



Human factors in control room design

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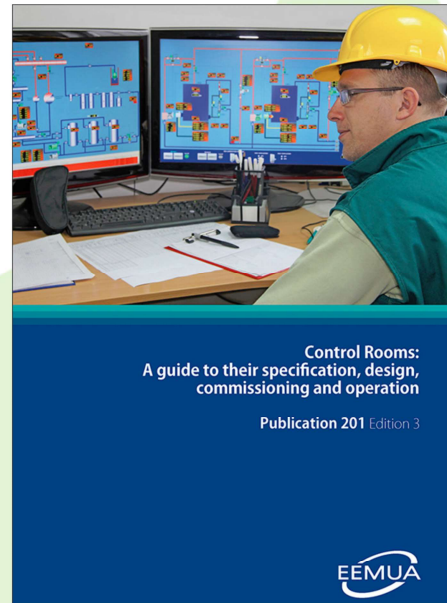
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My plan is to share a few insights I gained from acting as lead author for EEMUA 201 guidance for control room design that was published in 2019.

Guidance vs standard

- △ Standards tell you what to do
- △ Guidance should help you decide how to do it
- △ EEMUA 201 control room guidance



We know that standards exist. ISO 11064 is probably the main one for control room design. I do get frustrated when people claim that we have to design to a standard. There is not a standard control room and the so the standard can only give us some idea of minimum requirements. Guidance can be more useful by giving you ideas about how to achieve and exceed the minimum requirements. The aim of EEMUA 201 is to help you develop better control rooms that go beyond compliance.

Design is always a compromise

△ Control rooms more than most

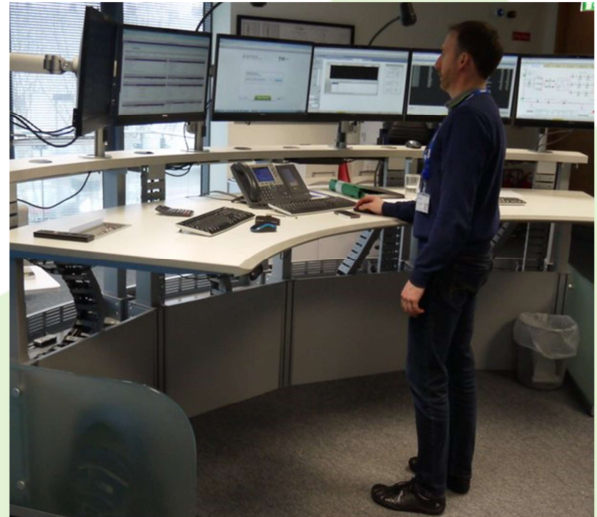
- △ Complex processes
- △ Different modes of operation
- △ Different people (shift workers)
- △ Things change



Design is always a compromise and a control room is particularly challenging. They are complex things that are used in lots of different ways by lots of different people. Also, things change so your great design today may not be so good in the future.

You won't get it right first time

- △ Iterative design
- △ Plan for expansion and change
- △ Sit-stand desk
 - △ High initial cost
 - △ Difficult to adapt
 - △ Maintenance cost
 - △ What is the benefit?



So it's fair to expect that your design will never be quite right. Allowing for an iterative design process through the whole life of the control room is the best way to achieve the optimum solution. Assume that things will have to change.

This is where we can get ourselves into trouble with aiming for rolls Royce solutions that cost a fortune. Take sit stand desks. I fully understand the benefit but whereas a standard desk probably cost 100 Euro per meter a sit stand is probably a 1000. It could be a good investment that will inevitably restrict the ability to adapt. They are also far more complicated than a standard desk and so have a maintenance cost.

It may be that the benefit is so great that the life cycle cost is appropriate. But do operators perform their tasks better stood up? There are benefits of changing posture frequently and a sit stand desk may encourage this. Whilst some people say they should be compulsory in all control rooms I see them as a nice to have in most cases.

Right answers – wrong questions

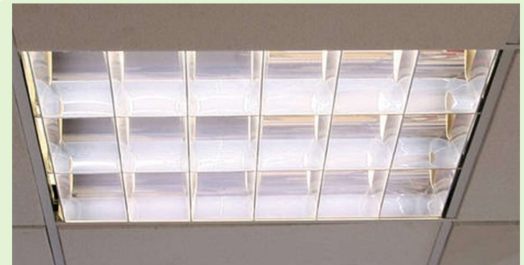
△ Lighting

△ Guidance

- △ How to increase alertness at work
- △ How to promote sleep at home
- △ Not how to do both

△ Operators

- △ Complain if bright - not if dim
- △ Do the opposite of guidance at night



Lighting was one aspect that surprised me when we updated EEMUA 201. I assumed I would find some good guidance on the brightness, colour etc. But what we actually found was a bit vague. There is guidance about turning lights up at night how to increase alertness, but this may make it more difficult for night workers to sleep at home. I didn't find any guidance about how to optimise both requirements.

Interestingly operators complain about lights being too bright but rarely comment if they are dim. In practice they do the opposite of what the guidance says at night – they turn the lights down; and where circadian lighting has been tried that automatically adjusts brightness during the day and night it has often been unpopular.

What do operators really want?

- △ Personal control of lighting
- △ Task lighting
- △ Windows!



What operators really want is control over their own lighting, but independent of other people in the room. There is a significant age issue here, which I can sympathise after turning 50 and finding I can't see very well in low light conditions – restaurant menus are a nightmare.

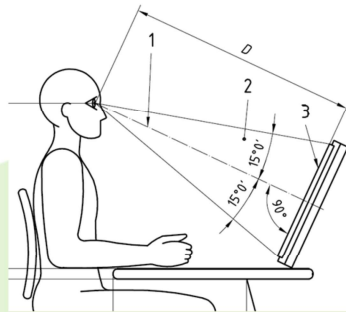
Task lighting is a very simple solution that is included in control room design very rarely.

But the one thing operators always want and we nearly always deny them is a window so that they can have natural light. It is a bit strange for a profession that is supposed to be focused on user requirements that we are not very good at working out how to give the user what they want.

HF people “don’t understand how we work”

△ Double height screens

- △ Standards warn about neck angles
- △ No operator has ever complained
- △ Instinctively use screens differently
- △ Alternative is a wider arc.



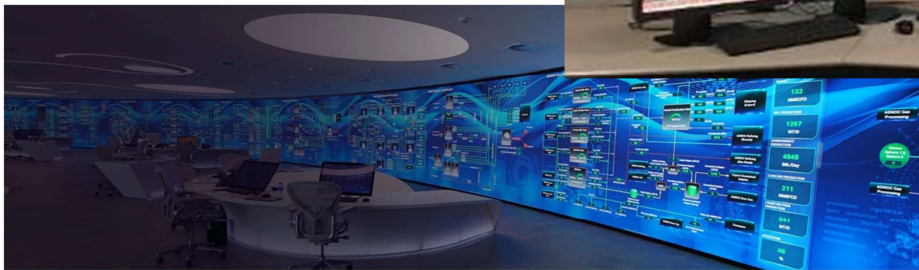
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This leads me to quite shocking revelation, which came about when discussing double height screens. Ergonomists told me that they should not be allowed because they require an unhealthy neck angle from looking up. But I have never heard an operator complain about them. When I pointed out the discrepancy the operators replied that it was because people writing the guidance didn’t understand how the screens were used in practice. This is a pretty poor impression of a profession that is supposed to be entirely focussed on what people do.

The reason why double height screens are rarely a problem is that operators instinctively use them in a safe way. If they need to do some close work they use the lower screens. The upper screens are used for monitoring, which only involves brief glances. Another thing to consider is that if we do not stack the screens we have to create a wider arc, which introduces far more challenges.

Large screens

- △ Who are they for?
- △ Video walls - essential or white elephant?



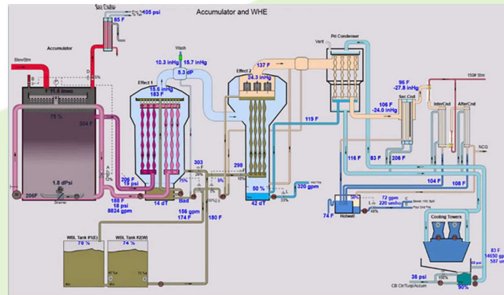
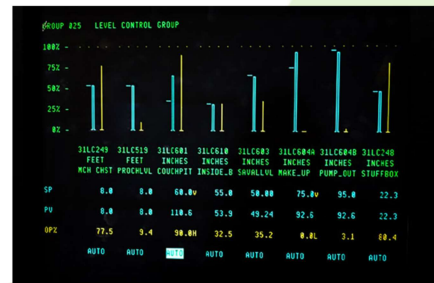
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Large screens in control rooms have been a bit of a mystery for a while. We usually include them in the design but only have a vague idea of how they are going to be used in practice. Operators have all the information they need on the normal screens, and whilst they may look at the large screens from time to time this hardly justifies the expense. People have admitted to me in the past that the large screens are mainly to give a bit of a wow factor to visitors.

This is one area where I think we have missed a trick. If we design display graphics well they can be very useful, mainly for helping to create a shared understanding of what is going on. Whether that justifies the huge expense of a video wall is debatable, although I do appreciate it is the best solution for some industries including transport and utilities. But when you can buy a 55" LCD monitor for 500 Euro, I would suggest for most a few of these is a better solution because they can be used far more flexibly.

Situational awareness – end user requirements

- ▲ 1960s
- ▲ 1980s
- ▲ 2000s

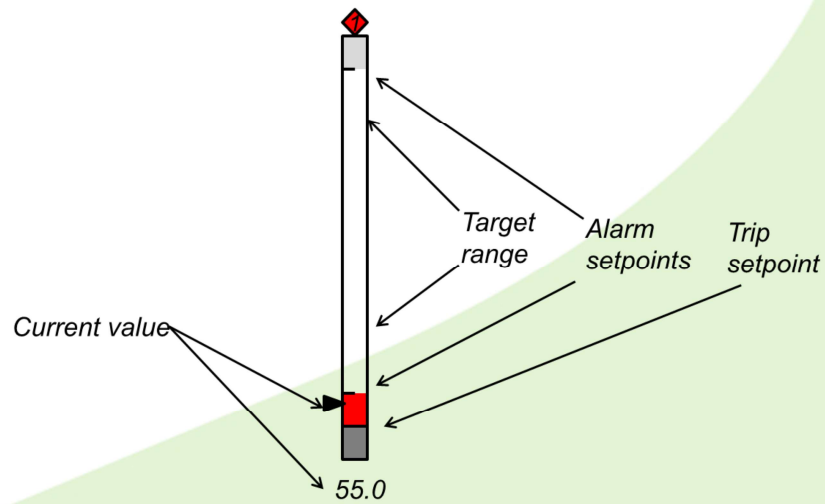


Whilst the physical design of a control room is important it is the way we present data to the operator that is most critical. The challenge here is to get a coherent basis for design. If we ask operators what they want they will usually ask for what they are familiar with. These images show how technology has changed what is possible, but

ironically unit recently each iteration was actually a backwards step in terms of operator situational awareness.

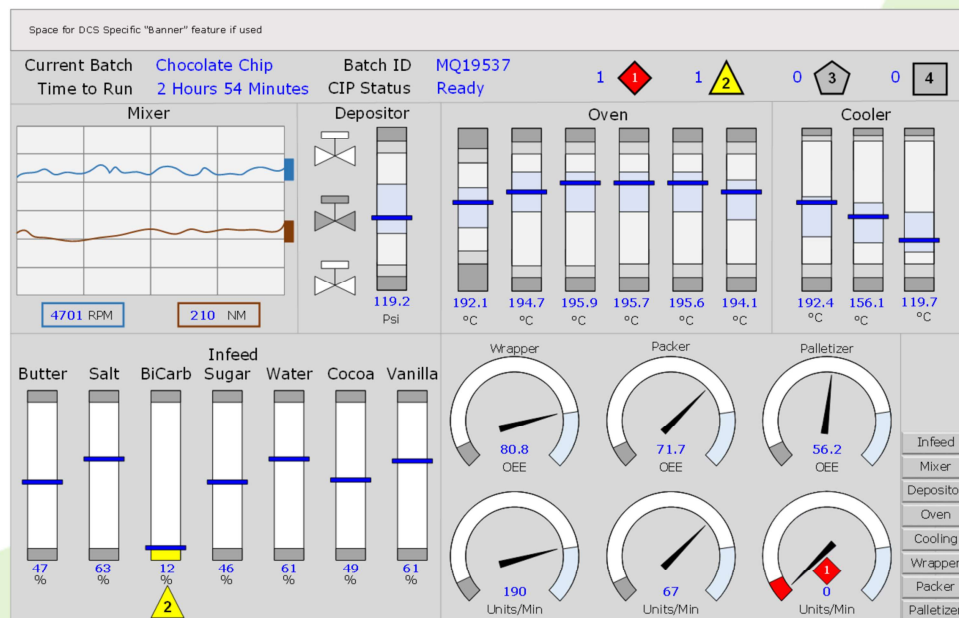
If you look at the top left image it may look old fashioned but all the data available from the plant was always visible to the operator. The bottom image is the most recent and whilst it has some pretty pictures the data displayed has been reduced to a few numerical outputs.

Display information not just data



This image shows how a graphical representation can give better situational awareness than a number showing the current value for a variable. From a very quick glance the operator can quickly understand how the plant is doing in relation to the measured range and target values. Colour and the graphical symbol at the top alert them in this case to the variable being in alarm.

Current guidance

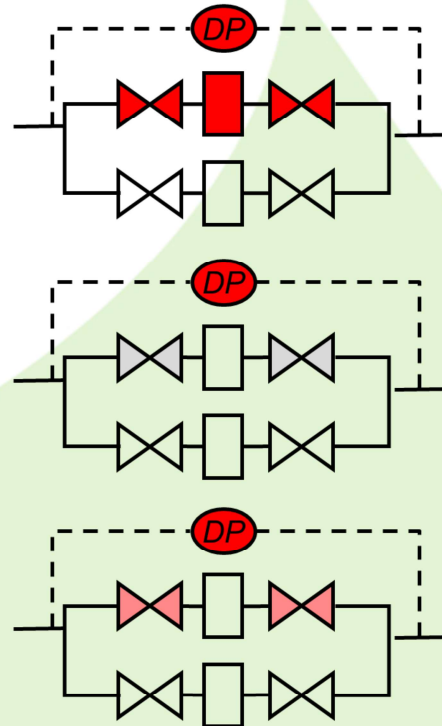


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This is an example of some recent guidance for developing overview graphics for control room operators. It moves on from the previous historical examples I showed a minute ago and uses some of the display principles from the previous slide. Whether operators like this and find it useful is still to be confirmed.

Use of colour

- Traditionally colourful displays
- Modern idea of shades of grey for status – operators dislike
 - General principles or change?
- Requirement for unique meaning
 - Doesn't have to be grey



The last topic I wanted to cover was use of colour on graphics. As computers developed and colour became available it seems like a sensible feature to use. But the result was the top image here. Red was used to show a high priority alarm but also to show status of equipment – in this case the symbols are valves.

This was identified as a problem because the alarm indication was less visible and so it was suggested that colour should not be used for status and reserved for alarms. This is the middle example. This has been followed in lots of places but operators have generally disliked it. What is not clear is whether they fundamentally cannot work with it or it is just resistance to change.

However, the requirement was not to eliminate colour from status indication but for each colour to have a unique meaning and to make sure the most important information stands out. The bottom image does this by using a pale red to show status whilst retaining the vibrant red for the alarm.

Incentives to work at this

△ Safer and more production operations

- △ Situational awareness
- △ Operator wellbeing

△ Knock-on benefits

- △ Easier to train people
- △ Improved retention – less staff turnover
- △ Improved morale
- △ Improved perceptions of everyone who enters.

I hope you have found some of this interesting and potentially useful. There is a lot at stake because control room operators are critical to our operations in terms of safety of the process and human health.

We may not get the design perfect but better design has many additional benefits. Making it easier to train operators, reduced staff turnover and better morale can all have wide ranging benefits. This can have positive effects on everyone who enters.

I hope you found that useful

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I hope you have found this useful and thank you for your interest. If you have any questions do not hesitate to contact me.