Preview

- **People as components of systems**
  - Factors affecting people
  - Strengths and weaknesses compared to machines

- **Usability / User interfaces**
  - What tends to make things usable?
  - What user interfaces work well?
A Word About Human Computer Interaction

◆ Not everyone is a 21 year old male engineering student
  • (Nor a female engineering student!)
  • So don’t design as if that is who your user population is
  • There are experts in the area of HCI – use them!

◆ Consider how well your system will work with these populations:
  • Non-English speakers
  • Left-handed (7-10% of population)
  • Color blind (esp. red/green – 7-10% of population)
  • Presbyopia (most people over 45 or so)
  • Polarized sunglasses (LCDs are also polarized; sometimes the wrong way)
  • Hearing impaired; wearing hearing protection
  • Gloves, coats, hats
  • Children (size, weight, child-proofing)
  • Arthritis (can’t manipulate small knobs, e.g., childproofing mechanisms)
  • Pets (e.g., cat on keyboard)
Human-Computer Interaction Issues

◆ Donald MacKenzie – 1994


• 1,100 computer-related accidental deaths (1979-1992)

• 4% of deaths due to physical sources

• 3% of deaths due to software error

• 92% of deaths due to human-computer interaction
  – (Will this change as software gets more control authority?)

◆ For example, in aviation, “controlled flight into terrain” (pilot error) is a common accident cause

• John Denver (the singer) was arguably killed by a poor user interface in a flying accident (fuel reserve tank switch on bulkhead behind him)
Software for Certain Medtronic Implanted Infusion Pumps Recalled
FDA Patient Safety News: Show #32, October 2004

Medtronic is recalling certain software application cards. They're used in the company's Model 8840 N'Vision Clinician Programmers. These hand-held devices are used to program a number of implantable devices, including the SynchroMed and SychroMed EL implantable infusion pumps.

The recall is prompted by reports of data entry errors that have led to serious drug overdoses, including two patient deaths. The overdoses occurred when clinicians who were programming the pump entered the wrong time duration or the wrong interval --- for example, mistakenly putting the time interval between periodic drug boluses in the "minutes" field, instead of the "hours" field.

The recalled software may have contributed to these errors because one part of the screen did not have labels on the fields for hours, minutes, and seconds. Medtronic is now distributing replacement software that adds time labels to the screen to help reduce the risk of these kinds of programming errors.

If you use the Model 8840 N'Vision Programmer with SynchroMed or SynchroMed EL infusion pumps, the company says you should pay particular attention to selecting the appropriate time field when entering time duration or time intervals. You should also be sure to check your software application card for your N'Vision Programmer. If you have the older software version (AAA 02), Medtronic says you should order the new version (AAD 02).

http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/psn/printer.cfm?id=261
Things Humans Are Good At

- **Detecting correlations and exceptions**
  - Patterns/clusters in graphical data
  - Breaks in lines

- **Detecting isolated movement**
  - Waving
  - Blinking
  - But not many things moving at once

- **Detecting the difference between “nothing” and “something”**
  - Sounds: alarms, acoustic nulling
  - Lights: on vs. off rather than brightness
  - Touch: shaking vs. smooth
Advantages of People Over Machines

◆ Sensing/Actuating
  • Excellent dynamic sensor range (logarithmic response to stimuli)
    – Hearing: 20 Hz – 20 KHz; 0 dB – 140 dB (factor of $10^{14}$ in energy)
    – Eye neurons can respond to a single photon; about 9 photon “hits” for people to get enough signal to say they saw light
  • Excellent image processing, especially edge & anomaly detection
  • Flexibility; ability to improvise actuations and tools

◆ Cognition
  • Ability to improvise in ill-structured situations
  • Able to make speed/accuracy tradeoffs
  • Machines do exactly what you tell them to do

◆ Issues that can be improved
  • Repeatability & predictability can be improved with intense training
Both Pilots Asleep While Approaching Denver

Lawmakers meeting about airline safety Wednesday heard about a government report that described a commercial pilot and his first officer falling asleep at the wheel 60 miles outside from Denver, and careening toward the airport at twice the speed allowed.

A commercial pilot had recently switched schedules to flying three “red eyes” in a row between Denver and Baltimore with only one hour in between flights. On March 4, 2004, during the third late-night flight, the pilot and his first officer were approaching Denver in an Airbus A319 and they were fast asleep.

“LAST 45 MINS OF FLT I FELL ASLEEP AND SO DID THE FO,”
“MISS ALL CALLS FROM ATC,” the report continues, saying that the plane was supposed to be traveling at less than 290 mph, but they were moving at a dip of about 590 mph.

“I WOKE UP, WHY I DON’T KNOW, AND HEARD FRANTIC CALLS FROM ATC. ... I ANSWERED ATC AND ABIDED BY ALL INSTRUCTIONS TO GET DOWN. WOKE FO UP,” the report says, adding that he then followed all the controller’s instructions, “AND LANDED WITH NO FURTHER INCIDENTS.”

Continue at source: http://www.foxnews.com/story/0,2933,307019,00.html

http://blog.flightstory.net/370/both-pilots-asleep-while-approaching-denver/
Army Surgeon General: Sleepy Soldiers as Impaired as Drunk Soldiers

The Army's surgeon general said the "new frontier" deploying agile and sharp soldiers is ensuring the soldier has a healthy brain.

"When we're talking about cognitive dominance [by our soldiers] you absolutely have to focus on ensuring a healthy brain, ensuring that [they] have that mental agility," Lt. Gen. Patricia D. Horoho said Wednesday during a presentation entitled The Human Dimension at the Association of the U.S. Army's annual conference in Washington, DC.

Part of maintaining a healthy brain is ensuring soldiers get enough sleep. The Army has understood the importance of sleep, but Horoho said this has often been disregarded by unit leaders who believe "that we're being effective when we're sleep deprived."

"If you have less than six hours of sleep for six days in a row you have a cognitive impairment of 20 percent – that you are cognitively impaired as if you had a .08 percent alcohol level," she said. "We never will allow a soldier in our formation with a .08 percent alcohol level, but we allow it every day to make those complex decisions."

Advantages of Machines Over People

◆ Sensing/Actuating
  • Can sense beyond human ranges
  • Sensors/actuators can directly interface with harsh environments
  • Actuation generally unaffected by fatigue

◆ Cognition
  • They don’t fall asleep!
  • No boredom; especially effective at dealing with infrequent (but anticipated) situations
  • Precise and accurate computations
  • Less overhead for multitasking than for people
  • Repeatable & predictable

  • Machines do exactly what you tell them to do
Should You Trust People Or Machines?

- **Boeing trusts people**
  - Pilot has ultimate authority
    - The pilot is the final authority for the operation of the airplane.

- **Airbus trusts machines**
  - Machine has ultimate authority
    - Automation must not lead the aircraft out of the safe flight envelope and it should maintain the aircraft within the normal flight envelope.
    - Within the normal flight envelope, the automation must not work against operator inputs, except when absolutely necessary for safety.
  - Several close calls because pilot had difficulty over-riding machines
  - Hard to say how many incidents were avoided by automation, but probably a lot

See: [http://www.crm-devel.org/resources/paper/autophil.htm](http://www.crm-devel.org/resources/paper/autophil.htm)
Role of Drivers in Automated Vehicles?

- Should we trust driver to be attentive in case of automation failure?

## Factors Affecting Performance [Hollnagel93]

- Operator experience
- Training quality
- Time available
- Procedure quality
- Supervision quality
- Noise
- Accessibility
- Use of checklist
- Motivation
- Information quality
- Stress
- Communication
- Team structure
- Design
- Location
- Cognitive complexity
- Physical complexity
- Perception of consequences

- **Best possible performance is about** $10^{-4}$ **error rate per action**
  - Improves to $10^{-5}$ error rate for well-trained team doing double-checks
  - These assume calm, everyday, trained nuclear power plant operations
Stress & Haste Reduce Operator Performance

<table>
<thead>
<tr>
<th>Human error probability</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2^{(n-1)}x$</td>
<td>Given severe time stress, as in trying to compensate for an error made in an emergency situation, the initial error rate, $x$, for an activity doubles for each attempt, $n$, after a previous incorrect attempt, until the limiting condition of an error rate of 1.0 is reached or until time runs out. This limiting condition corresponds to an individual’s becoming completely disorganized or ineffective</td>
</tr>
<tr>
<td>$\sim 1.0$</td>
<td>Operator fails to act correctly in first 60 seconds after the onset of an extremely high stress condition, e.g. a large LOCA</td>
</tr>
<tr>
<td>0.9</td>
<td>Operator fails to act correctly after the first 5 minutes after the onset of an extremely high stress condition</td>
</tr>
<tr>
<td>$10^{-1}$</td>
<td>Operator fails to act correctly after the first 30 minutes in an extreme stress condition</td>
</tr>
<tr>
<td>$10^{-2}$</td>
<td>Operator fails to act correctly after the first several hours in a high stress condition</td>
</tr>
<tr>
<td>$x$</td>
<td>After 7 days after a large LOCA, there is a complete recovery to the normal error rate, $x$, for any task</td>
</tr>
</tbody>
</table>

Note: LOCA: Loss of coolant accident (break in the primary circuit)
<table>
<thead>
<tr>
<th>Human error probability</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^{-4}$</td>
<td>Selection of a key-operated switch rather than a non-key switch (this value does not include the error of decision where the operator misinterprets situation and believes key switch is correct choice)</td>
</tr>
<tr>
<td>$10^{-3}$</td>
<td>Selection of a switch (or pair of switches) dissimilar in shape or location to the desired switch (or pair of switches), assuming no decision error. For example, operator actuates large handled switch rather than small switch</td>
</tr>
<tr>
<td>$3 \times 10^{-3}$</td>
<td>General human error of commission, e.g. misreading label and therefore selecting wrong switch</td>
</tr>
<tr>
<td>$10^{-2}$</td>
<td>General human error of omission where there is no display in the control room of the status of the item omitted, e.g. failure to return manually operated test valve to proper configuration after maintenance</td>
</tr>
<tr>
<td>$3 \times 10^{-3}$</td>
<td>Errors of omission, where the items being omitted are embedded in a procedure rather than at the end as above</td>
</tr>
<tr>
<td>$3 \times 10^{-2}$</td>
<td>Simple arithmetic errors with self-checking but without repeating the calculation by re-doing it on another piece of paper</td>
</tr>
<tr>
<td>$1/x$</td>
<td>Given that an operator is reaching for an incorrect switch (or pair of switches), he selects a particular similar appearing switch (or pair of switches), where $x =$ the number of incorrect switches (or pair of switches) adjacent to the desired switch (or pair of switches). The $1/x$ applies up to 5 or 6 items. After that point the error rate would be lower because the operator would take more time to search. With up to 5 or 6 items he does not expect to be wrong and therefore is more likely to do less deliberate searching</td>
</tr>
</tbody>
</table>

[Villemeur]
10^{-1} \quad \text{Given that an operator is reaching for a wrong motor operated valve (MOV) switch (or pair of switches), he fails to note from the indicator lamps that the MOV(s) is (are) already in the desired state and merely changes the status of the MOV(s) without recognizing he had selected the wrong switch(es)}

\sim 1.0 \quad \text{Same as above, except that the state(s) of the incorrect switch(es) is (are) not the desired state}

\sim 1.0 \quad \text{If an operator fails to operate correctly one of two closely coupled valves or switches in a procedural step, he also fails to correctly operate the other valve}

10^{-1} \quad \text{Monitor or inspector fails to recognize initial error by operator. Note: With continuing feedback of the error on the annunciator panel, this high error rate would not apply}

10^{-1} \quad \text{Personnel on different work shift fail to check condition of hardware unless required by checklist or written directive}

5 \times 10^{-1} \quad \text{Monitor fails to detect undesired position of valves, etc., during general walk-around inspections, assuming no checklist is used}

0.2-0.3 \quad \text{General error rate given very high stress levels where dangerous activities are occurring rapidly}
<table>
<thead>
<tr>
<th>Description</th>
<th>Human-error probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General rate for errors involving very high stress levels</td>
<td>0.3</td>
</tr>
<tr>
<td>2. Complicated non-routine task, with stress</td>
<td>0.3</td>
</tr>
<tr>
<td>3. Supervisor does not recognise the operator's error</td>
<td>0.1</td>
</tr>
<tr>
<td>4. Non-routine operation, with other duties at the same time</td>
<td>0.1</td>
</tr>
<tr>
<td>5. Operator fails to act correctly in the first 30 minutes of a stressful emergency situation</td>
<td>0.1</td>
</tr>
<tr>
<td>6. Errors in simple arithmetic with self-checking</td>
<td>0.03</td>
</tr>
<tr>
<td>7. General error rate for oral communication</td>
<td>0.03</td>
</tr>
<tr>
<td>8. Failure to return the manually operated test valve to the correct configuration after maintenance</td>
<td>0.01</td>
</tr>
<tr>
<td>9. Operator fails to act correctly after the first few hours in a high-stress scenario</td>
<td>0.01</td>
</tr>
<tr>
<td>10. General error of omission</td>
<td>0.01</td>
</tr>
<tr>
<td>11. Error in a routine operation where care is required</td>
<td>0.01</td>
</tr>
<tr>
<td>12. Error of omission of an act embedded in a procedure</td>
<td>0.003</td>
</tr>
<tr>
<td>13. General error rate for an act performed incorrectly</td>
<td>0.003</td>
</tr>
<tr>
<td>14. Error in simple routine operation</td>
<td>0.001</td>
</tr>
<tr>
<td>15. Selection of the wrong switch (dissimilar in shape)</td>
<td>0.001</td>
</tr>
<tr>
<td>16. Selection of a key-operated switch rather than a non-key-operated switch (EOC)</td>
<td>0.00001</td>
</tr>
<tr>
<td>17. Human-performance limit: single operator</td>
<td>0.0001</td>
</tr>
<tr>
<td>18. Human-performance limit: team of operators performing a well-designed task, very good PSFs, etc.</td>
<td>0.000001</td>
</tr>
</tbody>
</table>

[Kirwan94]
**Reaction Times**

Reaction times vary according to different factors, as shown in the following.

<table>
<thead>
<tr>
<th>By Sense Preceptor</th>
<th>sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touching</td>
<td>.11–.15</td>
</tr>
<tr>
<td>Temperature</td>
<td>.15–.22</td>
</tr>
<tr>
<td>Pain</td>
<td>.70–1.00</td>
</tr>
<tr>
<td>Hearing</td>
<td>.12–.22</td>
</tr>
<tr>
<td>Smelling</td>
<td>.29</td>
</tr>
<tr>
<td>Tasting</td>
<td>.20–1.10</td>
</tr>
<tr>
<td>Seeing</td>
<td>.15–.20</td>
</tr>
<tr>
<td>Eyes to focus</td>
<td>.165</td>
</tr>
<tr>
<td>Eyes move to 40° without focusing</td>
<td>.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>By Age</th>
<th>sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 years</td>
<td>.40</td>
</tr>
<tr>
<td>10 years</td>
<td>.30</td>
</tr>
<tr>
<td>20 years</td>
<td>.20</td>
</tr>
<tr>
<td>30 years</td>
<td>.22</td>
</tr>
<tr>
<td>40 years</td>
<td>.25</td>
</tr>
<tr>
<td>50 years</td>
<td>.38</td>
</tr>
<tr>
<td>55 years</td>
<td>.35</td>
</tr>
<tr>
<td>60 years</td>
<td>.50</td>
</tr>
</tbody>
</table>

Reaction time varies with sex: men take 0.1 second less for sound and light than women.

Reaction time varies with limbs: feet take 20% more time than hands.

The left hand, for the right-handed, takes 3% more time than the right hand.

Reaction time varies with training; with practice, it can be reduced 10%.

Reaction time varies with signal characteristics. The minimum signal period is 0.2 seconds. Short signals of 0.1 second are not good. Alerting signals can reduce reaction time up to 40%.

An illustration of total reaction time follows: A pilot sees an approaching plane through the haze:

1. The pilot detects a plane (eye moves) 0.3 sec
2. Intercepts image (perception) 0.6 sec
3. Selects course of action (decision) 0.5 sec
4. Pilot moves control (response) 0.3 sec

Total reaction time 1.7 sec

If both planes are headed toward one another at 400 mph, each pilot has only 1,000 feet before a collision. That distance will be covered in the 1.7 seconds of reaction time.

[Tilley93]
Human time perception in computer interfaces

- Less than 100 msec is instantaneous
  - With more than ~100 msec lag, hand-eye coordination becomes more difficult
- Less than 1 second is fast enough to be “interactive”
  - After about 1 second, productivity goes down due to loss of train of thought
- Less than 10 seconds if fast enough that user doesn’t assume things failed
  - After 10 seconds, web users usually assume page is broken

SAE J2364 navigation standard (for automobiles)

- Driver should not glance away from road for more than 15 seconds
- 15 seconds @ 100 kph = 416 meters

UK Def-std 00-25 is a set of freely available human factors standards

- http://www.dstan.mod.uk/
Errors of Commission & Omission

- Generally errors of omission are more common
  - “Forgot to do something” more common than doing wrong thing
  - Checklists are best way to handle omission errors
Human Perception Of Risk

◆ The “Dread Risk” effect
  • People might fear calamities more than everyday mortalities
    – Nuclear war; Nuclear power
    – Aircraft
    – Cars; Walking
  • The fear is non-linear with risk, and increases with scope (and news coverage) of catastrophic failures

◆ “Risk Homeostasis” – sometimes people change behavior
  • Anti-lock brakes seem to encourage people to follow more closely
  • Cars are arguably “safer,” but in the end, risk wasn’t been changed

◆ Degree of perceived control affects reactions
  • A person controlling a vehicle experiences less perceived risk
    – Even if their ability to actually control the vehicle is not as good as another person’s
    – Most drivers think they have “above average” ability (above median ability too)
Usability Principles [Nielsen93]

1. Simple and Natural Dialogue (simple; no distractions)
2. Speak the user’s language (know your audience)
3. Minimize user’s memory load
   • (Involves the 7 +/-2 rule and limit to 3 levels of recursion)
4. Consistency
5. Feedback
6. Clearly marked exits (undo and cancel facilities)
7. Shortcuts (accelerators)
8. Good error messages
9. Design that avoids common error sources
10. Help and documentation

◆ Plus: play to strengths of user physiology/psychology
Good Error Messages [Nielsen93]

- **Phrased in clear language and avoid obscure codes**
  - User should understand error message without having to refer to manual

- **Precise rather than vague or general**
  - Bad: “Cannot open this document”
  - Good: “Cannot open ‘Chapter 5’ because the application is not on the disk

- **Constructively help the user solve the problem**
  - Guess what the user meant to do
  - Suggest corrective actions, e.g., correct misspelled words

- **Error messages should be polite and not intimidate the user**
  - Users feel bad enough as it is when they make mistakes
  - Avoid screaming at the user
  - Bad: “ILLEGAL USER ACTION, JOB ABORTED”
    - Does this mean a SWAT team will be showing up to arrest the user?
    - MS Windows used to have an “illegal instruction” pop-up; but not anymore
An Example User Interface

- Bad interface – which dial is abnormal?
  - General rule – put "normal" at 12 O’clock position
OK, But Could Be Better

- Which dial isn’t at 12:00 “normal” position?
  - How would you like to try to find it 4 times per minute?
Exploiting Human Eye Edge/Line Detection

- Only 5 degree change is readily perceptible
Human Interface Guidance

◆ There are experts for user interfaces
  • Often a good idea to have them do design reviews on user interfaces

◆ One place for guidance is NUREG 0700
  • NUREG 0700 Human-System Interface Design Review Guidelines
    – 659 page document on design review!
  • Display formats (text; graph, charts)
  • Display elements (characters, icons, labels, colors)
  • Data Quality and update rate
  • Display pages
  • Display devices (video, projectors, meters, lights, numeric displays)
  • Interface interactions (menus, cursors, what shows up where, help)
  • Alarms
  • Display customization
  • Communications/annunciations
  • Workplace/workstation design
  • ……
Usability Testing

- **Important to test usability of interface with actual people**
  - People tend to find new ways to use a product
  - Might introduce risks not obvious to designers

- **Create test plan**
  - What is the goal of test?
  - What software tools do you need?
  - What are the test tasks?
  - …

- **Perform pilot test**
  - Helps catch deficiencies in the test early

- **Identify experimenters and test users**
  - Test users should be as representative as possible of intended audience

- **Run test and measure performance**
  - Time taken, tasks completed, ratio between successful tasks and errors
Measuring Usability [Nielsen93]

**Goal:** Usability

**Component:** Learnability

**Component:** Efficiency of use

**Quantification:** Average time needed to perform five specified tasks

**Measurement Method:** User brought to lab, given list of the tasks, and performs them without help

**Data-Collection Technique:** Stopwatch (with rules for when to start and stop the watch)
"Measure of Man and Woman"

LARGE MAN
99 PERCENTILE US POP.
STATURE 75.6 IN – 1920 mm
WEIGHT 244.6 LB – 111.2 KG
SLUMP 1 IN – 25 mm
ABDOMEN 13.7 IN – 349 mm

SMALL WOMAN
1 PERCENTILE US POP.
STATURE 59.1 IN – 1476 mm
WEIGHT 87.1 LB – 39.5 KG
SLUMP 0

NOTE:
HEAD LINES ARE VERTICAL TO FLOORS

HEAD SUPPORT REQUIRED ON RACE CARS
CONSIDER HELMET

MIN HEAD CLEARANCE
6" FOR ROUGH TERRAIN

TOTAL THORACIC SUPPORT

WHEEL DIAMETERS
RACE CAR 10-12" (254-305)
SPORT CAR 12-14" (305-356)
AUTO 14-16" (356-406)
TRUCKS 16-18" (406-460)
INDUST 13-18" (330-457)

COMFORT ANGLES:
SEAT ANGLES...95°-100° FOR ALERT
KNEE ANGLE...110°-120° FOR STRENGTH
ANKLE ANGLE...90°-100° FOR COMFORT
ELBOW ANGLE...80°-160° FOR COMFORT
UPPER ARM ANGLE...0°-35° FOR COMFORT

NOTE:
SHANK AND THIGH LINKS ARE FORESHORTENED FOR 15° LEG SPREAD IN PLAN

NOTE:
SEAT REFERENCE PLANE ANGLES Θ ARE EQUAL TO CATEGORIZATION ANGLES.
COMPARTMENTS CHANGE

[ Tilley93 ]
CIRCULAR DIALS
QUANTITATIVE/QUALITATIVE AND SNAP CHECK
- NOS. INCREASE CLOCKWISE
- ARE VERTICAL AND OUTSIDE
- THE SCALE
- ZER0 AT TOP IS POSSIBLE
- 12 ON CLOCKS
- FOR LEFT HAND ONLY
- AVOID CLUTTER
- OPTIMUM DIAL DIA.
- 2.75-4" (67-102)
- FOR HIGH ACCURACY
- ASSOCIATED CONTROL
- PREFERRED LOCATION
- CLOCKWISE TO INCREASE READING

SEMICIRCULAR DIALS
QUANTITATIVE/QUALITATIVE AND SNAP CHECK
- AVOID MOVING DIAL FACES
- UPSIDE DOWN IS POSSIBLE
- USE ZONES TO SIMPLIFY SCALE IF POSSIBLE
- AVOID DISTRACTING LOGOS ON ALL DIAL FACES
- NOS. AND SPACING OF SCALE MARKINGS
- ULTIMATELY DETERMINE THE SIZE OF THE DIAL

HORIZONTAL SCALES
QUANTITATIVE/QUALITATIVE AND SNAP CHECK
- FOR FIXED SCALES AND MOVING POINTERS
- QUANTITATIVE ONLY FOR MOVING SCALES WITH THE
- POSSIBILITY OF USING LONG SCALE TAPES
- TITLE
- FOR LEFT HAND (ALT)
- NOS INCREASE LEFT TO RIGHT
- TURN KNOB COUNTERCLOCKWISE TO INCREASE
- RECOMMEND FIXED SCALE AND MOVING POINTER

CHECK DIALS (FOR GROSS READINGS)
- ORDER OF SEQUENCE
- NORMAL POSITION FOR VERTICAL ARRAYS
- PREFER HORIZONTAL ARRAYS AS SHOWN
- NOS. INSIDE INDICES ON SMALL DIALS
- OPT → 0
- POINTER POSITION FOR CHECK READING
- MIN SPACING

ZONE CODED DIALS
DIAL READING CAN BE SIMPLIFIED BY THE USE OF ZONE MARKINGS IF PRECISE NUMERICAL VALUES ARE NOT REQUIRED
- EXAMPLE 1
- EXAMPLE 2
- CONSIDER COLOR CODING THE ZONE MARKINGS
- GREEN-SAFE, NORMAL, SATISFACTORY, DESIRABLE
- YELLOW-CAUTION, WARNING
- RED-DANGER, Undesirable, Inefficient

MULTI-REVOLUTION DIALS
LIMIT MULTI-POINTER DIALS TO 2 HANDS
- ALTERNATE:
- LONG SCALE CHECK AND
- QUALITATIVE DIAL HAS COUNTER FOR
- PRECISE DATA
- SOME WATCHES HAVE FOUR SUBDIALS E.G.
- DATE, DAY, MONTH AND SEC
- 1 REV EQUALS 1 INTERVAL ON MAIN DIAL
- MULTI-POINTER DIALS ARE CONFUSING TO READ
- THE COMMON ALARM CLOCK WORKS IF SWEEP HAND IS RED AND ALARM HAND IS INCONSPICUOUS

SCALES
MINIMIZE NUMBER OF MARKINGS IF NOT REQUIRED
- S RECOMMENDED SCALES:
- 0 1 5 10 15 GOOD
- FOR TIME/COMPASS
- SUPERIOR SCALE
- 0 1 2 3 4 FAIR
- 0 1 2 3 GOOD
- CAN ADD ZEROS OR DECIMALS TO DIGITS ABOVE
- AVOID SCALES: 2.5 5 7.5 AND 4 8 12
- AVOID VARIABLE SCALES E.G. LOGARITHMIC
- AVOID MIXING DIFFERENT SCALES NEARBY

INDICES
MINIMUM SIZE SCALES FOR LOW ILLUMINATION,
VIEWING DISTANCE: 28-36" (711-914mm)
- MINIMUM SIZE OF SCALES FOR HIGH ILLUMINATION
- MINIMUM SPACE BETWEEN INDICES:
- 2X INDEX WIDTH IF INDICES ARE WHITE ON BLACK
- 1X INDEX WIDTH IF INDICES ARE BLACK ON WHITE
- SIZES ARE DIRECTLY PROPORTIONAL VIEWING DIST

POINTERS
- PROPORTIONS
- DIRECTION ARROW ABOVE IS OPTIMUM FOR RECOGNITION
- AVOID ORNATE POINTERS WHICH ARE DISTRACTING
Safety Symbols

- ANSI Z535.2 Standard for Environmental and Facility Safety Signs

Snopes Says This Isn’t True:

Smilodon
Firmware Engineer
commented on Sep 19, 2008 10:56:44 AM

dalinaz wrote, "My 21 inch 5 hp gas lawn mower contains a warning not to try to pick the mower up and use it as a hedge trimmer. Want to bet that some idiot (now known as "Stubby")) tried to do just that??"

My former boss testified in a product liability case on this exact issue. It was actually Mr. AND Mrs. "Stubby," who picked up their rotary mower on either side of its deck. The Stubby Family prevailed, as apparently the court thought a reasonable person might use a rotary mower as a hedge trimmer unless cautioned not to.

http://www.embedded.com/columns/technicalinsights/210601616?_requestid=219820

• Should there be a warning label saying “don’t use mower as hedge trimmer?”

Some robot mowers use a “Swing Blade”

http://www.theregister.co.uk/2014/06/24/review_bosch_indego_robot_lawn_mower/
FIGURE 7-1  Evolution of Japanese nuclear power plant control rooms: (a) 1970s (Mihama-3 plant); (b) 1980s (Takahama-3 plant); (c) 1990s (Ohi-3 plant); (d) next generation plant. Source: Kansai Electric Power Co., Inc.
Submarine nuclear power plant control panel; Smithsonian exhibition

Safety Control Rod Axe Man = SCRAM
Summary: Improving Human Performance

◆ Practice makes perfect
  • Training is the proven way to improve performance

◆ Avoid operator drop-out
  • Give human some (non-stressful) task that requires attention all the time
    – Example: automate vehicle speed or steering, but not both
  • Inject a moderate level of drills

◆ Strike an appropriate alarm frequency balance
  • Too many false alarms means they will be ignored
  • Too few alarms means people will be unprepared and hazards may be missed

◆ Use a well designed operator interface
  • Use anthropometric data; use psychology / cognition / perception data
  • Use humans only for what they are good at
  • Perform user interface studies
  • Blaming the user is (usually) counter-productive in an accident investigation