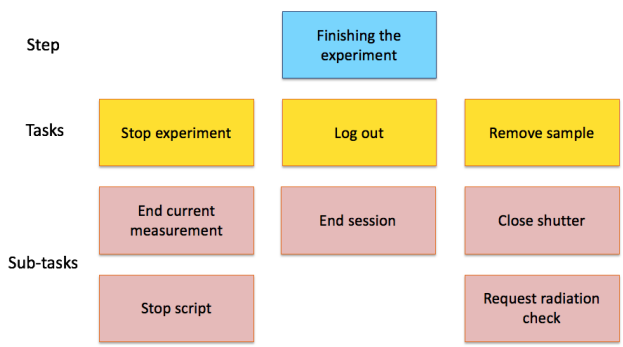

Figure 6: The task breakdown for the "Finishing the experiment" step in the NICOS workflow.

The tasks and sub-tasks were matched to features that already exist in the software. If it is not possible to match a task to an existing feature then this could be an indication of missing functionality. From these tasks and sub-tasks

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workflows were defined that could be used for the basis of the new UX design.

For SciCat, there are a number of different workflows depending on the status of the experiment; for example, at the proposal stage the workflow is different to the workflow of a running experiment. During the workshop, a new publication workflow was developed from scratch. The workflow is somewhat similar to that of, say, an online bookseller, for example:

1. Log on
2. Browse data-sets - browse books
3. Select interesting data-sets - add books to shopping basket/cart
4. Publish data-sets to a DOI - choose shipping and pay
5. Log out

For NICOS the main workflow is superficially linear, but it has additional complexity because there is a need to be able to go back to previous steps in an iterative manner, for example, start data collection -> monitor the data -> assess data quality -> stop data collection -> rotate sample -> repeat. Users of NICOS also need to see a significant amount of information relating to the status of the beamline, incoming data, script status, etc. This means any design must allow the user to switch between steps quickly and be able to access status information from within any step.

Interaction

Based on the workflows determined for SciCat and NICOS, new mock layouts for the user interfaces were created. This was done using Microsoft PowerPoint as this allows new layouts to be created quickly by combining PowerPoint's drawing tools with screenshots of components from the existing user interface. Alternatives would be use a whiteboard with print-outs or using dedicated wire-framing software.

As SciCat's publication workflow resembles that of a shopping website, it was proposed that it should follow the familiar design conventions of popular e-commerce websites. By adopting such conventions, where practical, it is possible to reduce the cognitive load for the user as they already have a feel for how the website works. Comparing SciCat to popular conventions revealed the following:

- It is not obvious who is logged on - most websites have that information in the top-right corner
- The existence of a basket/cart is not clear - this is also usually found in the top-right corner
- The search functionality is on the left-hand side - the search functionality for websites is usually at the top

A mock-up based on these conventions was created. This was done by adding icons from Noun Project [11] to a screen-grab of SciCat to represent the user, cart and search. Following on from this, an obvious and positive side effect of moving the search functionality is that more space becomes available for the main part of the user interface. It was felt that the main part contained too much information and was too crowded and, thus, daunting for new users. After discussing a few options it was decided to remove some of the less useful columns in the table and instead make the rows expandable/collapsible to show/hide extra information. The mock-up shown in Figure 7 is a new user interface design created during the workshop to incorporate these changes.

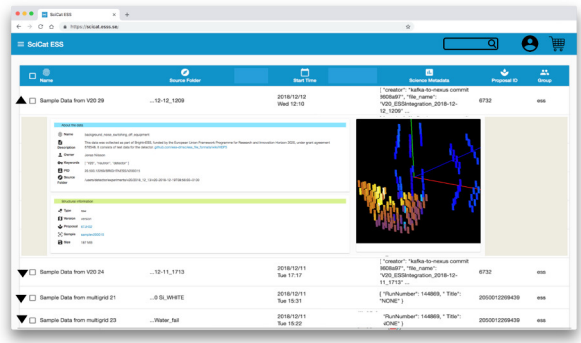

Figure 7: A mock-up of SciCat with expandable rows and new icons.

For NICOS, the main issue was to find a way for the user to navigate easily through the stages of an experiment whilst still having quick access to the critical experiment information. For this the design includes vertical tabs on the left-hand side to allow the user to quickly jump to the information they need. Figure 8 shows the vertical tabs in a mock-up. A status bar has also been added to the user interface, this gives an overview of the experiment and is always visible regardless of which tab is selected.

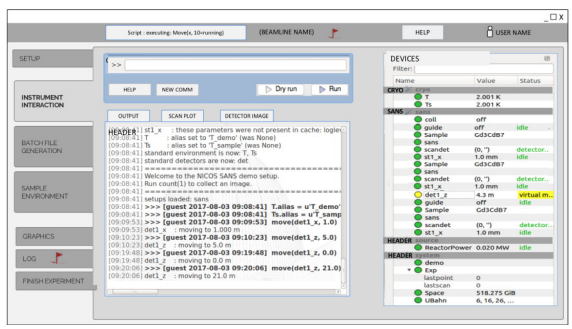

Figure 8: A mock-up of NICOS using vertical tabs to simplify the view.

The mock-up also uses colour and space to provide clearer distinction between the general components that make up the screen, and similarly more obvious separation between levels of devices in the devices list was added. The use of colour and space help reduce the cogitative load on the user and are discussed in more detail later.

Perceptual

The perceptual layer is perhaps the hardest for the standard developer to improve as it usually requires professional

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graphical design skills. For web applications there is a lot of flexibility due to technologies like Cascading Style Sheets (CSS), so with a good designer almost anything is possible. For desktop applications, it mostly comes down to making a choice over which graphical user interface framework to use; however, frameworks are increasingly starting to offer styling options analogous to what is possible on the web, so it may be possible to have greater control over appearance in the near future.

As time was short in the workshops, the perceptual layer was not examined in significant detail. After the workshops, Design Psychology improved the mock-ups and added some low-level styling options. The professionally realised mock-ups of SciCat and NICOS are shown in Figure 9 and Figure 10, respectively.

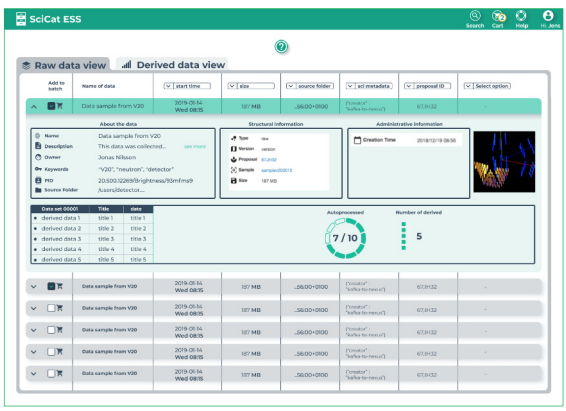

Figure 9: A professional mock-up of a new SciCat user interface.

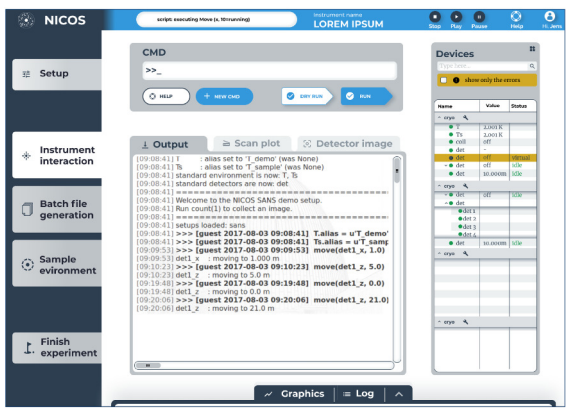

Figure 10: A professional mock-up of a new NICOS user interface.

THE SQUINT TEST

Typically, only five percent of a person's field of vision incorporates what is actually being focused on. This focal vision is concerned with details and high resolution information and, thus, has a high cognitive load. The remaining ambient field of vision is low resolution and conveys information about general shapes, structures, contrast and orientation; it has very little cognitive load. Ambient vision is mostly off-loaded to the part of the brain that handles visual stimuli without conscious effort. These two different visual regimes map to Daniel Kahneman's concept of System 1 and System 2 modes of thought as discussed in "Thinking, Fast and Slow" [12]; where System 1 is fast, instinctive and emotional and System 2 is slower, deliberative and rational. By designing for System 1 is it possible to make it easier for a user to get a fast overview of what is happening on an interface even at a distance. This clarity may also be important for those users with visual impairments.

The squint test is simple cost-free method for approximating the user interface's effect on the user's ambient vision. The simplest way to perform a squint test is literally to look at the user interface through mostly closed eyes and assess what can be seen and not seen. However, there are also simple technology-based ways of achieving a similar effect which is easier to analyse, and present! One is to use PowerPoint or similar software to apply a blur effect to a screen capture; the other is to create a terminal window with a white background and with thirty percent opacity and blur to act as a filter for viewing the live user interface through.

Regardless of the method used, the squint test can be used to assess the ambient visual clarity of the user interface. By identifying which parts are and are not distinguishable through the blurring, it is possible to determine areas for improvement.

Figure 11: The original NICOS user interface through a blur filter, for the squint test.

Figure 11 shows the NICOS user interface through a blur filter. There are some elements that stand out through the filter such as the use of green and yellow status "lights" on the right-hand side, the red error messages and the vertical borders/dividers used to separate sections, but in general the user interface is mostly light grey and white, so provides little structure or contrast to aid ambient vision. Compare this with Figure 12 which shows the mock-up user interface created by Design Psychology through a blur filter. There is much more contrast in the new design which provides more visible structure to the user's ambient vision and helps System 1. On the other hand, the green status lights do not come through as clearly as in Figure 11, so this could be one area of the design to revisit.

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Figure 12: The mock-up new NICOS user interface through a blur filter, for the squint test.

CONCLUSION

It was decided to conduct UX workshops for two of the DMSC's user-facing software projects under the guidance of the UX professionals at Design Psychology. The goal of the workshops was to perform a detailed examination of both SciCat and NICOS to analyse where improvements could be made to UX and, ultimately, produce new UI designs based on this information.

It was decided in both workshops to focus on the novice user as this was likely to be the most common type of user at the ESS and there is no reason why UX improvements for the novice user cannot offer improvements for the more experienced user.

Based on the uxValuEQ™ and analysis workflow, new UX-centric mock-ups were produced for SciCat and NICOS during the workshops. The coarse mock-ups produced in the workshop were further refined by the graphic designers at Design Psychology to improve contrast and presentation of information.

What Next?

Though new user interface designs have been produced for both SciCat and NICOS this is not the end of the process. The new designs will be shown to real users for feedback before development effort is spent on the implementation. This may lead to a number of iterations where feedback from the users is used to modify the mock-ups in preparation for further user feedback. It is also necessary to assess the designs from a technological stand-point to see if they are actually implementable. It is likely that the designs for SciCat are achievable because web applications have considerable flexibility when it comes to appearance; however, for a desktop application like NICOS there may be limits to what can be achieved due to the underlying graphical framework used.

Once these steps have been completed the implementation of the final design will be started.

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