Chapter Three:
Task Analysis and Interaction Design

2014 E.C.

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Introduction

- Human being communicate with interactive systems using different ways .
- Developers of interactive systems have to establish requirements
  - ✓ Used to evaluate them if they match with the real needs of full range of users
- Two types of requirements:
  - ✓ **functional** and **non-functional**
- **Functional** requirements are those which are related to the technical functionality of the system.
- **Non-functional** requirement is a requirement that specifies criteria that can be used to judge the operation of a system in particular conditions, rather than specific behaviors.

.

Con…

- There are many types of Non-functional requirements
  - ✓ Usability, Accessibility, Reusability, Maintainability, Performance, Reliability, Security, …
- Requirement Analysis techniques can categorized into two:
  - ➢ Ask (potential) users questions
    - ✓ Questionnaires
    - ✓ Interviews
  - ➢ Observe them doing things

Task Analysis for HCI

- **Task analysis:** is the process of analyzing the way people perform their jobs:
  - ✓ is a diagram explaining the steps that a user must take in order to complete a goal
  - ✓ The things they do, the things they act on and the things they need to know
- Once you have arrange all the steps out, you will then be in a position to see where additional user support is required
  - ✓ You might wish to **automate some actions** that the user currently undertakes or
  - ✓ **Eliminate unnecessary steps**, in order to minimize the number of actions
- Task analysis focuses on user rather than the system

Con…

- TA: is listing of actions a user carries out in performing a task.
  - For example, a person preparing an overhead projector for use would be seen to carry out the following actions :-
    - Plug in to main and switch on supply.
    - Locate on/off switch on projector
    - Discover which way to press the switch
    - Press the switch for power
    - Put on the slide and orientate correctly
    - Align the projector on the screen
    - Focus the slide

CON…

- **Applied to a variety of techniques for:**
  - identifying and understanding the structure,
  - the flow, and
  - the attributes of tasks.
- **Task analysis identifies the:**
  - actions and,
  - cognitive processes required for:
    - a user to complete a task or achieve a particular goal.

AIM of Task Analysis

- **Aim is to determine:**
  - What they do
  - What things they use
  - Predict difficulties
  - Evaluate systems against usability and/ or functional requirements

- Generally, task analysis is important to analyze, model and evaluate requirements of interactive systems
- Task analysis techniques support user-centered design

Task Analysis Techniques

- Task analysis is a fundamental methodology in the **assessment** and **reduction of human error**.
- There are many techniques
  - HTA (hierarchical Task Analysis)
  - GOMS(Goals operators methods selection rules)
    - ✓ KLM **(**Keystroke-Level Model)
    - ✓ CMN-GOMS (Card, Moran and Newell)
    - ✓ NGOMSL (Natural GOMS Language)
    - ✓ CPM-GOMS (**C**ritical **P**ath **M**ethods)
- ✓ All four models produce the same sequence of observable operator at different levels of detail.

Hierarchical Task Analysis (HTA)

- Also called hierarchical decomposition
  - A high-level task is decomposed into a hierarchy of subtasks.
- These are then grouped together as plans that specify how the tasks might be performed in an actual situation
- Hierarchical task analysis
  - Provides an understanding of the tasks users need to achieve certain goals.
  - Lets you to explore various possible approaches to completing the same task.
  - Can help to optimize particular interactions

Con…

- HTA - Means of breaking tasks down into a hierarchy of goals, operations (actions) and plans.
- **Goals** - Goal to achieve and describe
  - **Expressed as verb phrase**, e.g. book lecture room, clean kitchen, mount a projector(increase) …
- **Operations/actions -** tasks to make the system approach goal
- **Plans** - To reach a goal the user usually needs a plan which involves a **set of tasks to be performed.**

Procedure for carrying out HTA

- Start with the overall goal e.g. “Use email”, “Print a letter”
- Break these down into meaningful sub-goals/tasks (asking how question)
- Break down sub-goals further until reach an appropriate stopping point.

Example – textual representation

Hierarchy description ...

0. in order to clean the house

1. get the vacuum cleaner out
2. get the appropriate attachment
3. clean the rooms
    - 3.1. clean the hall
    - 3.2. clean the living rooms
    - 3.3. clean the bedrooms
4. empty the dust bag
5. put vacuum cleaner and attachments away

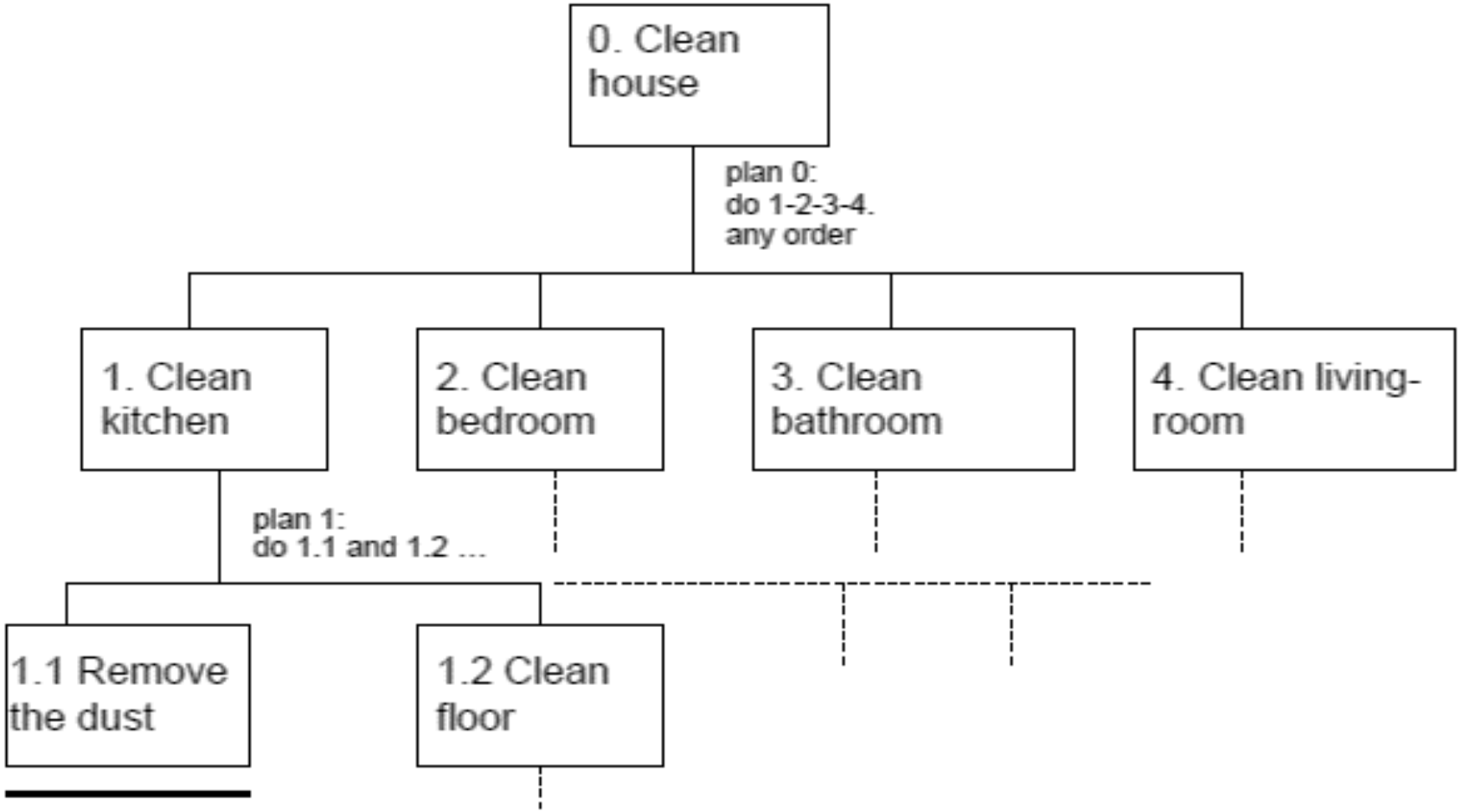
... and plans

Plan 0: do 1 - 2 - 3 - 5 in that order. when the dust bag gets full do 4

Plan 3: do any of 3.1, 3.2 or 3.3 in any order depending on which rooms need cleaning

N.B. only the plans denote order

Example - graphical representation

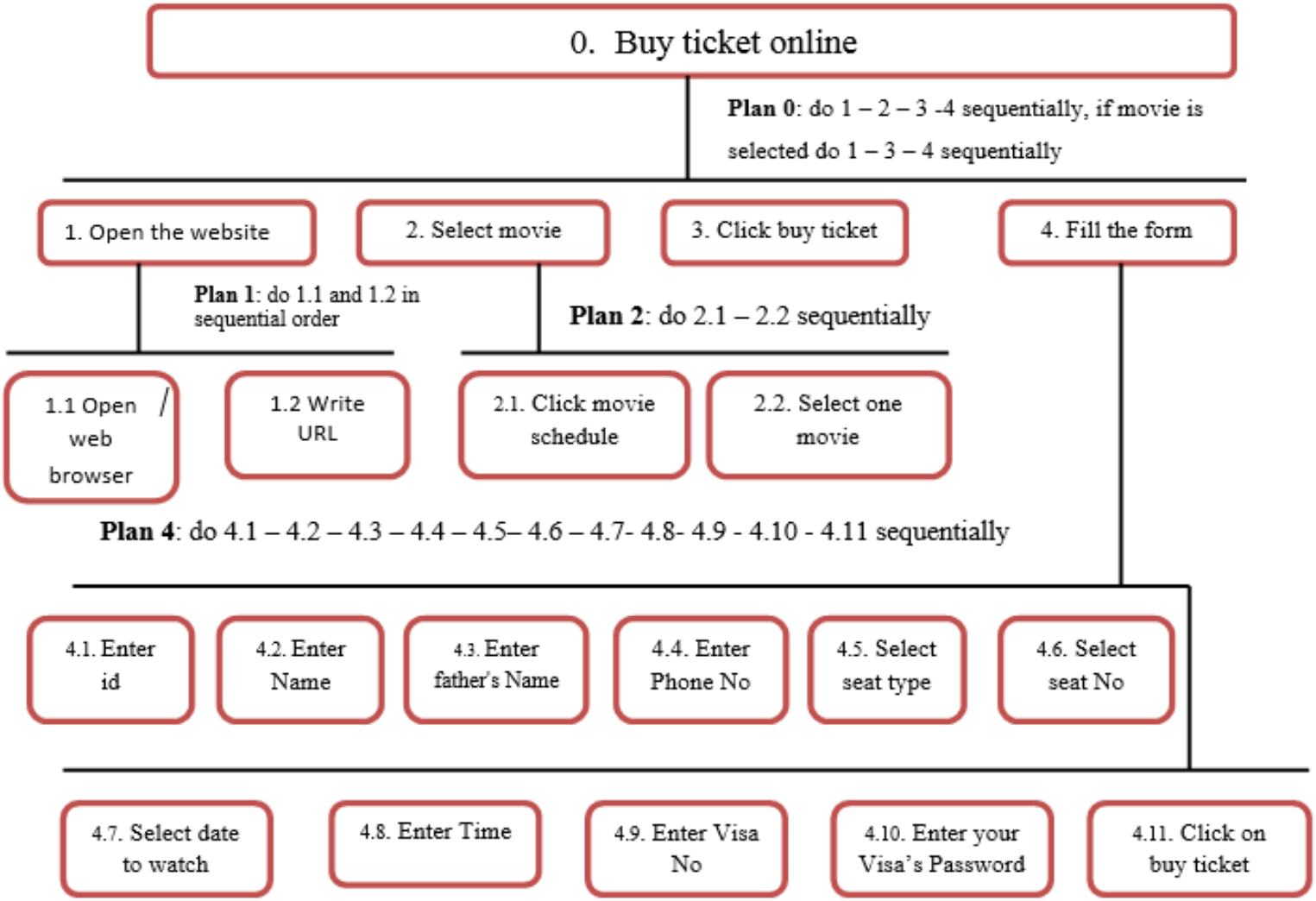


HTA – Example 2

GOAL 0: buy ticket online

1. Open the website
   - 1.1 Open web browser
   - 1.2 Write the URL
2. Select a movie
   - 2.1 Click on the movie schedule
   - 2.2 Select one movie
3. Click on the buy ticket button
4. Fill the form
   - 4.1 Enter id (random id is given)
   - 4.2 Enter your name
   - 4.3 Enter your father's name
   - 4.4 Enter your address / phone number
   - 4.5 Select sit type (VIP or normal)
   - 4.6 Select the seat number
   - 4.7 Select the date to watch
   - 4.8 Enter the time to watch
   - 4.9 Enter your visa number
   - 4.10 enter your visa card password
   - 4.11 Click on Buy ticket button

Graphical representation



GOMS Models for Task Analysis

- **GOMS**: is a modelling technique that analyses the user complexity of interactive systems.
- It models tasks in terms of
  - **Goals -** what the user wants to accomplish
    - ✓Edit an article
  - **Operators -** the means that leads to a goal at a detailed level
    - ✓Use arrow keys, Use mouse, Use other keys
  - **Methods -** sequences of operators
    - ✓Positioning, Marking, Delete
  - **Selection rules** – rules (general or personal) for choosing a certain method
    - if close, use arrow key etc.
- It predicts user performance with a particular interface and can be **used to filter particular design options**

Keystroke Level Model - KLM

- Is the first and simplest GOMS technique **for predicting user performance**
  - Predicts how long it will take an expert user to accomplish a routine(usual) task without errors using an interactive computer system
- Using KLM, execution time is estimated by listing the sequence operators and then summing the times of the individual operators.
- KLM aggregates all perceptual and cognitive function into a single value for an entire task, using a heuristic.
- KLM does not employ selection rules.

Keystroke Level Model – KLM…

- The Keystroke-Level Model consists of **seven operators**: the first five are physical motor operators followed by one mental operator and one system response operator
  - K = Key or button press => 0.2
  - B = Pressing a mouse button => 0.1
  - P = Pointing to a target on a display with a mouse => 1.1
  - H = Homing the hand(s) on the keyboard or other device => 0.4
  - D = Drawing a line (domain dependent)
  - M =Mentally preparing for executing physical actions (thinking)=1.35
  - R = Response time of the system (system dependent)
  - Total = K + B + P + H + D + M + R

Cont..

- For instance, imagine we are using a mouse-based editor. If we notice a single character error we will point at the error, **delete the character and retype it**, and then return to our previous typing point. This is decomposed as follows

1. Move hand to mouse H[mouse]
2. Position mouse after bad character PB[LEFT]
3. Return to keyboard H[keyboard]
4. Delete character MK[DELETE]
5. Type correction K[char]
6. Reposition insertion point H[mouse]MPB[LEFT]

Total=3H + 2P + 2B + 2K + 2M = 6.1

KLM - Example

Text Editing Task of searching a Microsoft Word document for all occurrences of a four-letter word, and replacing it with another four-letter word.

Description	Operation	Time (sec)
Reach for mouse	H[mouse]	0.40
Move pointer to "Replace" button	P[menu item]	1.10
Click on "Replace" command	K[mouse]	0.20
Home on keyboard	H[keyboard]	0.40
Specify word to be replaced	M4K[word]	2.15
Reach for mouse	H[mouse]	0.40
Point to correct field	P[field]	1.10
Click on field	K[mouse]	0.20
Home on keyboard	H[keyboard]	0.40
Type new word	M4K[word]	2.15
Reach for mouse	H[mouse]	0.40
Move pointer on Replace-all	P[replace-all]	1.10
Click on field	K[mouse]	0.20
Total		**10.2**

According to this KLM model, it takes 10.2 seconds to accomplish this task.

KLM - Example

delete a file

Design A: drag the file into the trash can

1. initiate the deletion (M)
2. find the file icon (M)
3. Reach for mouse(H)
4. point to file icon (P)
5. press and hold mouse button (B)
6. drag file icon to trash can icon (P)
7. point to original window (P)

Total Time = 3P + B + 2M +H =
3*1.1 sec + .1 sec+ 2*1.35 sec + .4
= 6.5 sec

Design B: use the short cut "control + D

1. initiate the deletion (M)
2. find the icon for the file (M)
3. Reach for mouse(H)
4. point to file icon (P)
5. press mouse button (B)
6. move hand to keyboard (H)
7. press control key (K)
8. press D key (K)
9. move hand back to mouse (H)

P + B + 3H + 2K + 2M
= 1.1 sec + .1 sec + 3*.4 sec
+ 2*.2 sec + 2*1.35 sec = 5.9 sec

Design B is 0.6 sec. faster than Design A

CMN-GOMS

- Takes the KLM as its basic and adds sub-goals and selection rules
  - requires a strict goal-method-operation-selection rules structure.
- This method can also be used to estimate the load task places on the user.
- It also provides a guide for how to formulate selection rules
- Like KLM ,the notion of operators is not restricted to those seven
  - The modeller has the freedom to define any cognitive operation and use that as operator
  - This model can predict operator sequence as well as execution time

Example - Deleting a file in Windows Explorer

```
GOAL: DELETE-FILE
.    GOAL: SELECT-FILE
.    .    [select:  GOAL: KEYBOARD-TAB-METHOD
.    .              GOAL: MOUSE-METHOD]
.    .    VERIFY-SELECTION
.    GOAL: ISSUE-DELETE-COMMAND
.    .    [select*: GOAL: KEYBOARD-DELETE-METHOD
.    .              .    PRESS-DELETE
.    .              .    GOAL: CONFIRM-DELETE
.    .              GOAL: DROP-DOWN-MENU-METHOD
.    .              .    MOVE-MOUSE-OVER-FILE-ICON
.    .              .    CLICK-RIGHT-MOUSE-BUTTON
.    .              .    LOCATE-DELETE-COMMAND
.    .              .    MOVE-MOUSE-TO-DELETE-COMMAND
.    .              .    CLICK-LEFT-MOUSE-BUTTON
.    .              .    GOAL: CONFIRM-DELETE
.    .              GOAL: DRAG-AND-DROP-METHOD
.    .              .    MOVE-MOUSE-OVER-FILE-ICON
.    .              .    PRESS-LEFT-MOUSE-BUTTON
.    .              .    LOCATE-RECYCLING-BIN
.    .              .    MOVE-MOUSE-TO-RECYCLING-BIN
.    .              .    RELEASE-LEFT-MOUSE-BUTTON]

*Selection rule for GOAL: ISSUE-DELETE-COMMAND
  If hands are on keyboard, use KEYBOARD-DELETE-METHOD,
    else if Recycle bin is visible, use DRAG-AND-DROP-METHOD,
    else use DROP-DOWN-MENU-METHOD
```

The time of each operator can be written in the right Side of each operator

GOMS model Strength

- It produces quantitative and qualitative predictions of how people will use a proposed system
- It helps **discover usability problems -** GOMS has been shown to be capable of finding usability problems that are not found through normal development or other forms of analysis.
- Helps find ways of reducing execution time and thereby save money
- Easy to construct a simple GOMS model and saves time

GOMS model Weakness

- Assumes tasks are performed by **expert users**
  - ✓ **GOMS** only applies to skilled users; not for the novice /beginner user
- Lack of account for errors
  - ✓ Even skilled users make errors but GOMS does not account for errors
- Does not address several important UI issues, such as
  - ✓ Readability of text, memorability of icons, commands, etc
  - ✓ GOMS represents only the procedural aspects of a task.

Interaction design

- What is design
- Interaction design
- Usability engineering
- Screen design and layout
- Evolution of HCI ‘interfaces
- User interface design principles
- Ergonomics

What is design?

- A creative activity for: **achieving goals within constraints**
  - **Goals** : Purpose, who is it for?, Why do they want it?
  - **Constraints:** Materials, and other constraints
  - Choosing which goals or constraints can be relaxed so that others can be met
- It is a plan for development
- Golden rule of design
  - **Understand computers:** limitations, capacities, tools, platforms.
  - **Understand people:** Psychological, social aspects
    - ✓ Human error: we know how users behave under stress
  - **And their interaction**

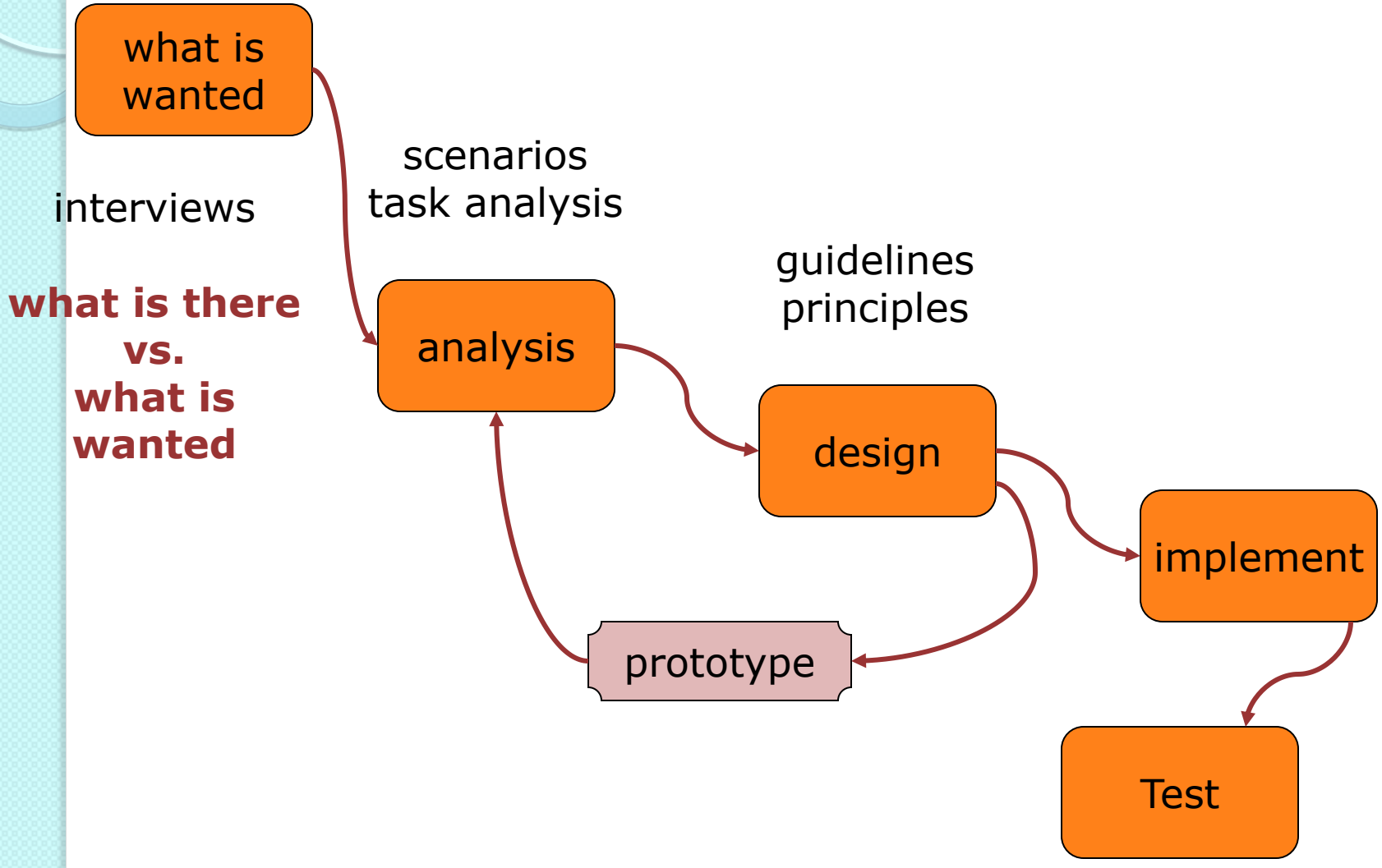
Understanding Users

- **Who are the users?**
  - ✓ End users , Admins, Maintenance technicians, etc…
  - ✓ Wider term: **stakeholders**
- Humans vary in many dimensions!
  - ✓ Strength - a child's toy requires little strength to operate
  - ✓ Size of hands may affect the size and positioning of input buttons;
  - ✓ Height of designing a physical stand

Interaction design

- There are four basic activities in interaction Design
  - ✓ Identifying needs and establishing requirements
  - ✓ Developing **alternative designs**
  - ✓ Building interactive versions of the designs
  - ✓ Evaluating designs
- The Goal of **Interaction design**
  - Develop usable products
  - Involve users in the design process

The process of design



Steps …

- Requirements: What is there and what is wanted …
- Analysis: Ordering and understanding
- Design: What to do and how to decide
- Iteration and prototyping: Getting it right … and finding what is really needed!
- Implementation and deployment: Making it and getting it out there
- Testing : evaluate by involving user(user centre design)

Usability Engineering

- **Usability:** is the **ease of use** and **learnability** of a human-made object such as a tool or device
- Also it may refer
  - Effectiveness of the system to use
    - ✓ can you achieve what you want to?
  - Efficiency of the system to use
    - ✓ can you do it without wasting effort?
  - Safety of the system to use
  - Easy to learn
  - Easy to remember how to use

Usability Engineering…

- **Usability engineering:** is used to determine to what degree a product or prototype will be user-friendly
- Usability specification should include
  - ✓ Usability attribute/principle
  - ✓ Measuring concept
  - ✓ Measuring method
  - ✓ Now level/ worst case/ planned level/ best case

Usability Engineering…

- **Usability Attributes**
  - ✓ General usability characteristic that we want to measure
  - ✓ Attributes should be measurable
  - ✓ Example of attributes include
    - Time to complete a task
    - % Of task completed
    - Number or % of errors made
    - % Of users who like the design
    - No of times user asks for help/gets lost

Screen design and layout

- Place controls that are functionally related together.
- If controls are used sequentially, organize them sequentially.
- Make the most frequently-used controls the most accessible.

- Consistency
- Location
- Format
- Point size
- Word and line spacing
- Indentation
- Color
- Font

Good Design vs. Bad Design

- Good design should be internally coherent to the user— it shouldn't require an external explanation.
  - Good design brings people joy
  - It helps people do things and to connect people
  - Have impact on both individuals ability and societies
  - Help for computing of hundreds of millions of desk
- Bad design costs, lives money, and time such as in
  - Medical devices
  - Airplane accident
  - Nuclear disasters

Discussion on Bad Design

- Classes with exclusively right-handed desks
  - This design does not work for all users:

Con…

- ATM's that dribble out your card after the cash
  - ATM users are waiting for one thing: cash. So when the cash dispenses their immediate reaction is to leave.

Con…

- Social Media Icons on Print Ads
  - Why are social media icons in print ads? A magazine is not a computer— no one can click icons!

What to design

- Need to take into account:
  - Who the users are
  - What activities are being carried out
  - Where the interaction is taking place
- Need to optimise the interactions users have with a product
  - Such that they match the users activities and needs

Evolution of HCI 'interfaces'

- *50s - Interface at the hardware level for engineers - switch panels*
- *60-70s - interface at the programming level - COBOL, FORTRAN*
- *70-80s - Interface at the terminal level - command languages*
- *80s - Interface at the interaction dialogue level - GUIs, multimedia*
- *90s - Interface at the work setting - networked systems, groupware*
- *00s - Interface becomes pervasive*
- *RF tags, Bluetooth technology, mobile devices, consumer electronics, interactive screens, embedded technology*

Cognitive aspects of interaction design

- Nowadays, humans' cognitive aspects have become more and more important for interaction design
- **Definition of cognitive**
  - Cognition refers to what goes on in humans mind when they carry out everyday activities
- It involves lots of cognitive processes, such as:
  - thinking
  - Remembering
  - learning and
  - decision making.

Con…

- Through study these humans' cognitive process, the developers of interaction system can be better at:
  - understanding users' psychological characteristic during the **process of interacting with computer systems**
- It is crucial for developers to design **high quality** interaction system,
  - which make the interaction between users and systems more effectively and efficiently.

Con…

Attention:

- It is the one from **Cognitive processes**
- Information at the interface should be structured to capture users' attention,
- e.g. use perceptual boundaries (windows), color, video, sound and flashing lights

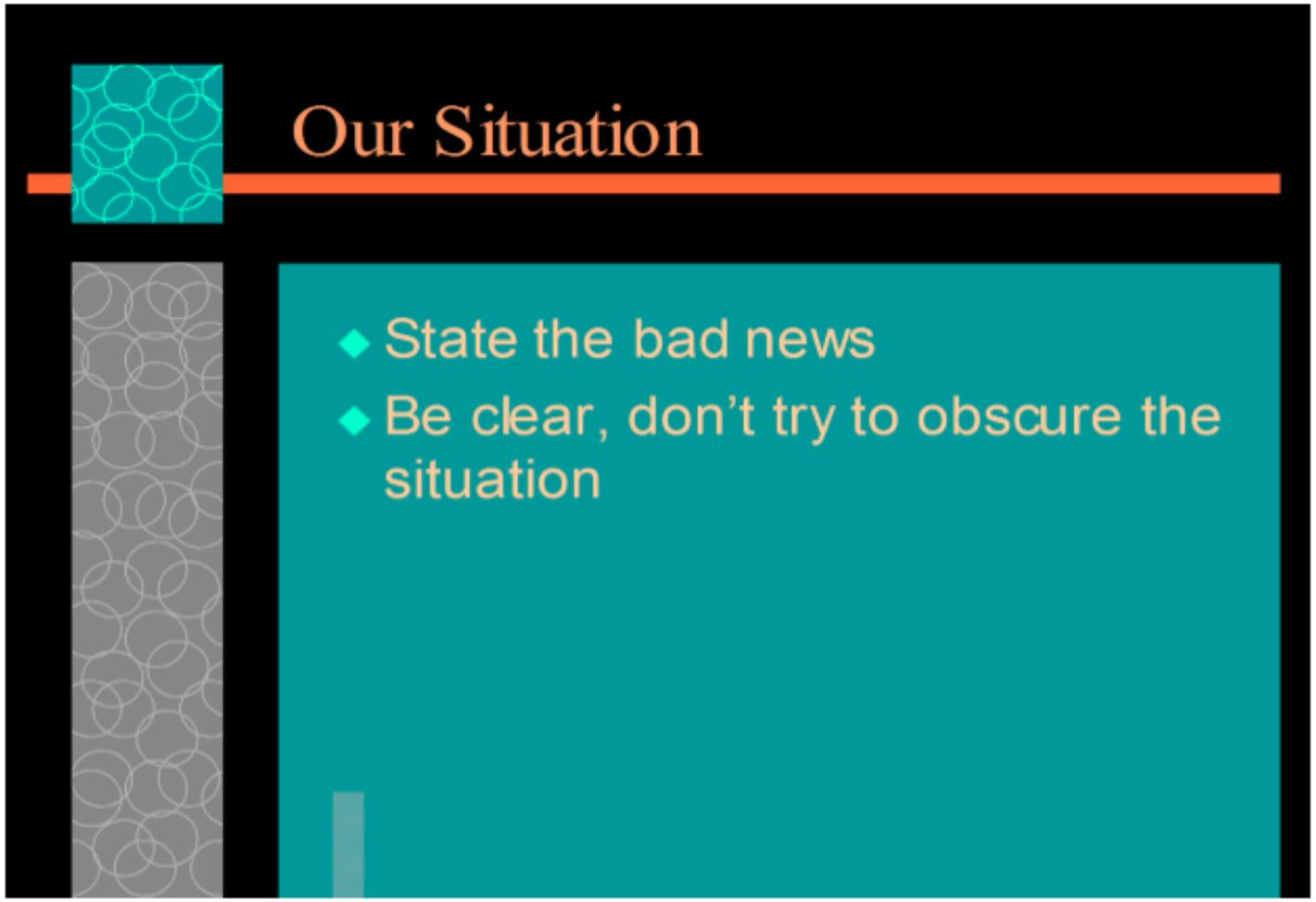
Which one is better to search

Pennsylvania
Bedford Motel/Hotel: Crinaline Courts
(814) 623-9511 S: $18 D: $20
Bedford Motel/Hotel: Holiday Inn
(814) 623-9006 S: $29 D: $36
Bedford Motel/Hotel: Midway
(814) 623-8107 S: $21 D: $26
Bedford Motel/Hotel: Penn Manor
(814) 623-8177 S: $19 D: $25
Bedford Motel/Hotel: Quality Inn
(814) 623-5189 S: $23 D: $28
Bedford Motel/Hotel: Terrace
(814) 623-5111 S: $22 D: $24
Bradley Motel/Hotel: De Soto
(814) 362-3567 S: $20 D: $24
Bradley Motel/Hotel: Holiday House
(814) 362-4511 S: $22 D: $25
Bradley Motel/Hotel: Holiday Inn
(814) 362-4501 S: $32 D: $40
Breezewood Motel/Hotel: Best Western Plaza
(814) 735-4352 S: $20 D: $27
Breezewood Motel/Hotel: Motel 70
(814) 735-4385 S: $16 D: $18

South Carolina

City	Motel/Hotel	Area code	Phone	Rates Single	Double
Charleston	Best Western	803	747-0961	$26	$30
Charleston	Days Inn	803	881-1000	$18	$24
Charleston	Holiday Inn N	803	744-1621	$36	$46
Charleston	Holiday Inn SW	803	556-7100	$33	$47
Charleston	Howard Johnsons	803	524-4148	$31	$36
Charleston	Ramada Inn	803	774-8281	$33	$40
Charleston	Sheraton Inn	803	744-2401	$34	$42
Columbia	Best Western	803	796-9400	$29	$34
Columbia	Carolina Inn	803	799-8200	$42	$48
Columbia	Days Inn	803	736-0000	$23	$27
Columbia	Holiday Inn NW	803	794-9440	$32	$39
Columbia	Howard Johnsons	803	772-7200	$25	$27
Columbia	Quality Inn	803	772-0270	$34	$41
Columbia	Ramada Inn	803	796-2700	$36	$44
Columbia	Vagabond Inn	803	796-6240	$27	$30

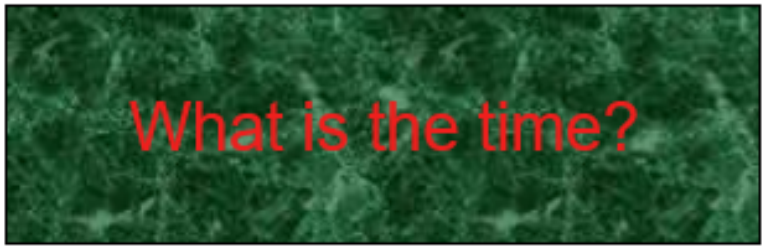
over-use of graphics



Good designs

- Enables the user to make predictions
- Pay attention to:
  - layout, color, icons, graphics,
- Characters, symbols, graphical elements should be easily noticeable.
- Readily perceivable
  - Text should be legible
  - Icons should be easy to distinguish and read

Which is easiest to read and why?



What is the time?

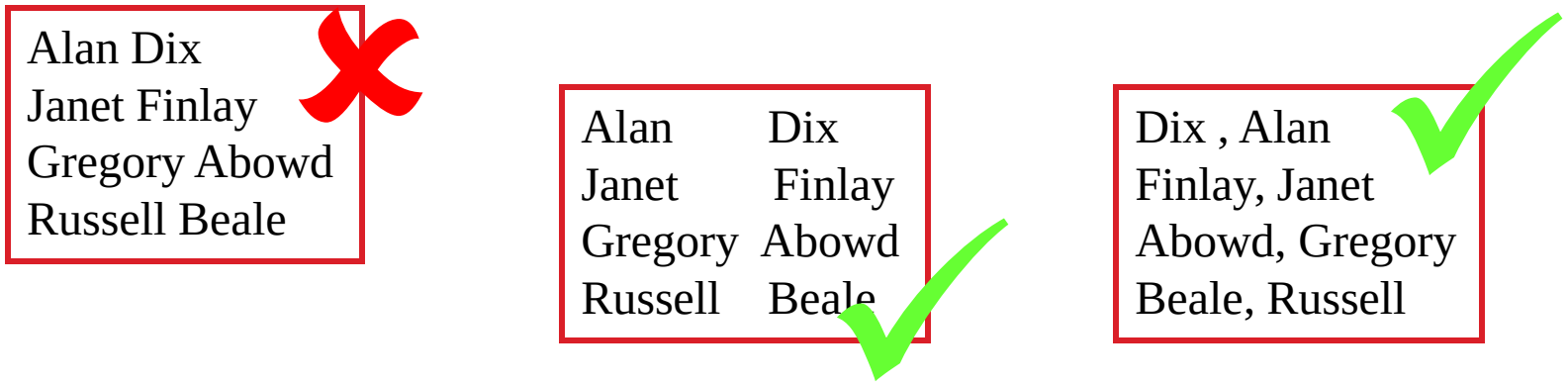
What is the time?

What is the time?

What is the time?

Good designs…

- Alignments
  - make it easy!



Good designs…

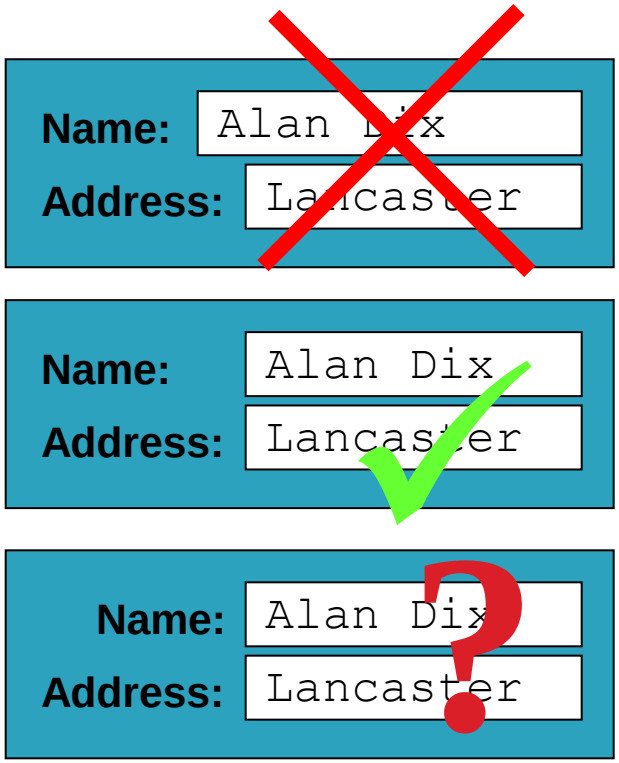
- Use leader or greying

orange	75
toffee	120
chocolate	35
fruit gums	27
coconut dreams	85

Orange	75
toffee	120
chocolate	35
fruit gums	27
coconut dreams	85

Good designs…

- Entering information: forms, dialogue boxes
  - ✓ Different label lengths
  - ✓ Similar layout issues
  - ✓ Alignment



Good designs…

- Avoid using of too many bright colours
- Avoid poorly designed icons
- Avoid bad error messages
  - Explain why and how the user can fix the problem
- Don’t ask for the same information twice
- Don’t crowd controls together
- Reduce visual work
- Reduce memory work also

Good designs…

- Avoid tiny click targets

- Avoid long registration forms
- Interface should "**disappear**" – users can focus on their task, not the interface

User interface design principles

- **Recoverability**
  - ✓ The system should provide some resilience to user errors and allow the user to recover from errors. This might include an undo facility, confirmation of destructive actions, 'soft' deletes, etc.
- **User guidance**
  - ✓ Some user guidance such as help systems, on-line manuals, etc. should be supplied.
- **User diversity**
  - ✓ Interaction facilities for different types of user should be supported.

Con...

- Avoid surprise
  - ✓ If a command operates in a known way, the user should be able to predict the operation of comparable commands
- 3-Click rule - user of a website should be able to find any information with no more than three mouse clicks
- Accessibility
- Visibility
- Choices
  - ✓ “Every time you provide an option, you're asking the user to make a decision.” – Joel Spolsky

Ergonomics

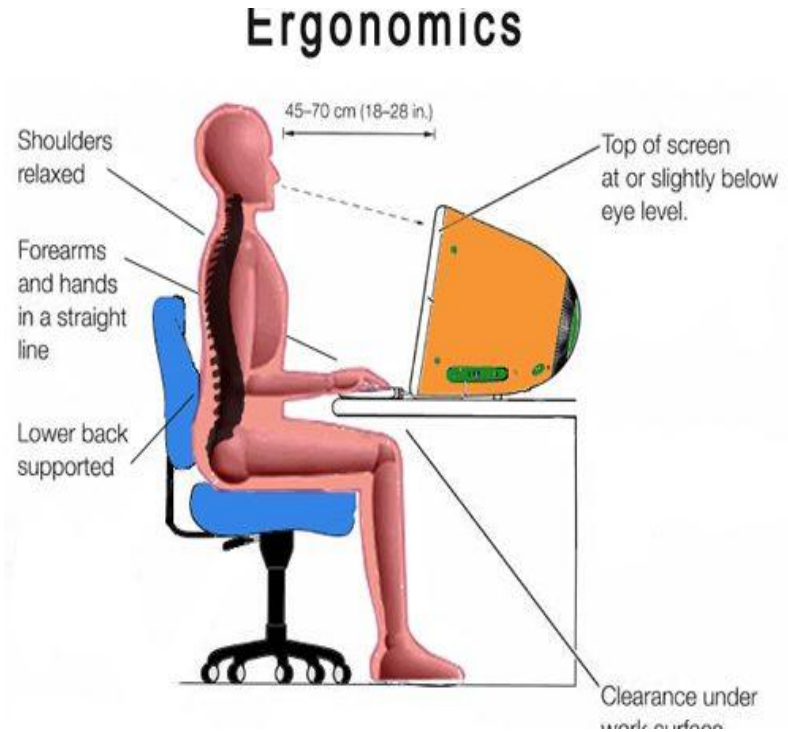
- Ergonomics is defined as the study of how people work in their environment.
- The science of the design of equipment, especially so as to reduce operator fatigue, discomfort and injury
- An example of ergonomics is a study of how people who primarily sit in their offices get work-related back injuries.
- The terms 'ergonomics' and 'human factors' can be used interchangeably
- ergonomics' is often used in relation to the physical aspects of the environment, such as workstations while 'human factors' is often used in relation to wider system in which people work
- Ergonomics include the placement of machines/equipment and components to suit human body measurements and design of seats etc

Ergonomics…

- **Best Examples of Ergonomics in the Workplace**
- Find Your Natural Posture.
- Adjusting Your Keyboard and Mouse.
- Adjusting Your Screens.
- Adjusting Your Chair.
- Don't Sit Around All Day - Stand Up and Move!

Con…


NO


Ergonomics
45–70 cm (18–28 in.)
Shoulders relaxed
Top of screen at or slightly below eye level.
Forearms and hands in a straight line
Lower back supported
Clearance under

Advantage of Ergonomics

- When you feel comfortable, you can focus better on the task at hand.
- Ergonomics **decreases pain, strengthens muscles, and increases blood flow**.
- Combined, this improves mental insight.
- You and your employees will experience less concern,
- increased awareness, focus

Thanks....