Process Solutions

Honeywell

Making UX Count – Best Practice in User Experience Development: A Case Study

Executive Summary

The user experience (UX) is central to the development of consumer electronics, being seen as key competitive advantage. The result is seen in the intuitive, user-friendly interfaces that dominate in mobile phone and tablet computing.

In the terminal automation environment, however, the user experience (UX) has largely been neglected, with innovation restricted to expanding device capabilities. This is despite the importance of the user experience to efficiency, reliability and safety.

Load computers make an instructive case study in this respect. While developments have concentrated on increasing the number of loading arms, blend and additive streams a device can manage, the user experience has remained largely unchanged. This results in a number of problems, from operational delays and bottlenecks, to increased potential for errors and consequent risks to safety. Moreover, as device capabilities have expanded, on-screen complexity has seen the problem only exacerbated.

This paper suggests an approach to UX design focused on three pillars:

1. An intelligent, coherent display

2. An interface built on use case mapping for intuitive interactions

3. Quality information, appropriately structured and made available to users.

Taking the case of Honeywell's Fusion4 MSC-L load computer, it shows focusing these three pillars results in a more intuitive, effective and safer device, bringing tangible benefits to the operation.

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Introduction: Falling Behind

To date the focus of load computer designers has been on technical capabilities. These are crucial. Meeting custody transfer, safety and other regulatory requirements is a prerequisite for successful operations. Increasing the number of loading arms, blend and additive streams a device can handle has brought important efficiencies and flexibility to midstream petrochemical terminal operations.

However, the development of more powerful devices has come at a cost: The user experience (UX), which, despite its importance in consumer technology and other settings, has been largely neglected in the terminal automation environment. In fact, load computers' increasing capabilities have made it worse. From controlling a single arm, to controlling six or more with blending and additive streams, the volume and complexity of the information to be monitored and controlled has increased significantly. Yet, more often than not, the traditional interface and eight-line LCD screen have remained the same.

The evolution of interfaces and displays for loading computers has resolutely failed to keep pace with the growing capabilities and complexity of the devices themselves. In many cases, they are simply inadequate.

This result is inefficiency, with unnecessary operational delays and bottlenecks created by poorly conceived workflows; increased uncertainty, since it is difficult to gain insight into the operation; and even threats to safety, with complexity and poor visibility making errors more likely. Ultimately, poor usability undermines the benefits that advancements in loading computer technology have brought. At the very least, it prevents them from being fully realized.

Nevertheless, the failure of manufacturers to address the issues is, in part, understandable. It is difficult to get right.

Three elements of good UX design

At least three different elements must work together for an effective solution:

1. **An intelligent, coherent display**
2. **An interface built on use case mapping for intuitive interactions**
3. **Quality information, appropriately structured and made available**

These can only come from understanding how the device is operated by different users; designing displays and operating
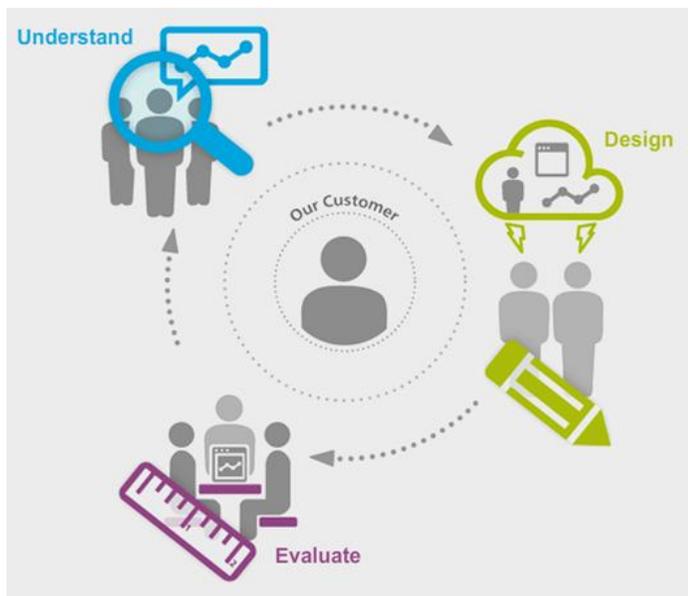
methodologies that meet their requirements; and evaluating how successful these are by testing on users in the field. This process – understanding, designing and evaluating – is iterative, with each revision bringing the device closer to the objective.

The process is not unique to developing UX; it is at the heart of the many automation technology providers' development programmes. Honeywell's attempts to capture the "Voice of Customer", for instance, involves continuous rounds of interviews, surveys, group discussions and forums. These establish their strategic challenges, develop solutions to meet these, and fine tune and improve the functionality of solutions.

This paper outlines the lessons learned in the design of Honeywell Enraf's Fusion4 MSC-L load computer, and best practice in developing devices with usability to match their capabilities.

Figure 1. Iterative product design

A Smarter Display

The main challenge in display design for load computers is to balance the need for clarity with the physical limitations imposed on a hazardous area device. Put simply, the screen is an inevitable weak point in an explosion-proof design.

Most device manufacturers simply give up, and settle for small, basic displays that force users to scroll through multiple screens to see the information they need.

The challenge can be overcome, however. First, large screens can be fitted to hazardous area devices without compromising the device's resilience. It simply requires a willingness to prioritise the screen when developing the enclosure design. Rather than selecting an enclosure and finding a display to fit, the ideal display for the intended application is chosen and the enclosure built around it.

Second, high quality components, in particular screens with higher levels of pixilation, enable significant levels of detail to be displayed. A higher resolution screen allows sharper, smaller fonts and graphics, increasing the amount and clarity of information on each screen.

The MSC-L uses an 8" screen, while using an internal flange on the enclosure, to prevent this significantly increasing the overall size of the device. The Hitachi TX20 has a 16:9 aspect ratio LCD with a resolution of 800:400, offering a Super WVGA format allowing engineers to present more information to the user. Up 400 cd/m^2 brightness and a 200:1 contrast ratio lets it display bright, saturated colours even outdoors in high ambient light conditions. The super wide viewing angle of this display (178◦) also permits undistorted viewing for the driver or operator even at acute angles, allowing a larger field of operation from the device and making the operation safer.

Design choices are also about knowing what technologies to forgo, however. The MSC-L device deliberately avoids using industrial touch screens, for example.

The benefits such screens bring in terms of soft buttons tailored to the context are outweighed by the disadvantages resulting from their use in hazardous area devices. The need for on-screen buttons of sufficient size to be operated accurately behind half-inch thick glass ultimately reduces the area available to display information, and therefore operational clarity. This can be partly addressed by "confirmation cursors", a cursor arrow that tracks to the touched point of the screen to confirm the correct button has been pressed and which can eliminate keying errors. However, this dramatically increases the length of time taken to key in data, as the user must wait for and align the tracking cursor for each entry. Finally, industrial touch screens lack the tactility users expect of modern devices. Not only is there no physical feedback, but consumer devices typically use audible cues to provide the user with feedback. In noisy industrial environments such as storage and distribution terminals, this is impractical.

Screen layout

An intelligent display requires an obsessive focus on design, with multiple iterations to find the best fonts, colours and layout to provide an at-a-glance overview of the operation or the particular information required. Screen layouts, colours, font styles, text positioning and sizes for the MSC-L were based on research and user tests to ensure information was clear, easy to read and easily accessed.

Figure 2(Left)). The main loading screen capturing, here in Chinese language version, with progress for each arm (on left of screen), and (from top to bottom in centre) arm number; compartment number; recipe number; load GOV; remaining quantity; and flow rate

Principals of good user interface design around visibility, consistency and minimalism were rigorously followed. Validation of the design, using paper prototypes, (interactive) digital prototypes on screen, and later complete test models included heuristic evaluation by user interface designers, as well as domain experts and users.

As the MSC-L main loading screen shows, all essential information for the primary users (drivers) is captured clearly on a single screen (Figure 2, above). Important data for all arms is visible at all times, while as many non-essential elements as possible are left out to reduce visual clutter.

To improve visibility, particularly outdoors, a white font on black background is used for high contrast and maximum readability. Likewise, the clear sans serif font can be read easily at a distance. The "rule of thirds" dictated that when possible main content is also positioned the away from the edges and the most important information in the central third of the screen to avoid visibility being obstructed by the screen encasing.

The UI design revolves around a dialogue with the user, presented in a clear, large white font. Secondary or background information is given less visual importance by presenting it in light grey on a dark grey background or using a smaller font. The option in focus is also clearly shown, using an inverted scheme: black text on a white rectangle.

Developing an intuitive interface

Just as usability must be central to the design of the display, it must be among the first principals underpinning the interface. There should be simplicity and clarity in the physical design. Buttons should be clearly labeled, and reflect, where possible, their use. The traditional reliance by load computers on function keys –"F1", "F2", and so on – introduces an unnecessary learning curve as users familiarize themselves with their purpose.

Instead the MSC-L combines simplicity in labeling with an intuitive layout and onscreen prompts and features that reflect the keyboard elements:
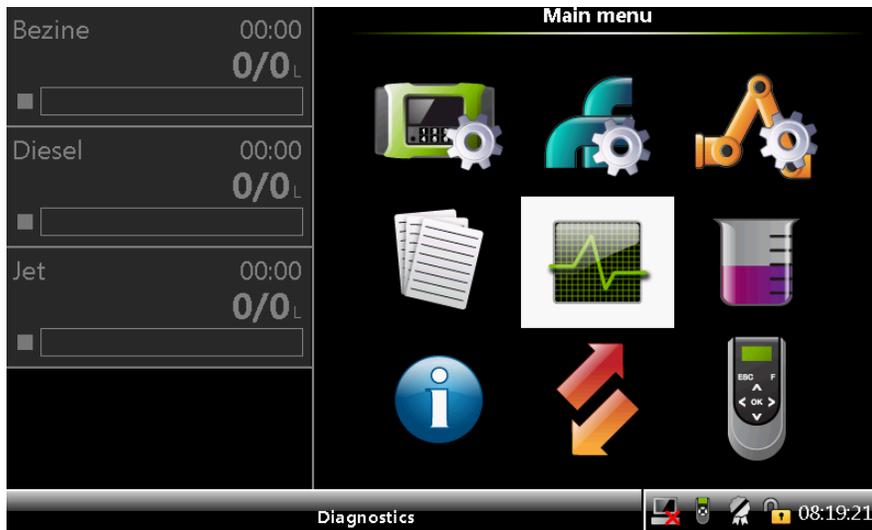
- Start and Stop buttons are clearly labeled and positioned immediately below the overview of the loading arms they control
- The numeric keypad and other buttons are visually tied to the input area on the screen with a grey background used for both
- Flashing cursors, up and down arrows, text box sizes reflecting the amount of data expected, and on-screen prompts ("press [OK] to continue") and tips guide users as they input information.

Figure 3: An icon-driven menu. From top, left to right: System Configuration, Stream Configuration, Arm Configuration, Logs, Diagnostics, Calibration, Info, Transfer, LAD functions

The interface uses graphics (Figure 3) that borrow heavily from the icon driven displays familiar from smart phone "apps". These help both guide and prompt users. Combined with an intelligent menu structure this allows users to navigate through the system structures easily with little or no training. To increase simplicity and connect the system to the physical world, bay names, arm names, product names and product colours can all be customized for the site to match the physical reality, with the colour in the progress bar (product colour) matched with the coloured sleeves on the loading arms, for example.

At the heart of the design is a main user workflow supported by a "wizard-like" interface, with the user guided through the process step by step. This helps the user execute the process more efficiently and prevents errors. To ensure the user feels in control (another design principle), in most cases they have the option to go back a step in navigation to make corrections, and in emergencies all batches can halted with the Stop button on the keyboard.

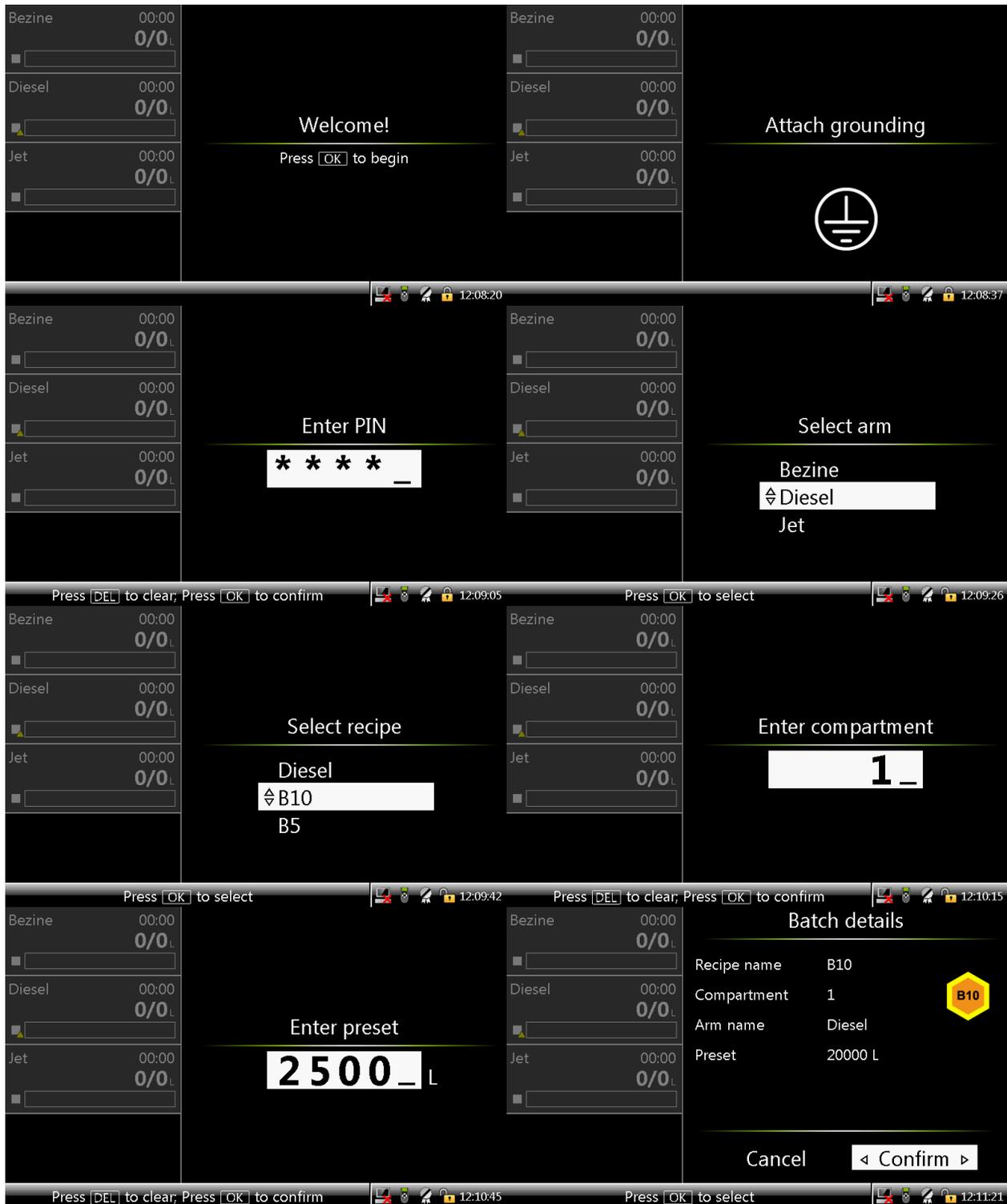Figure 4 (below) shows a simple workflow for loading a compartment.

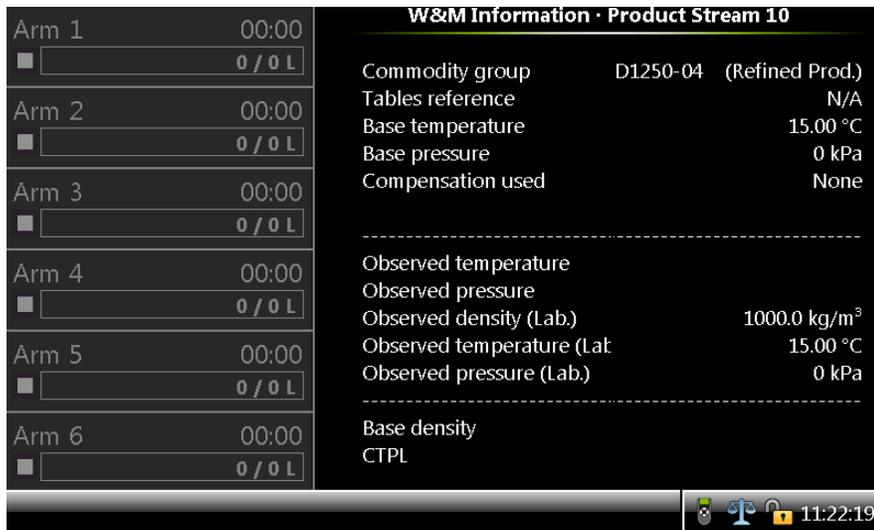Figure 4. A typical loading process for the truck drivers

Simple to follow menus

Linear menus replace the more traditional approach relying on operators using parameter codes obtained from technical documents to access various settings and input pages. Instead, users can easily navigate to the required page without training. To ensure the menus are well structured and intuitive, they are built on a map developed through use case diagrams, detailing all various users' requirements and interactions with the device using.

The use cases not only ensure logical arrangement and progression of the pages but also prevent "dead-ends" and other time-wasting issues with the menu structures. It helps prevent input errors by grouping information logically. For example, all streams assigned to a load arm – the main product, the blend stream and multiple additive streams – each with their own settings, can be viewed together and modified from a single page. Menus are also dynamic so selecting options will remove conflicting options (which appear greyed out) on subsequent pages. Once a recipe is assigned to an arm, for example, the arm no longer appears as an option when assigning the next recipe.

Figure 5. Flow chart of common use cases

Figure 5 shows the flow chart for common functions for both truck drivers and services engineers, the separate operational areas for each user and the transition points between the two.

The use cases are developed not just for common users of the device but also those that interact with it less frequently. A use case map was designed for weights and measures engineers responsible for W&M approval and sealing, for example. Consequently, the various measures and data required, usually dispersed across dozens of unrelated pages are all available from a single screen, significantly cutting the time taken for the approval and sealing process (Figure 6, below).

For more common maintenance functions a Diagnostics Dashboard monitors all the I/O and control elements of the device on the single page. As well as listing by I/O types, these can be organized by function to show digital control valves or all meter inputs, for example. Similarly, users can choose to view by location, with all I/O types on a single arm displayed. This enables maintenance technicians to follow the sequence for an arm from a single window to pinpoint at what stage in the process any problems occur.

Figure 6. W&M information collected on a single screen for convenience

User tests

Feedback from users was central to the development of the interface design. Three tests were conducted after initial designs were completed to test usability.

Tests in an Amsterdam terminal in November 2013 were typical. Designed to establish if the MSC-L was ready to market, truck drivers were recruited for the tests from the terminal

- 14 tests of 20-25 minutes were conducted, with drivers' interactions with the device carefully monitored and feedback taken after the test through questionnaires.
- Two test monitors and two observers from the device development team were present for each test, with tests also videoed.
- Subjects were mostly truck drivers (12) with experience with similar systems
- All subjects were asked to evaluate their computer literacy. Half (7) rated themselves as beginners, 4 average, 2 advanced and 1 expert.

Results

The tests showed the device was easy to learn and quick to operate. The main task, setting up a batch to be loaded, was easily completed by 13 of the 14 test subjects, without any prior training or guidance.

Nevertheless, a number of potential problems were identified: Correcting errors in some cases led to confusion and created problems requiring assistance from an operator; users occasionally stopped the pumps accidentally when batches are running; some unintentionally cancelled batches during setup before they were confirmed.

The tests also suggested the design of the screen interface and keyboard could be improved to reduce input errors and reduce hesitation; and that some steps could be combined to improve efficiency.

The final design reflects the findings in a number of ways:

- The Start and Stop buttons were repositioned to be below the arms overview display and separated from the OK button
- The OK and ESC buttons labeling was enhanced
- Flashing cursors were added to signify text boxes
- Recipes were sorted by popularity to reduce the need for scrolling
- Some font sizes were increased for better readability
- On screen prompts to cancel selections were added to make it clearer how to correct errors without operator assistance.

Even before the refinements, the tests showed the system was largely intuitive, clear and easy to use. In post evaluation tests, subjects were asked to rate their experience from a number perspectives on a scale of 1-5. Table 1 shows the average scores from the Amsterdam test, which were typical. All tests were conducted with no preliminary training on the device.

Table 1. Post test evaluation of test subjects in Amsterdam (average scores on 1-5 scale)	
How much effort did it take you to operate this system? (1 = a lot of effort)	4.5
How sure are you about filling the right compartments with the right fuel? (1 = very unsure)	4.9
Was it clear which buttons you should use? (1= very unclear)	4.6
Was the information on the screen clear? (1 = very unclear)	4.7

Hands-on

A further point is worth mentioning: As with the display, where a large, high resolution is preferred, the focus on usability and a detailed understanding of the requirements of different users also impacts on the physical design choices. Consequently simplicity in the physical design is not solely focused on the primary user, but extends to servicing and maintenance.

Before a device is even powered up in the field it must be installed and commissioned. Nevertheless, the UX of the installation engineer is frequently ignored in the design of hazardous area field devices. As a result of efforts to squeeze as much technology into as small as space as possible, those responsible for installing equipment are often left struggling and frustrated, with serviceability squeezed out in favour of enhanced capabilities.

Figure 7. Simplified wiring using a backplane

As with other aspects, however, if stakeholders' requirements are recognized at the conceptual stage, the product design can enhance their user experience.

Consequently, the MSC-L includes a number of physical design features that optimize safety and accessibility for installation and maintenance technicians. Probably the most important is the omission of termination connectors on individual system boards (printed circuit boards – PCBs).

Typically a board contains a number of control elements that are accessed by wiring directly to them. However, this creates an intrinsic link between PCB function design and cabling termination so that the termination connector positioning is determined by board location, rather than the wiring technician's convenience. MSC-L decouples this interdependency by routing all PCB terminations through a backplane, which the cards plug into. This allows the termination connectors to be placed independently of the PCB on which the function is located (Figure 7), bringing a number of benefits:

- The omission of terminal connectors on the PCBs allows increased functionality to be deployed on each board
- The backplane allows all the connectors to be positioned at the rear of the enclosure, creating a large open space for routing all incoming cables
- Connectors can be grouped by function type, creating a logical wiring sequence for the technician
- Grouping of connectors allows for optimization of high/low voltage separation within the enclosure
- PCBs do not have to be handled or removed to carry out wiring modification.

Information

There are two important aspects to information: first, the richness and depth of information available; second the ability to access, transfer and use the information as required. Information must be captured, organized and made available to the right people, at the right time

Mapping who needs what information where, when and how, starts, as with the interface design, with the use case mapping. This identifies all the interacting users of the device, and determines their key interactive functions and objectives. This map informs early thinking about the initial information levels required, and how frequently, in what format, and at what location they are needed.

It is important not to reinvent the wheel. The design process includes an assessment of the industry benchmarks and how well current information distribution works for different users. Innovation should be focused on improving poor aspects and filling existing gaps. The MSCL's downloadable calibration records serves as a good example of such innovation in action.

Meter proving and calibration have always been manually-intensive processes. A large part is due to the manual documentation of all calibration parameters used later to create proving records for the meter owner. MSC-L removes the need for this slow and potentially inaccurate process, with automatic creation of an electronic calibration record every time a proving run is carried out. This pulls all the information from across the device relevant for the proving process, and embeds it in a time stamped record. It provides the depth of information needed to authenticate any given proven run, eliminating the need to manually capture all the different meter profiles, flow rates, and other data.

The use case mapping, however, shows this only tackles half the problem. The user in question not only needs to capture the data, he must ultimately reconfigure it all into proving records for the meter owner. This task is equally as time consuming as the first.

Consequently, at the end of each proving/calibration run, the engineer is given the option on screen, to download the calibration record to a handheld Local Access Device (LAD), a service tool used to navigate the MSC-L. As a result, when all the site's meters have been proved, which could take days or weeks, the engineer has a complete library of downloaded calibration files stored on the LAD. These can be simply uploaded into the Fusion4 Calgen app on a PC to create the necessary customer documents, while the app also automatically creates the sign-off records for the customer.

Ensuring detailed quality information, as well as ensuring its availability, this functionality saves the engineer a vast amount of time, and consequently reduces costs for the meter owner. Furthermore, since the calibration data is electronically reproduced directly from the MSC-L's own records, the customer benefits from greater certainty, eliminating concerns around human error and fraudulent tampering of the data.

Overall, the features result in quicker proving and report generation, manpower savings, and increased security and traceability for meter owner through secure electronic data transfers.

Conclusion

There is no silver bullet for UX design for load computers or other field devices. Indeed the complexity and requirement for many different facets of design to work together explains in part why the user experience of many devices in the terminal environment remains so poor.

However, there is also no great secret as to how a better experience can be achieved, and the failure to take on many of the lessons from the consumer electronics that designers use in their day-to-day lives imposes needles complexity, costs and risks on terminal operators. Simply by putting the user-experience at the heart of design, and considering it at the conception stage and throughout, the design can be significantly improved: visually, physically and operationally.

Where these three aspects work together, it not only eliminates many of the inefficiencies, errors and bottlenecks that can be attributed to poor design; it can enable operators to realise significant gains in productivity and safety. It is, in short, an important – yet still undervalued – source of competitive advantage.

For More Information
Learn more about how Honeywell's Fusion4 can bring power back to the operator visit our website http://www.honeywellprocess.com/Fusion4 or contact your Honeywell account manager.

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