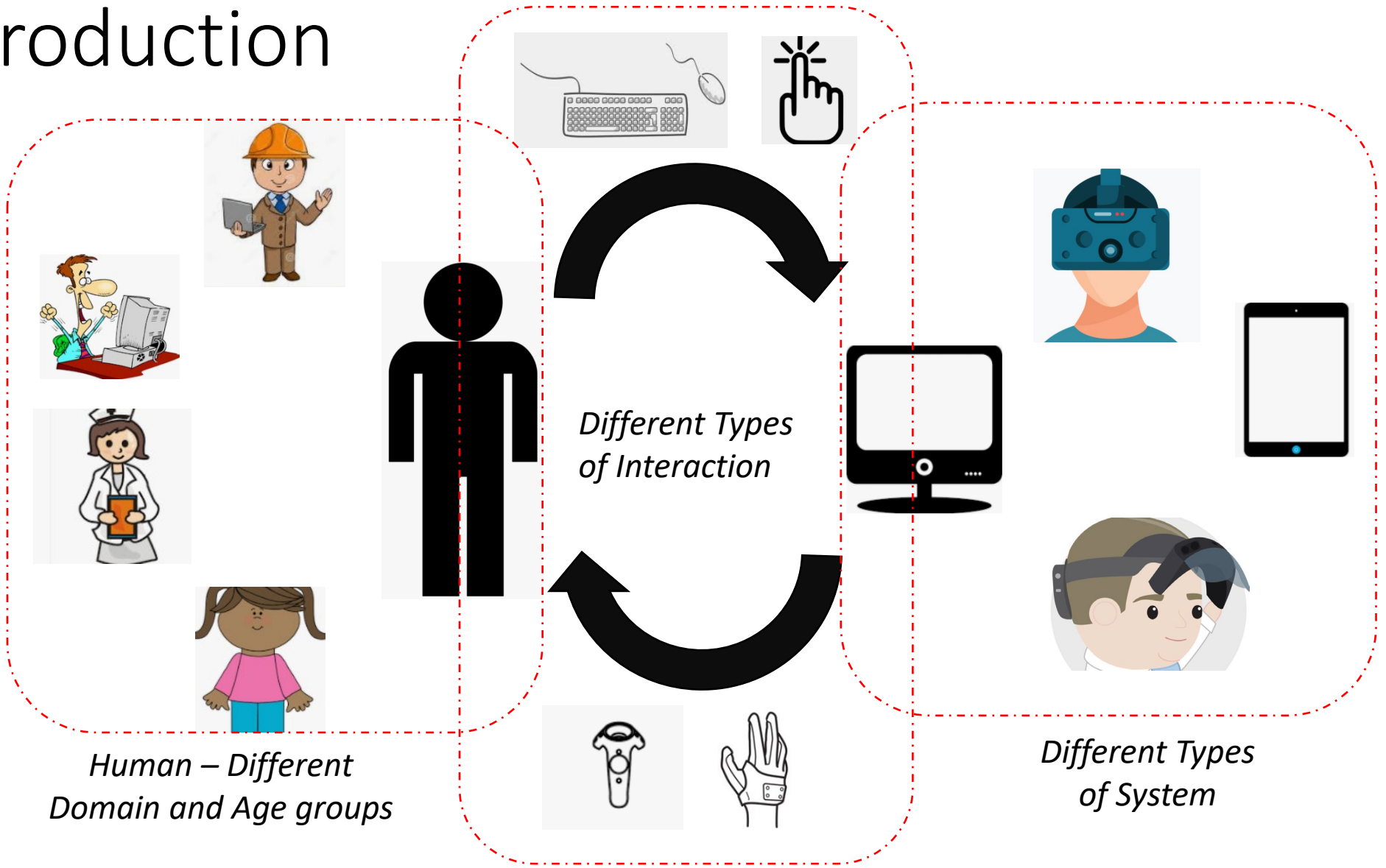
# Introduction to Human Computer Interaction (HCI)

# Outline

- Introduction
- Principles
- Criteria
- Benefits

# Introduction

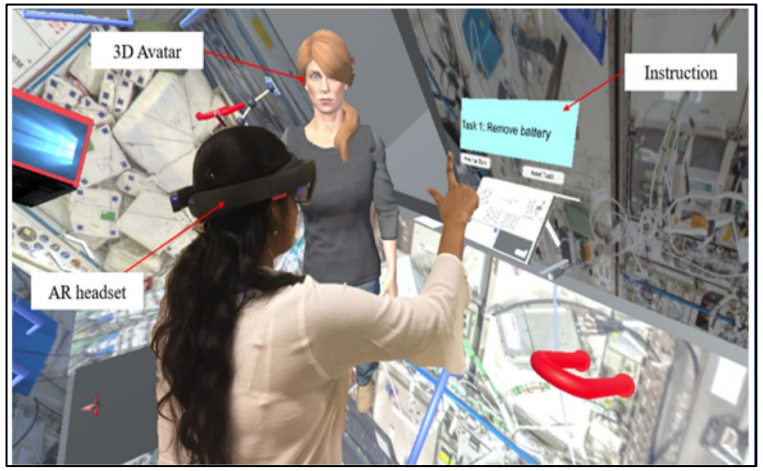


# Introduction

- According to Association for Computing Machinery (ACM) defines
- A discipline concerned with the
  - Design
  - Evaluation
  - Implementation of interactive computing systems
- For human use and with the study of major phenomena surrounding them
- An important facet of HCI is user satisfaction

# Human Interactions with Computers

# Human Interactions with VR/AR


# Principles of HCI

- Early Focus on Users and Tasks
- Empirical Measurement
- Iterative Design

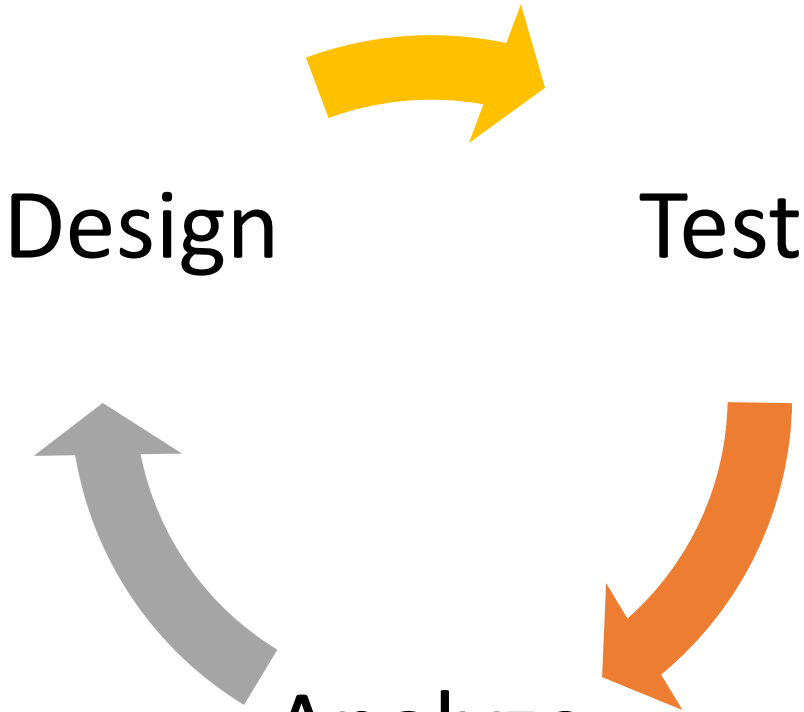
# Early Focus on Users and Tasks

- Determine the Users – who will interact with the systems?
- Determine the Tasks – what will the users do?
- Involve Users in Design – Participatory Design Approach!
- A democratic design process for the design of social and technological systems
- Based on the argument that users should be involved in the design and all stakeholders should have input during the design process

# Empirical Measurement

- Validation and Testing
  - Interaction with Experts
  - Continuous Feedback and Modifications
- User Assessment
  - Objective Assessment
  - Subjective Surveys

# Iterative Design




Results of Iterative Design Process

# Discuss with your group

- Your group have been awarded a project to create AR based training environments for NASA astronauts
- How would you apply HCI principles during the design and development of Project?
- Discuss based on the principles
  - Early Focus on Users and Task
  - Empirical Measurement
  - Iterative Design

# HCI Criteria

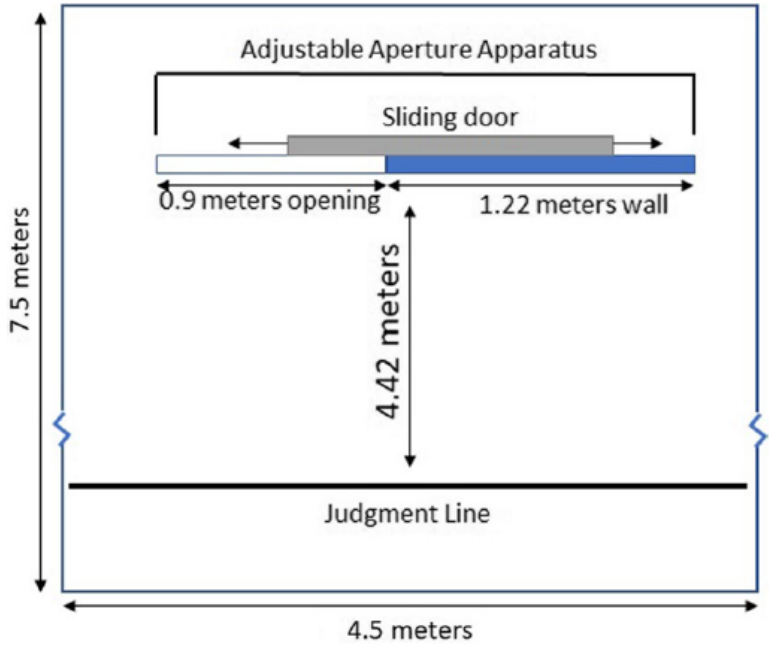
- Affordance
- Visual Density
- Cognitive Load
- Usability

# Affordance

- Gibson defined affordance as ‘what the environment offers to the individual’
- In the context of HCI, the term affordance was defined by Norman as action possibilities that are perceivable readily by an actor
- Gaver delineated affordances as the properties of the world which are defined with respect to how people interact with them
- Understanding the relationship between affordances of the environment and comprehension becomes critical

# Affordance

- Types of Affordance
  - Spatial Affordance
    - Pass through different widths and distances between virtual poles/door
    - Influence of person and environmental properties in the perception of standing on virtual grounds
    - Ability to step across the gaps in VR/AR
  - Learning Affordance
    - Ability of the system to influence learning on users



# Functional Process Affordance (FPA)

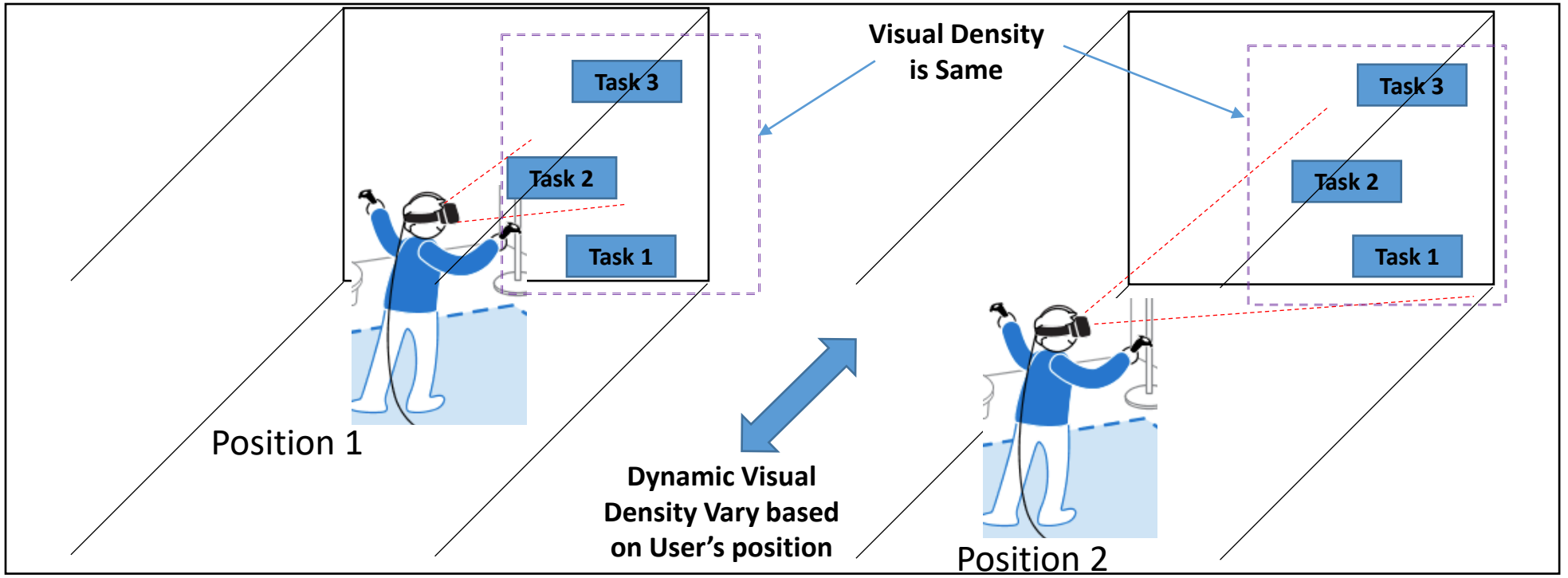
- Defined as a function of comprehension of functional relationship of a scene by a user
  - inside a virtual 3D environment
  - moving along a specific path P (within that target 3D environment)
  - over a fixed period of time (T)
- FPA = f (P, ΔT)

# Visual Density

- In the terms of 2D user interface components, visual density is defined as the vertical and horizontal compactness of the components in the UI
- In the context of 3D VR environments, visual density refers to the number of objects per cubic unit of the environment
- Focus on understanding the impact of visual density on affordance of a VR environment

# Visual Density and Affordance

- Visual Density can be dynamic based on position of the user in a scene
- Understanding the effect of Visual Density when user is positioned at different locations in a scene

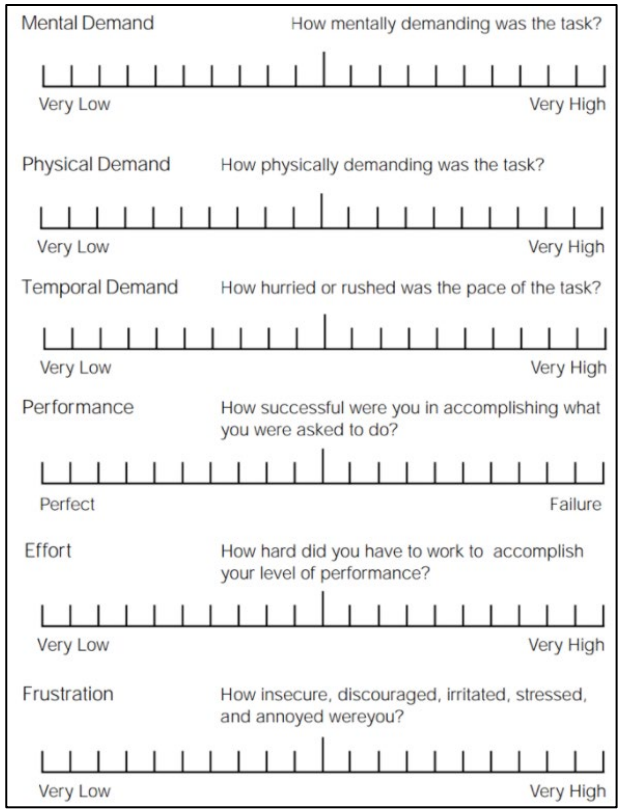


# Cognitive Load

- Cognitive load refers to the working memory load utilized by a user when performing a particular task
- Crucial factor - In learning complex tasks such as flying airplanes and performing surgery
- Important that the user is not cognitively overloaded

# Measuring Cognitive Load

- Subjective Assessment
  - NASA TLX test
  - Paas Scale




*In solving or studying the preceding problem I invested*

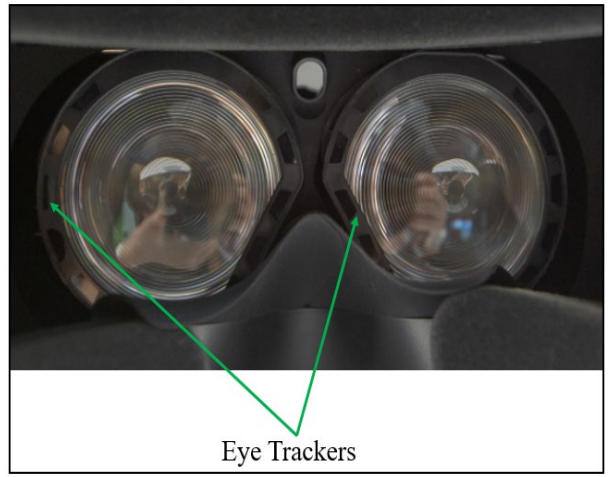
1. very, very low mental effort
2. very low mental effort
3. low mental effort
4. rather low mental effort
5. neither low nor high mental effort
6. rather high mental effort
7. high mental effort
8. very high mental effort
9. very, very high mental effort

# Measuring Cognitive Load

- Objective Assessment
  - Dual Task Measures
    - Primary and Secondary Tasks
  - Physiological indices
    - pupil dilation
    - eye movement and gaze
    - facial expression
    - Heart rate
    - Electroencephalography (EEG)

Primary Task – Task for which the system is designed
Eg: VR based Surgical Training

Secondary Task – Designed to measure Load
Eg: Pressing a button, Responding to a sound

# Usability

- Capacity of a system to provide its users condition to perform tasks
  - Safely
  - Effectively
  - Efficiently
  - with Satisfaction
- Measurement of Usability
  - Success rate
  - Time a task required
  - Error rate
  - Users’ subjective satisfaction

| Acronym | Instrument | Reference | Institution | Example |
|---|---|---|---|---|
| QUIS | Questionnaire for User Interface Satisfaction | Chin *et al*, 1988 | Maryland | 27 questions |
| PUEU | Perceived Usefulness and Ease of Use | Davis, 1989 | IBM | 12 questions |
| NAU | Nielsen's Attributes of Usability | Nielsen, 1993 | Bellcore | 5 attributes |
| NHE | Nielsen's Heuristic Evaluation | Nielsen, 1993 | Bellcore | 10 heuristics |
| CSUQ | Computer System Usability Questionnaire | Lewis, 1995 | IBM | 19 questions |
| ASQ | After Scenario Questionnaire | Lewis, 1995 | IBM | 3 questions |
| PHUE | Practical Heuristics for Usability Evaluation | Perlman, 1997 | OSU | 13 heuristics |
| PUTQ | Purdue Usability Testing Questionnaire | Lin *et al*, 1997 | Purdue | 100 questions |
| USE | USE Questionnaire | Lund, 2001 | Sapient | 30 questions |

# Benefits

- Effective and Efficient environments
- Design of user friendly environments
- User centric design