Common Human Factors Issues Detected in the Designs of PTC HMIs

Carolynn R. Johnson, Ph.D.

INTERNATIONAL SEMINAR & EXPO
RAIL SAFETY 2016
APRIL 18-19, 2016 • ORLANDO, USA

We notice things that don't work.
We don't notice things that do.
We notice computers, we don't notice pennies.
We notice e-book readers, we don't notice books.

Douglas Adams

We are stuck with **technology**, when what we really want is just **stuff that works**.

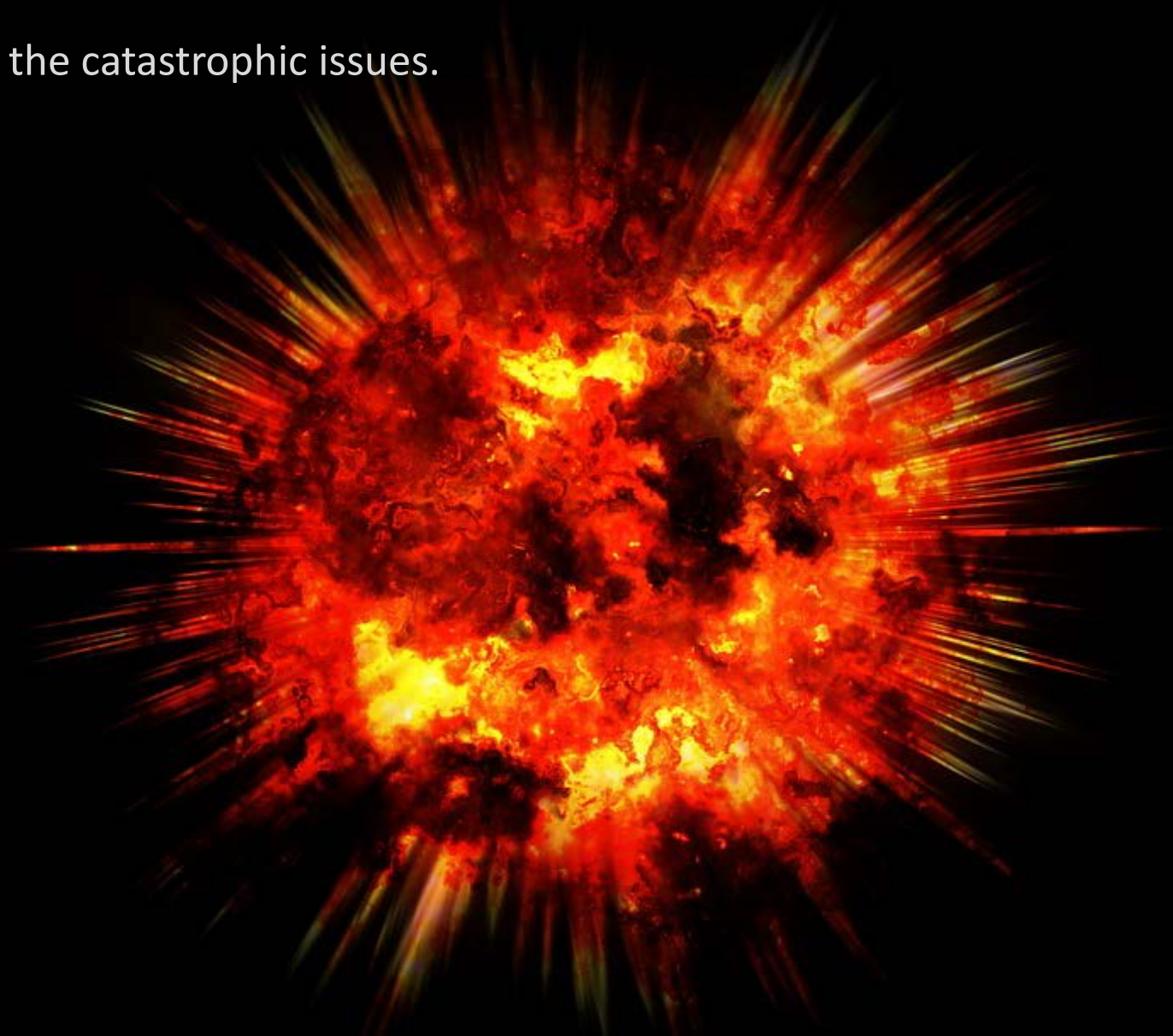
Research

Engineering

Design

Usability *- the ease of use and learnability of a human made object*

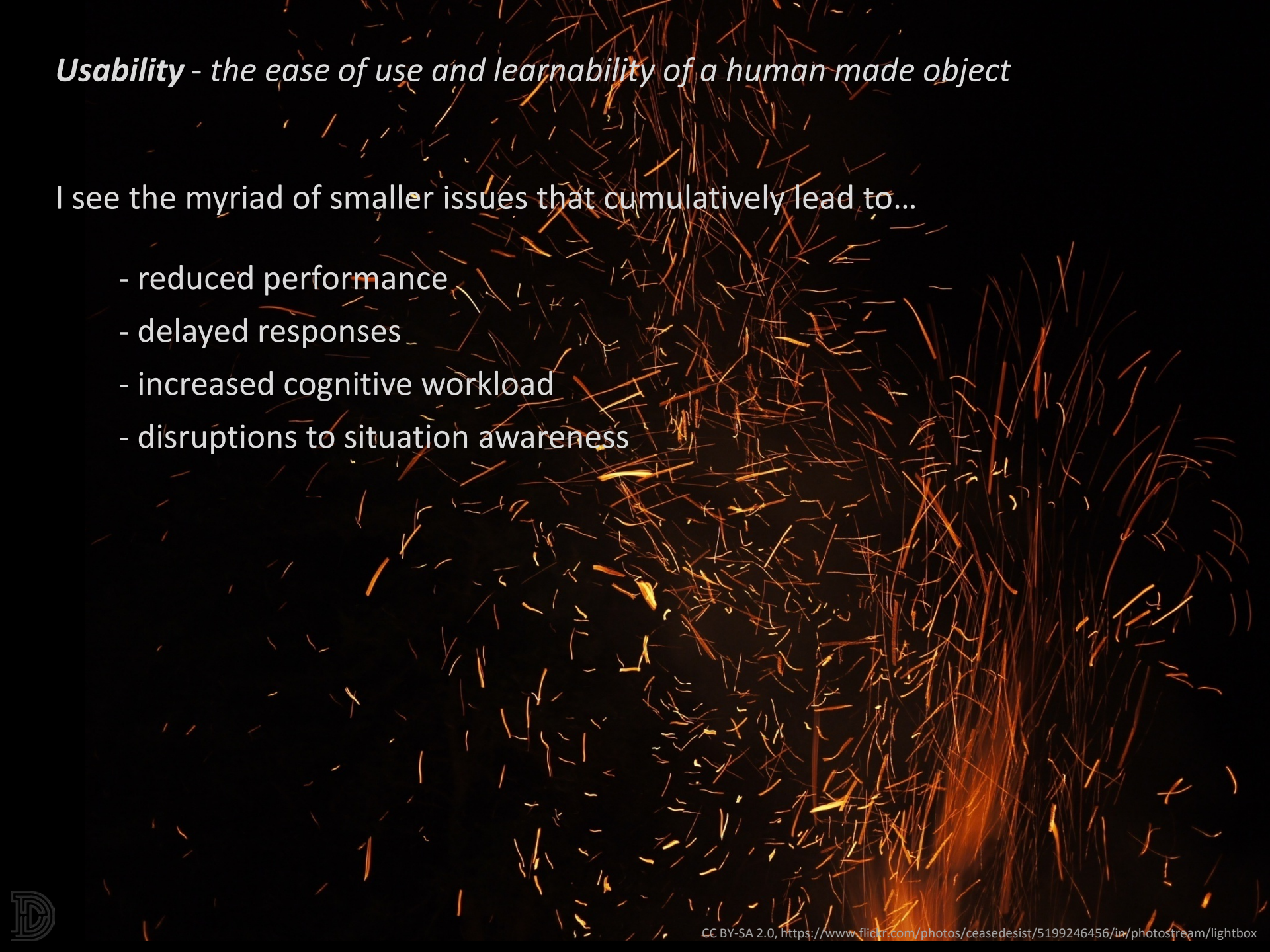
I don’t see the catastrophic issues.



Usability *- the ease of use and learnability of a human made object*

I see the myriad of smaller issues that cumulatively lead to…

- reduced performance
- delayed responses
- increased cognitive workload
- disruptions to situation awareness



Common Usability Issues

1. Color use
2. Visual density
3. Salience issues
4. Inconsistency
5. Convoluted workflows
6. Inadequate feedback
7. Verbiage & syntax

Color Use

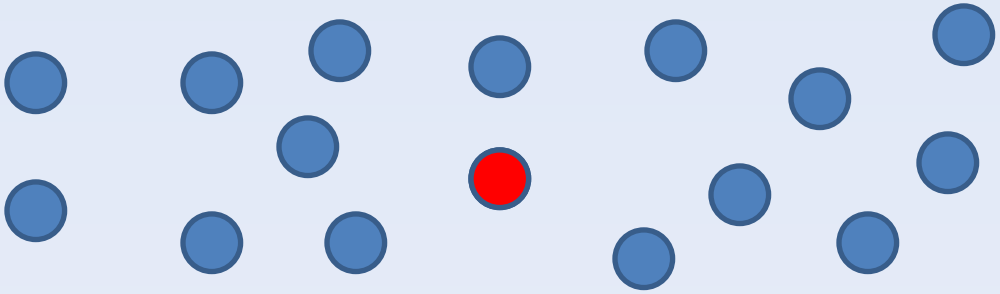
Appendix E to Part 236

(f10) Design all visual displays to meet human performance criteria under monochrome conditions and add color only if it will help the user in performing a task, and use color coding as a redundant coding technique;

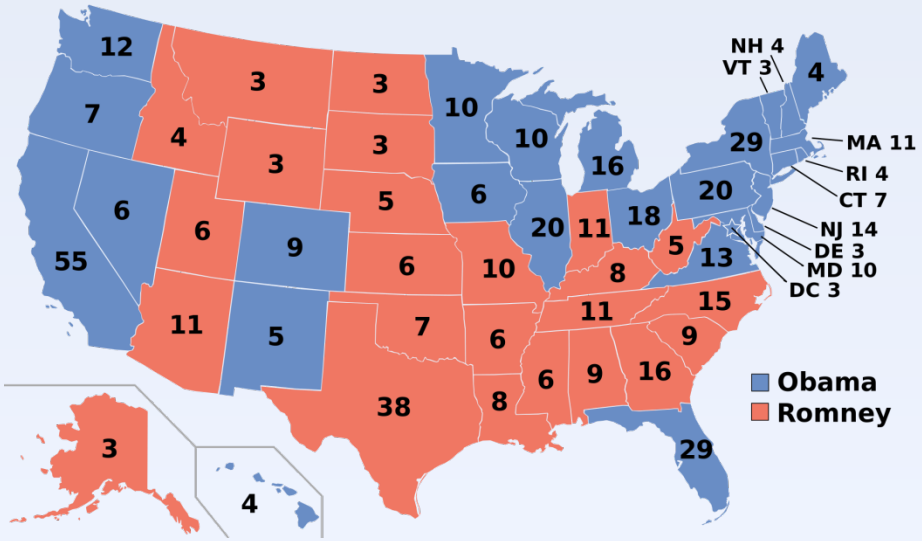
(f11) Limit the number of colors over a group of displays to no more than seven;

How does color help the user?

1) Color draws attention to something by increasing its salience – its noticeability.



2) Color helps categorize items at a glance.



Good and Not So Good Uses of Color

This is a great use of color.

There is clear meaning behind the track color.

Good and Not So Good Uses of Color

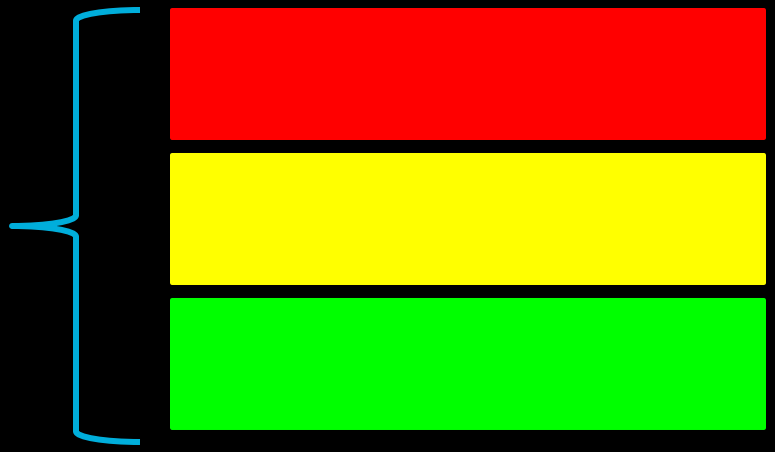
These are borders, but the colors never change and there is no meaning tied to the color.

When you add color to an element, even if you don't

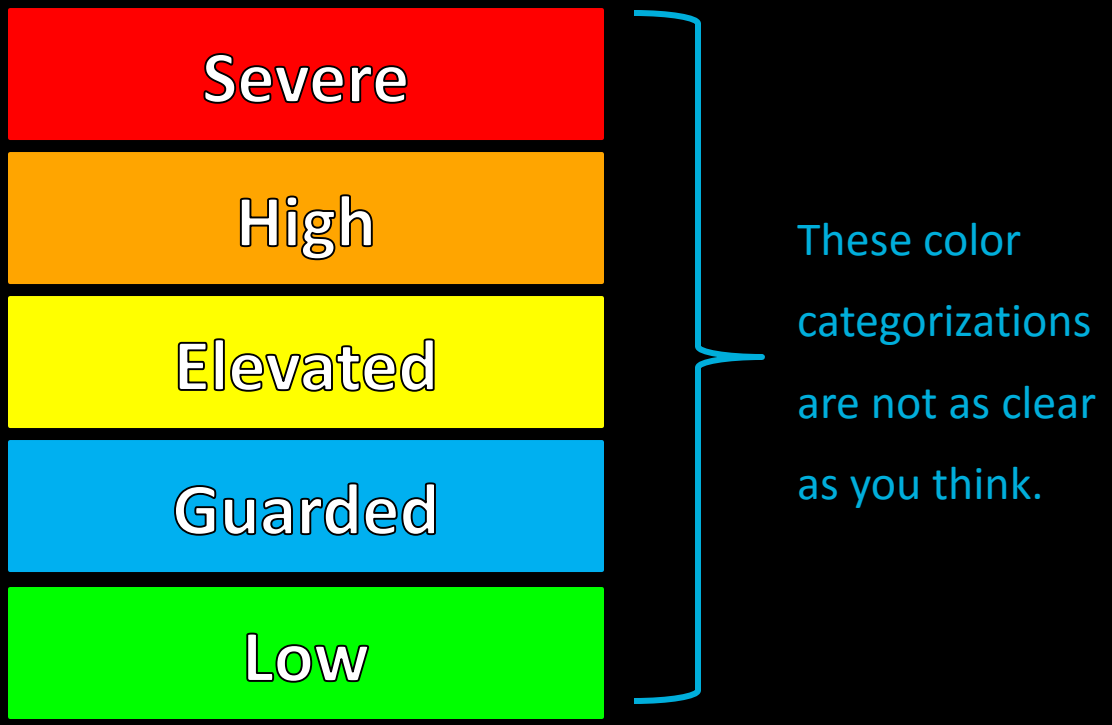
assign meaning to that color, your user may *infer* meaning.

Good and Not So Good Uses of Color

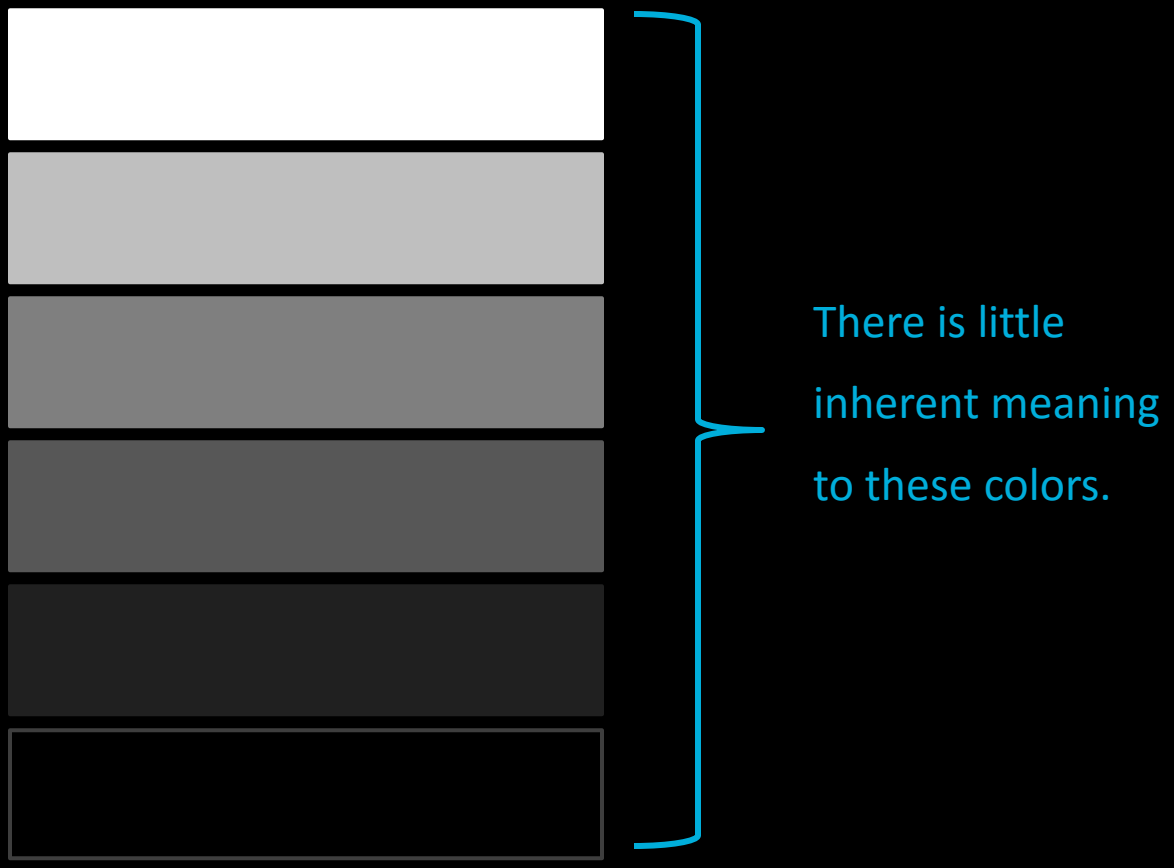
These color categorizations are clear.



Good and Not So Good Uses of Color

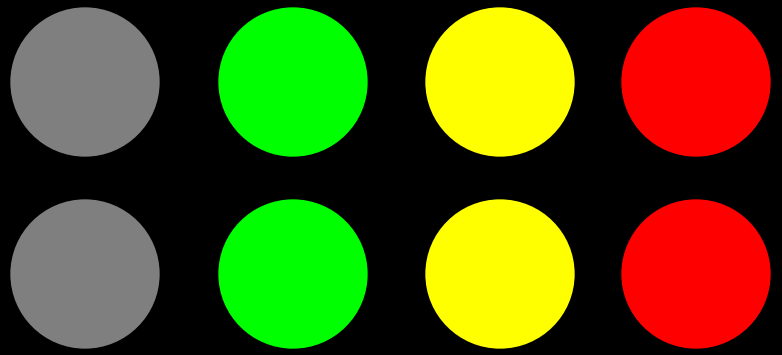


Good and Not So Good Uses of Color



Good and Not So Good Uses of Color

If these are in the same screen your user will assume there is a relationship between similarly colored elements.



Which of these conditions are cause for concern?

Action	Action	Action	Action	Action	Action
Action	Action	Action	Action	Action	Action

What are the consequences of these actions?

00:59

00:23 This one a bad outcome.

Tips for Using Color

- Use color with meaning and intention – you should be to articulate why something is the color it is.
- Always use red, yellow, and green in line with cultural conventions and use sparingly for best effectiveness.
- If you use color to categorize items, make certain that your categorizes are meaningful and meaningfully assigned to color.
- When assigning color to categories, consider whether your categories are ordinal or nominal.
- Limit categories to a manageable level.
- Be consistent with your color use.
- Avoid using the same color to mean more than one thing, particularly in the same screen.

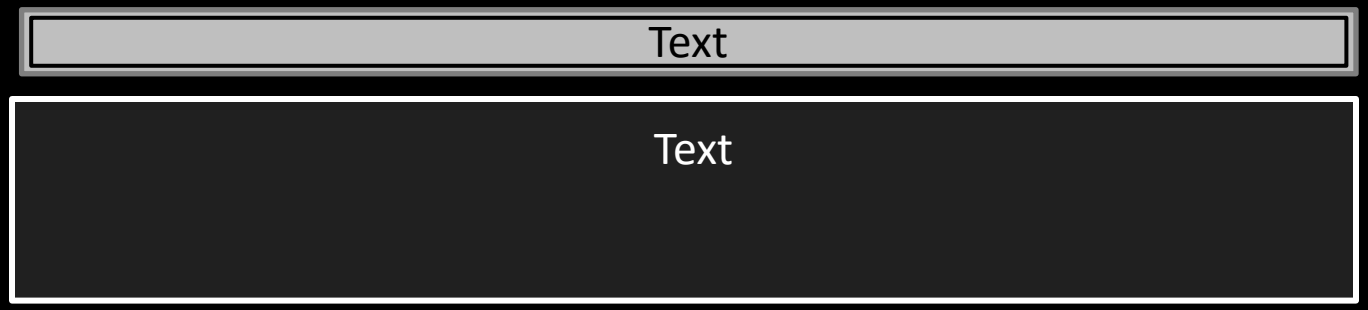
Visual Density

Clutter → To fill or cover something with many things

Every element that is added to an interface increases the amount of time required by the user to find and focus on any one particular piece of information.

Designing error-free simplicity means evaluating every demand on the user's attention.

Bright backgrounds (in a dark screen) compete with other elements for visual importance.



Unnecessary borders add density and when in the same color as the text, compete with it.

Reducing Visual Density

Text

Text

Labels in the same font size as the value
give equal visual importance to each.

Label 222

Label 222

Heavy separator lines.

**** Warning Message ****

Unnecessary Characters

Warning Message

REJECTED ✗ Lorem ipsum dolor sit amet, ius modo nostro torquatos ut. Error debitis no vix.

ACCEPTED ✓ Est an invidunt honestatis dissentiet, nam decore euismod ne.

ACCEPTED ✓ Lorem ipsum dolor sit amet, ius modo nostro torquatos ut. Error debitis no vix.

REJECTED ✗ Lorem ipsum dolor sit amet, ius modo nostro torquatos ut. Error debitis no vix.

ACCEPTED ✓ Est an invidunt honestatis dissentiet, nam decore euismod ne.

Redundant indicators

Tips for Reducing Visual Density

- If you can't articulate why a displayed element is in the screen, question why it is there.
- Borders and backgrounds are intended to perceptually group common elements. They should never be the brightest, biggest, or most salient things in the screen.
- Visual importance should reflect actual importance – borders and backgrounds are less important than their contents, labels are less important than values.
- Redundant coding mechanisms are good, redundant display elements are not.

Salience Issues

Salience → The state or condition of being prominent

How do you increase the salience of something?

1. Where it's at (top/left)

(f8) Display critical information in the center of the operator's field of view by placing items that need to be found quickly in the upper left hand corner and items which are not time-critical in the lower right hand corner of the field of view;

Eye Movement Patterns

Multiple studies have shown that viewers pay quicker and greater attention to items along the top of the screen, followed by those on the left edge of the screen.

http://www.vanseodesign.com/web-design/3-design-layouts

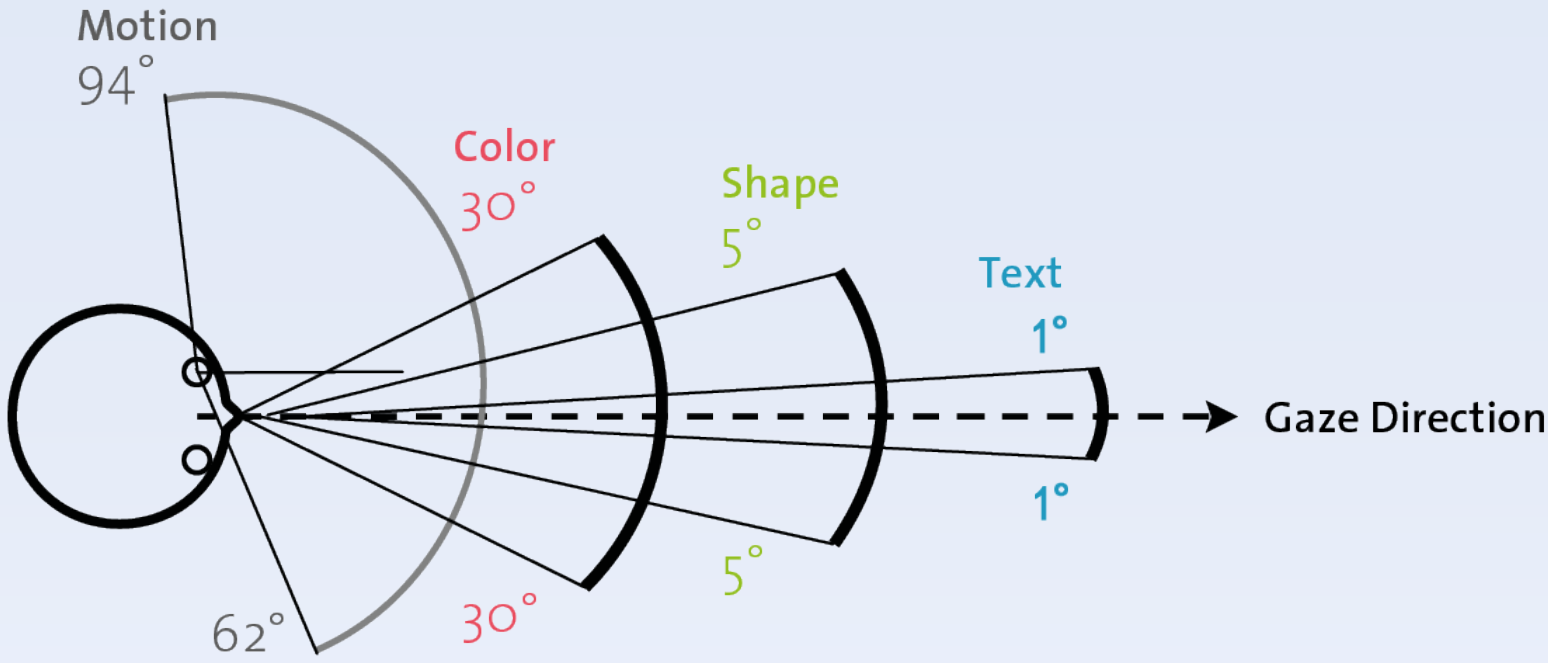
Salience Issues

Salience → The state or condition of being prominent

How do you increase the salience of something?

1. Where it's at (top/left)
2. Make it bigger
3. Make it brighter
4. Change its color
5. Make it flash

Field of view



Salience Issues

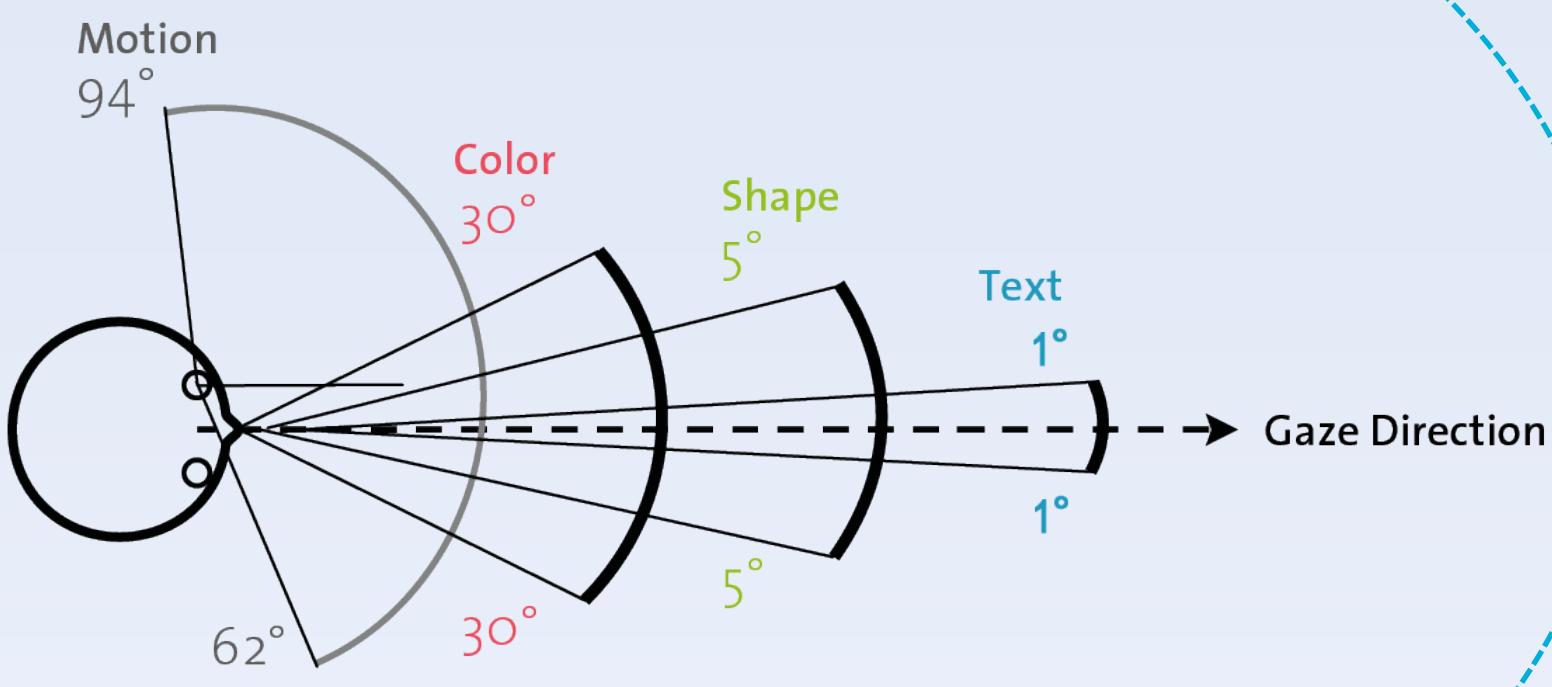
Salience → The state or condition of being prominent

How do you increase the salience of something?

1. Where it's at (top/left)
2. Make it bigger
3. Make it brighter
4. Change its color
5. Make it flash
6. Sound a tone
7. Sound more tones

Field of view

Field of audition



User's action is to verify changes… but what changed?

LOREM IPSUM:	**DOLOR SIT**
LEGENDOUS EA HABEO:	**1200 EAM**
MEDIOCRITATEM:	**2**
NAM LEGERE PER IN:	**12000**
DOLREM OPERTERE:	**100**
MUNDI NOSTRO:	**400**
AD DESERUNT:	**6000**
DES TE HARET:	**100**
LIBER BEDET:	**0**
ESSE POSSITT AN IUS:	**50 MPH**

User's action is to verify changes… but what changed?

LOREM IPSUM:	**DOLOR SIT**
LEGENDOUS EA HABEO:	**1200 EAM**
MEDIOCRITATEM:	**2**
NAM LEGERE PER IN:	**12000**
DOLREM OPERTERE:	**100**
MUNDI NOSTRO:	**400**
AD DESERUNT:	**6000**
DES TE HARET:	**100**
LIBER BEDET:	**0**
ESSE POSSITT AN IUS:	**50 MPH**

Item #11111, APRIL 18, 2016

Lorem ipsum dolor sit amet, ius modo nostro torquatos ut. Error debitis no vix. Ut brute ridens mei. Quo lorem adipisci conclusionemque ei, ei vis prompta temporibus scribentur. Qui error prompta consectetuer in, duo admodum placerat ex.

Item #22222, APRIL 18, 2016

Eum ei putent oportere. Natum veniam ad ius, te tritani oblique per. Altera iuvaret est cu, vituperata scriptorem vix eu, falli scripta phaedrum quo ei. Nam choro postea iudicabit te, viderer constituam vis et, est ei audiam molestiae. Vix tantas commune an, his eu hinc falli. Alii populo at his, ne duis offendit eam, cu usu unum lobortis.

Item #33333, APRIL 18, 2016

Est an invidunt honestatis dissentiet, nam decore euismod ne. Eros velit at pri, has sint nostrum ad. Vulputate efficiantur ei mei. Duo id prima labore, ea pri vocent vidisse philosophia, quo ne quidam commodo.

Yellow is a very salient color.
This is a lot of yellow.

Item #11111, APRIL 18, 2016

Lorem ipsum dolor sit amet, ius modo nostro torquatos ut. Error debitis no vix. Ut brute ridens mei. Quo lorem adipisci conclusionemque ei, ei vis prompta temporibus scribentur. Qui error prompta consectetuer in, duo admodum placerat ex.

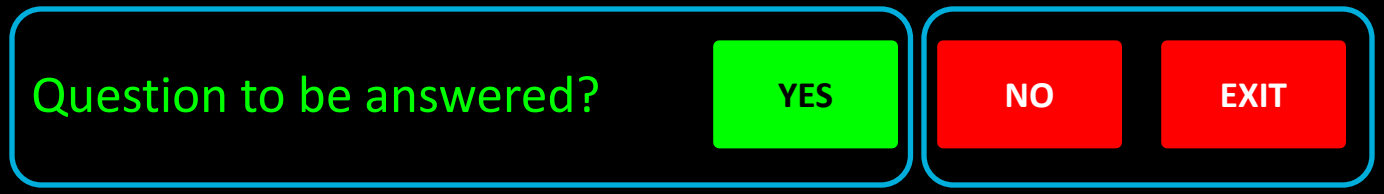
Item #22222, APRIL 18, 2016

Eum ei putent oportere. Natum veniam ad ius, te tritani oblique per. Altera iuvaret est cu, vituperata scriptorem vix eu, falli scripta phaedrum quo ei. Nam choro postea iudicabit te, viderer constituam vis et, est ei audiam molestiae. Vix tantas commune an, his eu hinc falli. Alii populo at his, ne duis offendit eam, cu usu unum lobortis.

Item #33333, APRIL 18, 2016

Est an invidunt honestatis dissentiet, nam decore euismod ne. Eros velit at pri, has sint nostrum ad. Vulputate efficiantur ei mei. Duo id prima labore, ea pri vocent vidisse philosophia, quo ne quidam commodo.

This also implies that selecting “Yes” is good or safe, but selecting “No” or “Exit” is bad or dangerous.



Two visual groups are implied here:

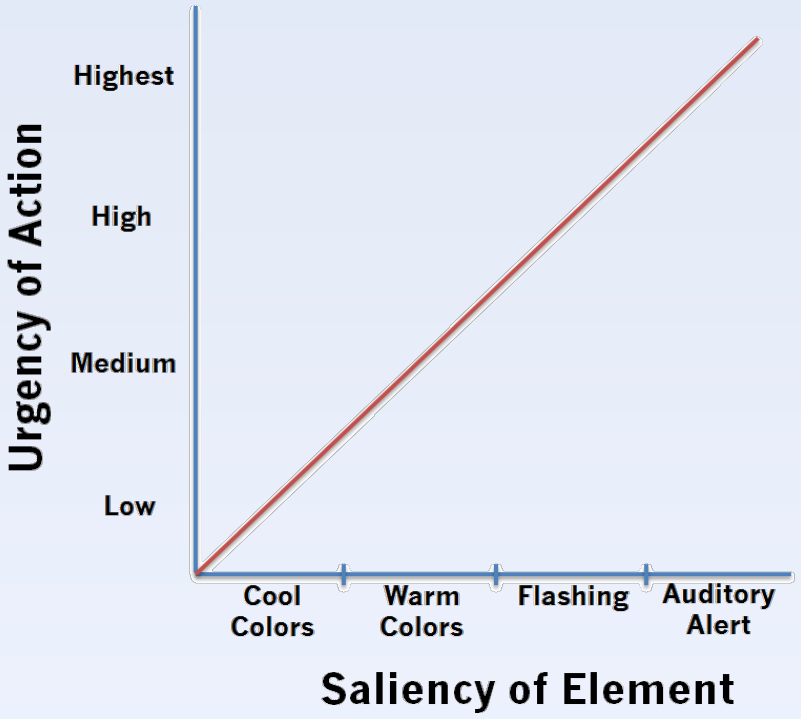
1) The question and “Yes”
2) “No” and “Exit”

Salience Issues

Salience → The state or condition of being prominent

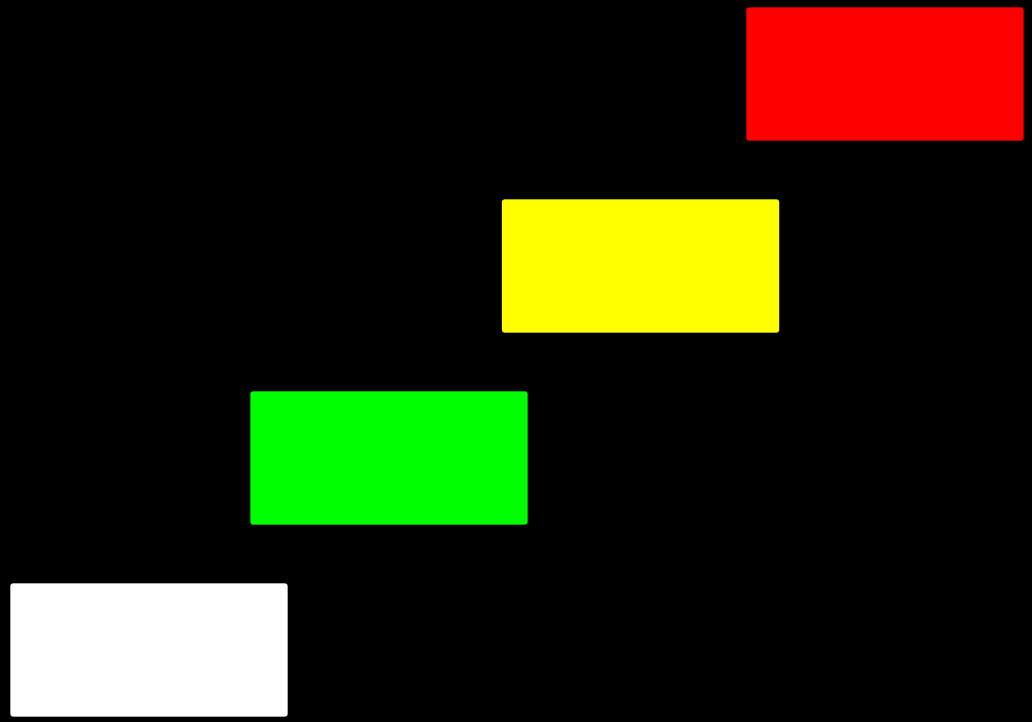
How do you increase the salience of something?

1. Where it's at (top/left)
2. Make it bigger
3. Make it brighter
4. Change its color
5. Make it flash
6. Sound a tone
7. Sound more tones

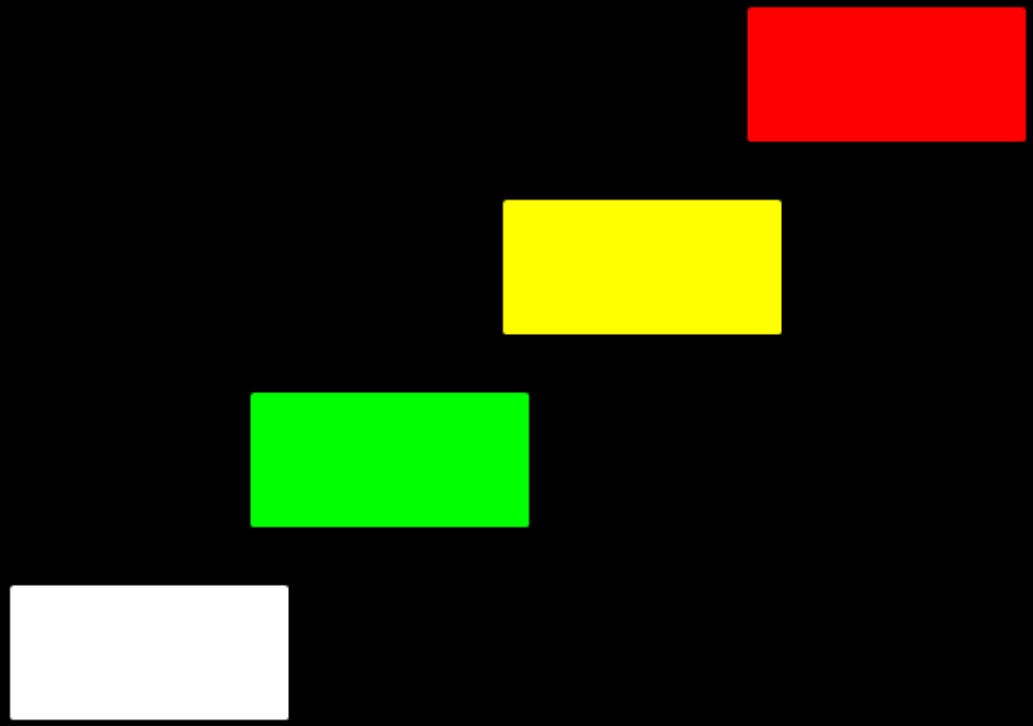


Saliency Attributes

This is a clear hierarchy of escalation.



This is still a clear hierarchy of escalation.

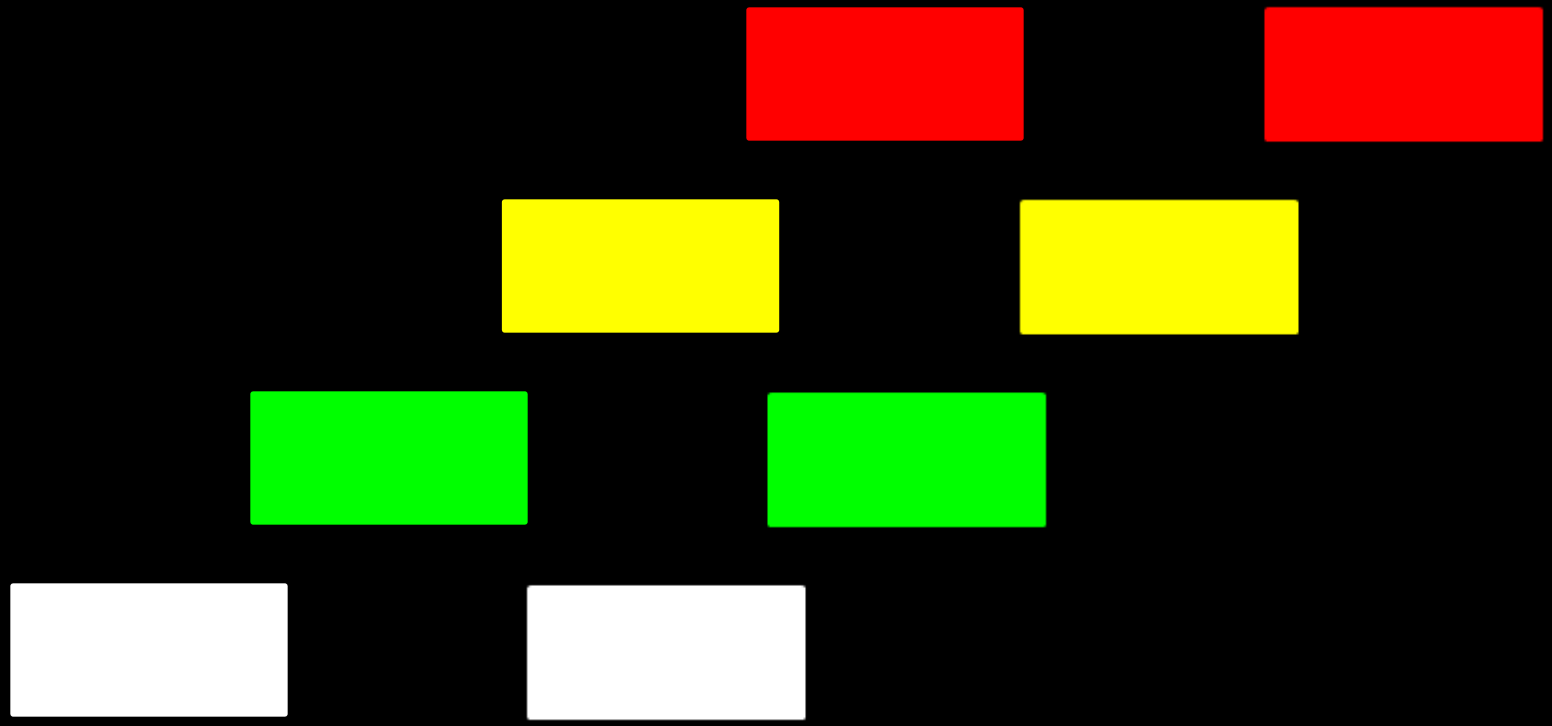


Saliency Attributes

This is not a clear escalation of hierarchy.

Is a yellow flashing element more or less important than a red element that doesn't flash?

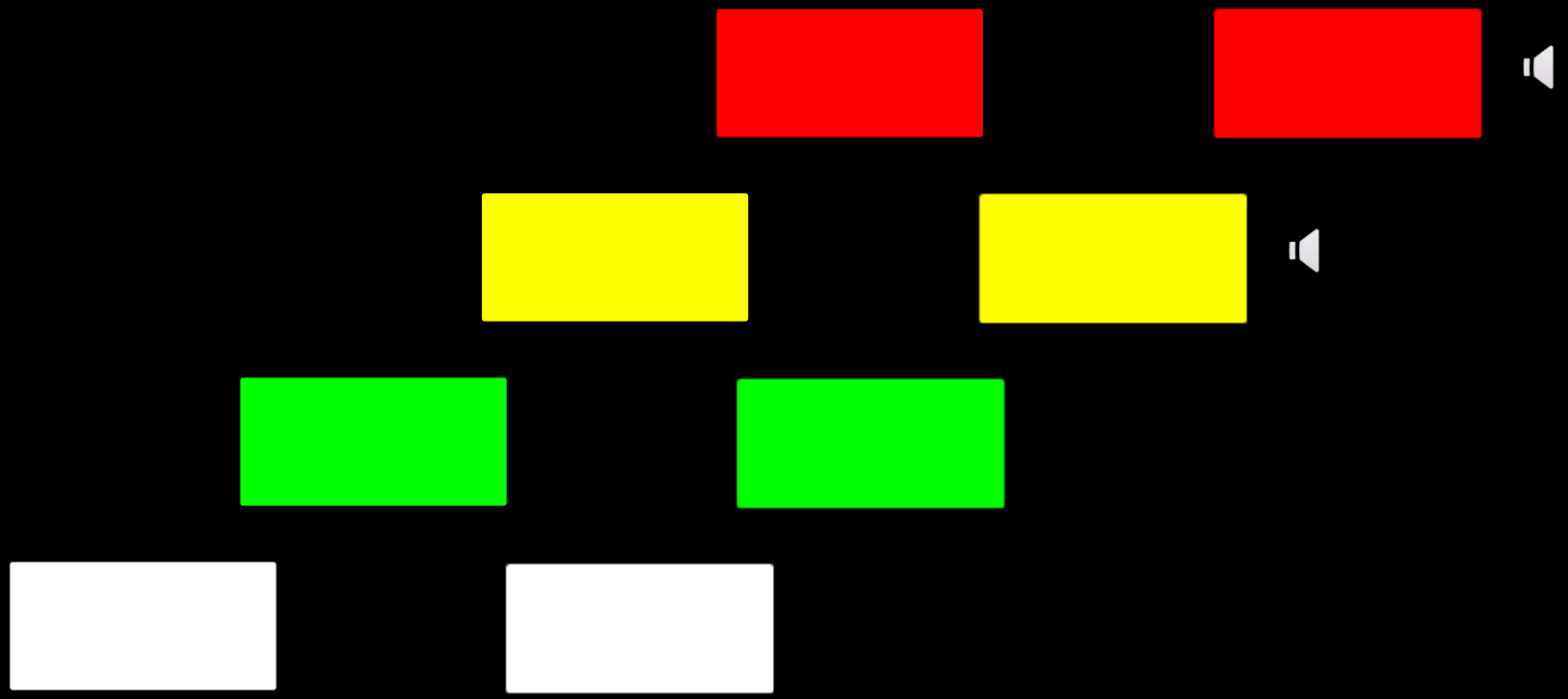
Is a white flashing element more or less important than a green element that doesn't flash?



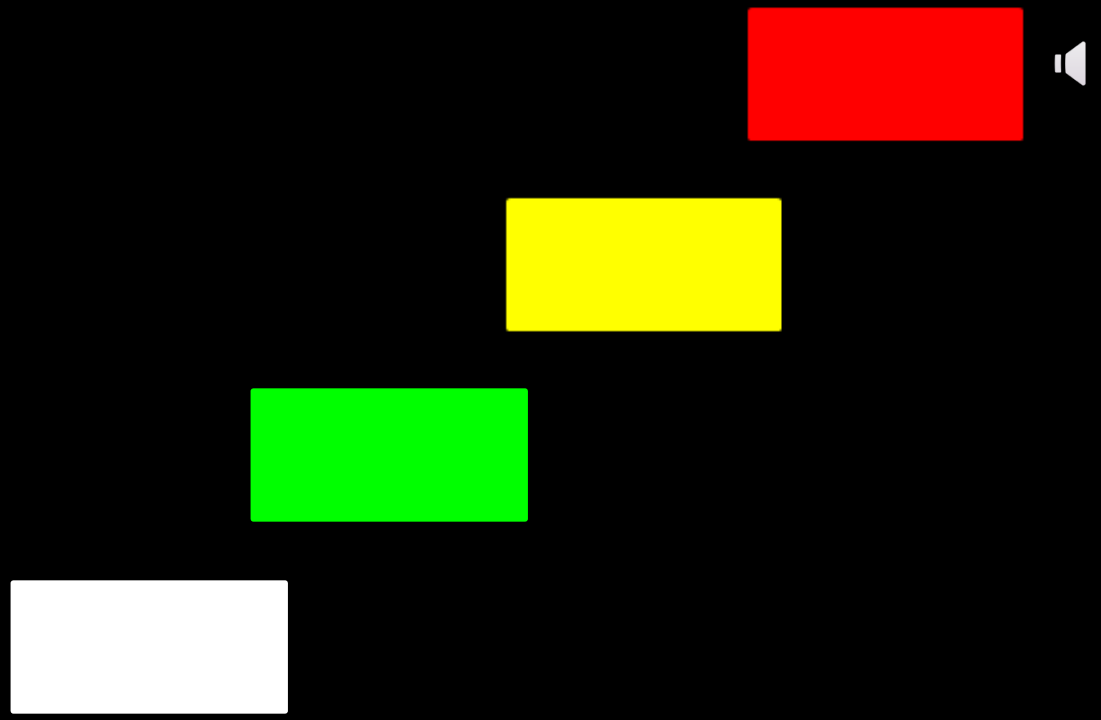
Saliency Attributes

This is not a clear escalation of hierarchy.

Is a yellow element with a tone more or less important than a red element with no tone?



This is (once again) a clear escalation of hierarchy.



And speaking of flashing elements… faster flashing = higher urgency.

Tips for Using Salience

- Your most important information should be the most salient.

Static

- Important elements should be larger.
- Important elements should be placed along the top of the screen.
- Use color to highlight important elements.

Dynamic

- Don’t expect users to quickly notice color changes in displays that are located in peripheral vision.
- Use flashing elements only for items that you specifically need to draw attention to – otherwise they are just visually distracting, and the higher the flashing rate, the more distracting they are.
- Use sound to draw the user’s attention when action is urgent.

Inconsistency

Inconsistent → Not staying the same throughout

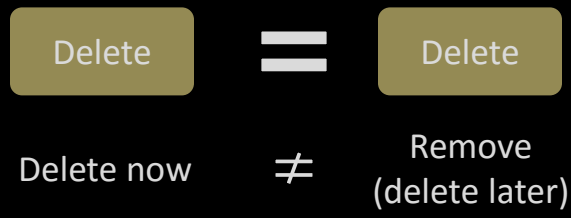
(c2) Expectation of predictability and consistency in product behavior and communications. HMI design must accommodate an operator's expectation of logical and consistent relationships between actions and results. Similar objects must behave consistently when an operator performs the same action upon them.

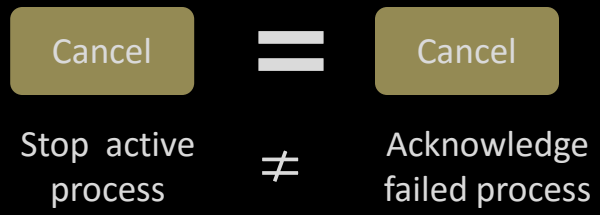
Users should not have to wonder what's going to happen when they press a button.

They shouldn't have to wonder whether different words, situations, or actions mean the same thing.

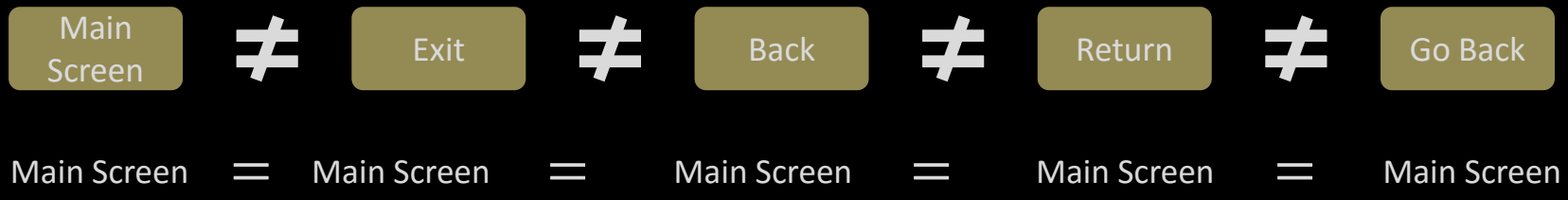
Inconsistency

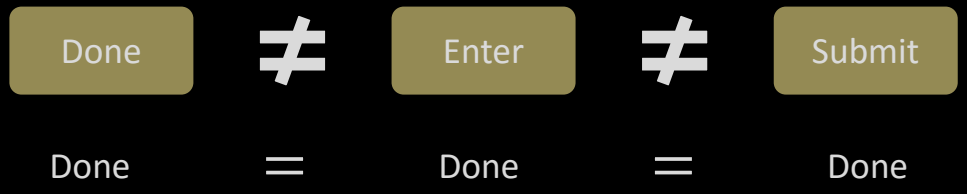
Identical button labels resulting in different actions:





Different button labels resulting in the same action:





Inconsistency

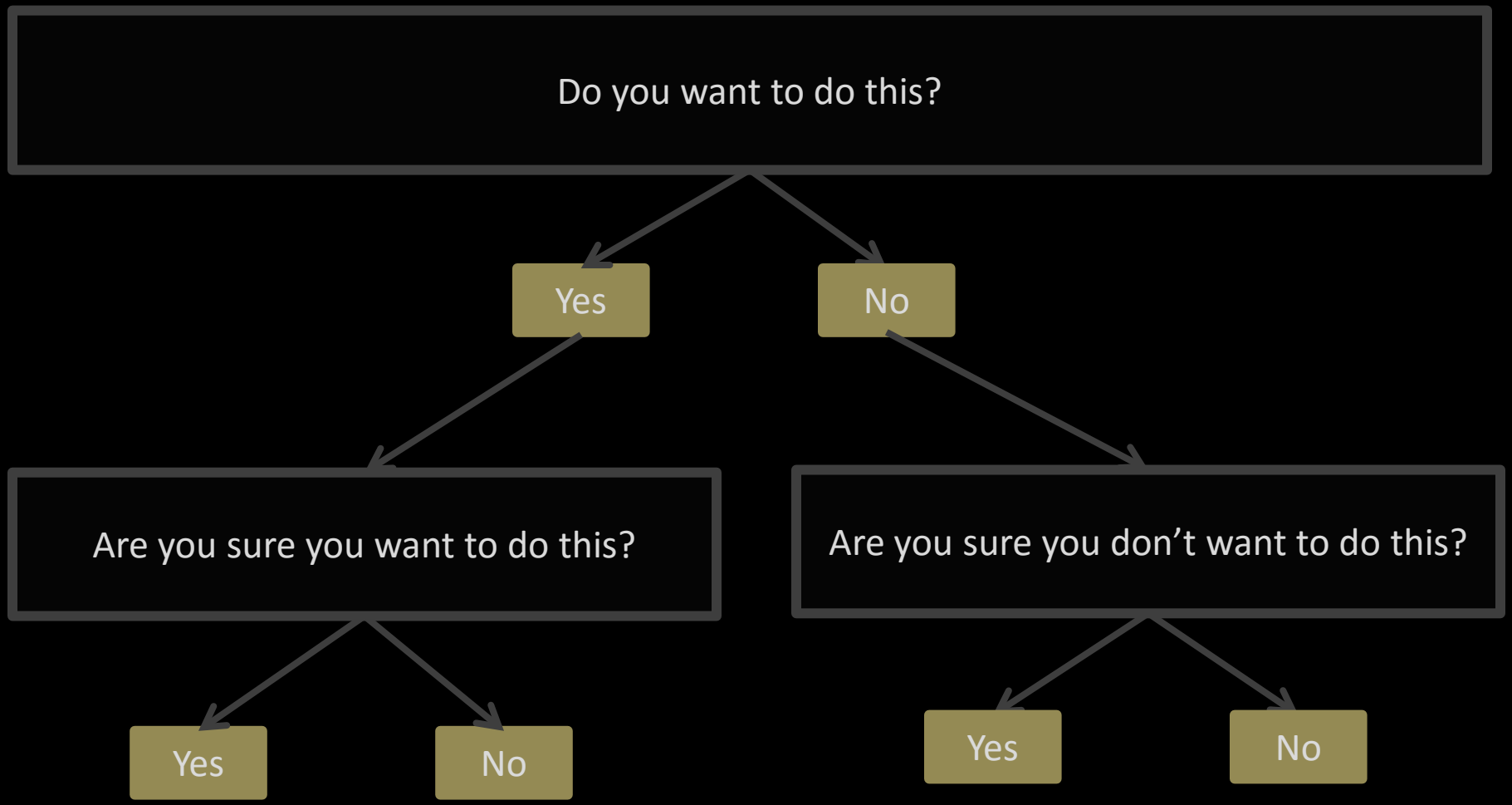
Convoluted Workflows

Convoluted → Unnecessarily complex or difficult to follow.

All interactions with a locomotive's on board display(s) divert the operator's attention away from the track ahead, even if it's just a momentary diversion.

For this reason, even if for no other, eliminate unnecessary steps and screens.

Convoluted Workflows



Is the action irrevocable? Is it dangerous? If no, you don’t need a confirmation.


Main Screen
Feature

Exit

If a screen adds no unique value, why show it?

Welcome to the feature that you just activated.

Please make a selection in the next 13 seconds:

Opt 1 | Opt 2 | Opt 3 | Opt 4

Please make a selection in the next 0 seconds:

Opt 1 | Opt 2 | Opt 3 | Opt 4

Your time has expired.

OK

Tips for Simplifying Workflows

- Require confirmation only for actions that are irrevocable or that are dangerous.
- Don’t over confirm an action.
- If a screen does not add any unique value, eliminate it.
- If a screen offers only a little value, consider off loading that value somewhere else.
- Users make mistakes. Help them to recover from those mistakes.
- When possible, prevent errors from occurring in the first place.
- Catch errors as soon as possible.

Inadequate Feedback

Feedback → Information about actions returned to the source of the actions

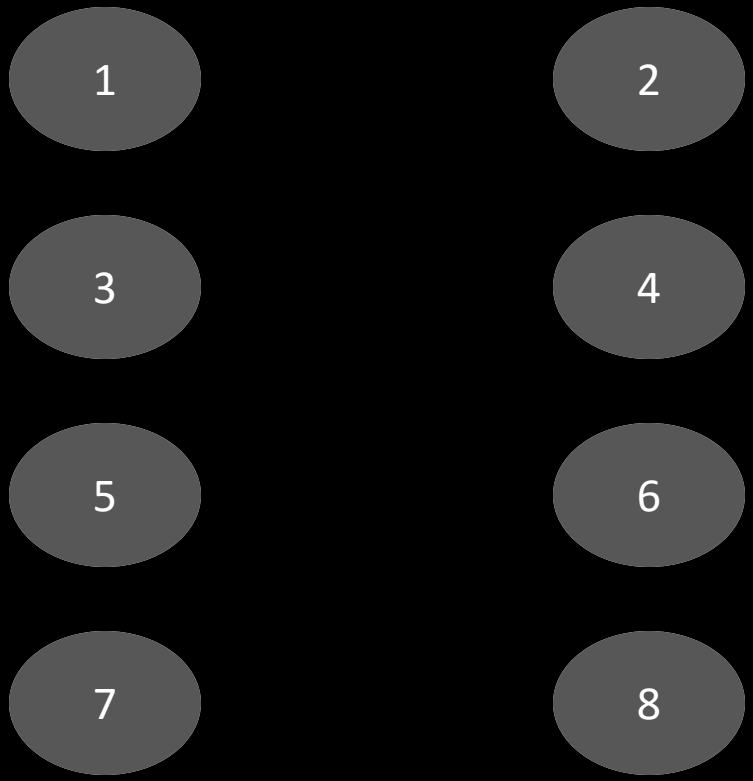
Visibility of system status

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

Actions must have reactions

When your user takes an action – whether correct or incorrect - there must be a corresponding reaction that is readily apparent.

Press all 8 buttons below:



No indication of which are completed.

Press all 8 buttons below:

1

2

3

4

5

6

7

8

Inadequate Feedback

Est an invidunt honestatis dissentiet, nam decore euismod ne. Eros velit at pri, has sint nostrum ad. Vulputate efficiantur ei mei. Duo id prima labore, ea pri vocent vidisse philosophia, quo ne quidam commodo.

Value to be entered:

Value to be entered:

Value to be entered:

These elements still look accessible.

This error message doesn't stand out.

Error message that must be acknowledged.

OK Cancel

Exit Save

Inadequate Feedback

Est an invidunt honestatis dissentiet, nam decore euismod ne. Eros velit at pri, has sint nostrum ad. Vulputate efficiantur ei mei. Duo id prima labore, ea pri vocent vidisse philosophia, quo ne quidam commodo.

Value to be entered:

Value to be entered:

Value to be entered:

Error message that must be acknowledged.

OK

Cancel

Exit

Save

Tips for Feedback

- System status should be obvious.
- Every user action should have an observable system reaction.
- Identify the goal of your feedback and build to it.
- Keep feedback simple.

Verbiage & Syntax

Verbiage→ 1) The way in which something is expressed;

2) speech or writing that uses too many words or excessively technical expressions.

Syntax → The arrangement of words and phrases to create well-formed sentences.

(f5) Where text is needed, use short, simple sentences or phrases with wording that an operator will understand and appropriate to the educational and cognitive capabilities of the intended operator;

(f6) Use complete words where possible; where abbreviations are necessary, choose a commonly accepted abbreviation or consistent method and select commonly used terms and words that the operator will understand;

This prompt and its responses are unnecessarily complex.

Please verify whether <action of interest> happened.

Fail Test	Re-run Action Test	Pass Test

This prompt means the same thing, but is much simpler.

Did <action of interest> happen?

No	Redo Action	Yes

WE MAKE FUN OF PEOPLE WHO DO THIS ON SOCIAL MEDIA.
SO WHY ARE YOU DOING IT IN YOUR INTERFACE?

If You Would Not Write A Sentence Like This In An Email To A Coworker Or Friend, Why Is It In Your Screen?

A great deal of evidence exists that reading prose is easier when capitalization is used conventionally to start sentences and to indicate proper nouns and acronyms.

http://www.usability.gov/sites/default/files/documents/guidelines_book.pdf

Tips for Writing Text for Interface Displays

- Speak the users' language, with words, phrases and concepts familiar to the user.
- Avoid passive voice and use action-oriented sentences.
- Simplify sentences and words where possible, but maintain good grammar.
- Error messages should be expressed in plain language, should be short, should precisely indicate the problem, and suggest a solution.
- Avoid abbreviations when possible, unless they are as well known - or better known - than the full word or phrase.
- Where abbreviations are necessary, use ones that are commonly accepted, easily understood, or industry standard.
- Use sentence style capitalization for sentences.
- Use Book Title Capitalization for labels.
- Avoid the use of ALL CAPS or use only for simple alerts.

Cognitive Walkthrough

Evaluators, who have an understanding of the users of the system and the tasks that they need to complete, walk through those tasks and evaluate the interface in terms of its:

- *understandability,*
- *ease of use,*
- *ease of learning.*

Literally … step through the interface and ask the following…

Cognitive Walkthrough Questions

Will the user know what he needs to do?

Finds problems with making unrealistic assumptions about the users' level of knowledge or experience.

Is the control for the action visible or easily found?

Finds problems with hidden controls or controls that are buried too deep in the system.

Is there a strong link between the control and the action?

Finds problems with ambiguous labels.

Will the user understand when a correct/incorrect action is taken?

Finds problems when feedback is missing, easy to miss, too brief, poorly worded, inappropriate, or ambiguous.

Finding Usability Issues

~~*"We'll take care of it in training."*~~

Training is for operating rules, railroad procedures, and learning to operate the locomotive.

If something inherent to your interface needs training, something is wrong.

Common Human Factors Issues Detected in the Designs of PTC HMIs

Carolynn R. Johnson, Ph.D.

cjohnson@daed.com