Unit III
Human Computer Interaction

To enable human to effectively interact with devices to perform tasks and to support activities, system need to be useful and to be usable

Basic Concept of HCI

- **Human:** single or multiple users, with diverse physical and mental abilities, interacting cooperatively or competitively.
- **Computer:** not just PCs but also a range of embedded computing devices and a range of device sizes such as dust, tabs, pads and boards.
- **Interaction:** may be directed via a command or by manipulating virtual objects(windows, desktop)but it can also involve more natural interaction such as speech interaction, gestures, etc

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- **Useful:** accomplish a user task that the user require to be done
- **Usable:** do the task easily, naturally, safely(without danger of error), etc
- **Used:** enrich the user experience by making it attractive, engaging, fun, etc.
- **Explicit HCI :** is complex for UbiCom scenarios even if it is well designed for individual device
- Because it used by different types of people, engaged in multiple concurrent activities, activities may be shared between participant

Implicit HCI: Motivation and Characteristics

- The concept of implicit HCI(iHCI),defined as ‘an action, performed by the user that is not primarily aimed to interact with a computerized system but which such a system understands as input’
- Implicit interaction is based on the assumption that the computer has a certain understanding of user behavior in a given situation

User Interfaces and Interaction for Four Widely Used Devices

- Four of the most commonly used networked ICT devices are the personal computer in its various forms such as desktop and laptop,
- hand held mobile devices used for communication, games consoles and remote controlled AV displays, players and recorders.

Diversity of ICT Device Interaction

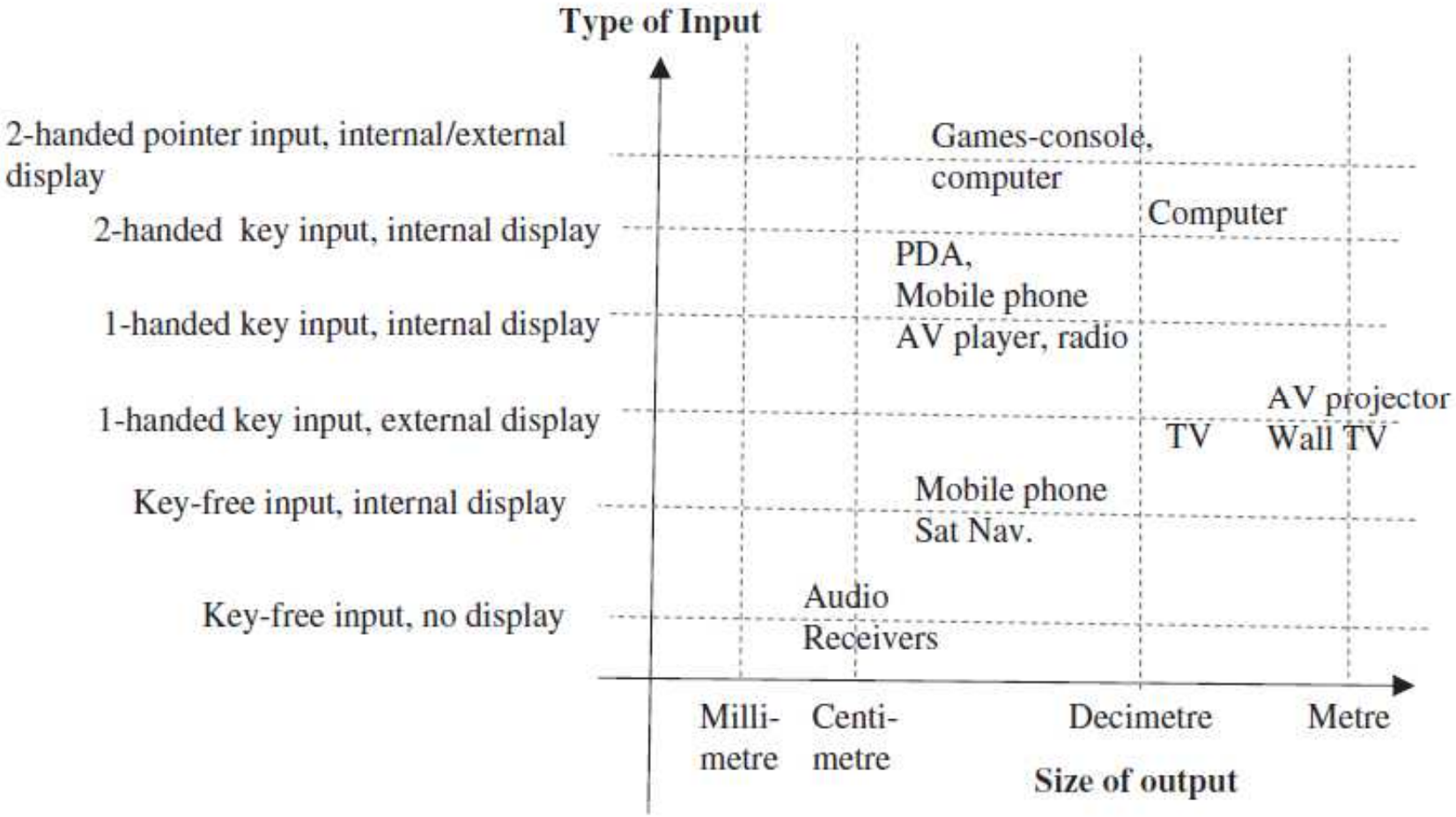

Figure 5.1 The range of ICT device sizes in common use in the 2000s

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- The term computer in the acronym HCI has a much more diverse meaning within the field of UbiCom.
- It refers to any device with a programmable IC chip inside, including a range of multi task operating system (MTOS) devices.
- Common multi task devices include desktop and laptops PCs, mobile phones, games consoles, AV recorders and players such as televisions, radios and cameras.

There are several dimensions devices could be characterized

- **size:** hand sized, centimetre sized, decimetre sized versus micro sized versus body sized or larger;
- **haptic input:** two handed versus one handed versus hands free operation;
- **interaction modalités:** single versus multiple;
- **single user versus shared interaction:** in personal space, friends' space or public space;.
- **posture for human operator:** lying, sitting, standing, walking, running, etc.;
- **distance of output display to input control:** centimetres to metres;

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- **position during operation:** fixed versus mobile;
- **connectivity:** stand alone versus networked, wired versus wireless;
- **tasking:** single task devices versus multi task devices;
- **multimedia content access:** voice and text communication oriented, alpha numeric data or text oriented, AV content access;
- **integrated:** embedded integrated devices versus dynamically interoperable devices

Mobile Hand-Held Device Interfaces

- Handling Limited Key Input: Multi-Tap, T9, Fastap, Soft keys and Soft Keyboard
- Handling Limited Output: There are multiple techniques for overcoming limited output.
- If content is too large, it can simply be cropped or the content resolution can be reduced or a zooming interface can be used.
- Games Console Interfaces and Interaction
- Localized Remote Control: Video Devices

Hidden UI Via Basic Smart Devices

- PCs is considered by many computer scientists to be obtrusive in the sense that it requires users to consciously think about how to operate a mouse pointer interface and which keys to press to use the computer
- The computer itself is localized and users must go to its location to use it.
- Now support more natural inputs and interaction such as touch sensitivity, gestures to control the display and speech input control.
- E.g. The projector itself can now be quite small but it is the screen itself that users interact with and this is much larger.
- E.g. Current cars often uses a remote control to lock and unlock it.
- Multi-Modal Visual Interfaces
- Gesture Interfaces

Gesture Interfaces

- Gestures are expressive, meaningful body motions involving physical movements of the fingers, hands, arms, head, face, or body, with the intent of conveying meaningful information about interacting with the environment.

- There are three main types of body gestures: hand and arm gestures, head and face gesture and full body movement

- Gestures can be sensed using: wearable devices such as gloves or body suits; by attaching sensors such as various magnetic field trackers, accelerometers and gyroscopes to the surface of the body; by using cameras and computer vision techniques.

- Flipping can be used to rotate a view by 90 degrees from horizontal to vertical.

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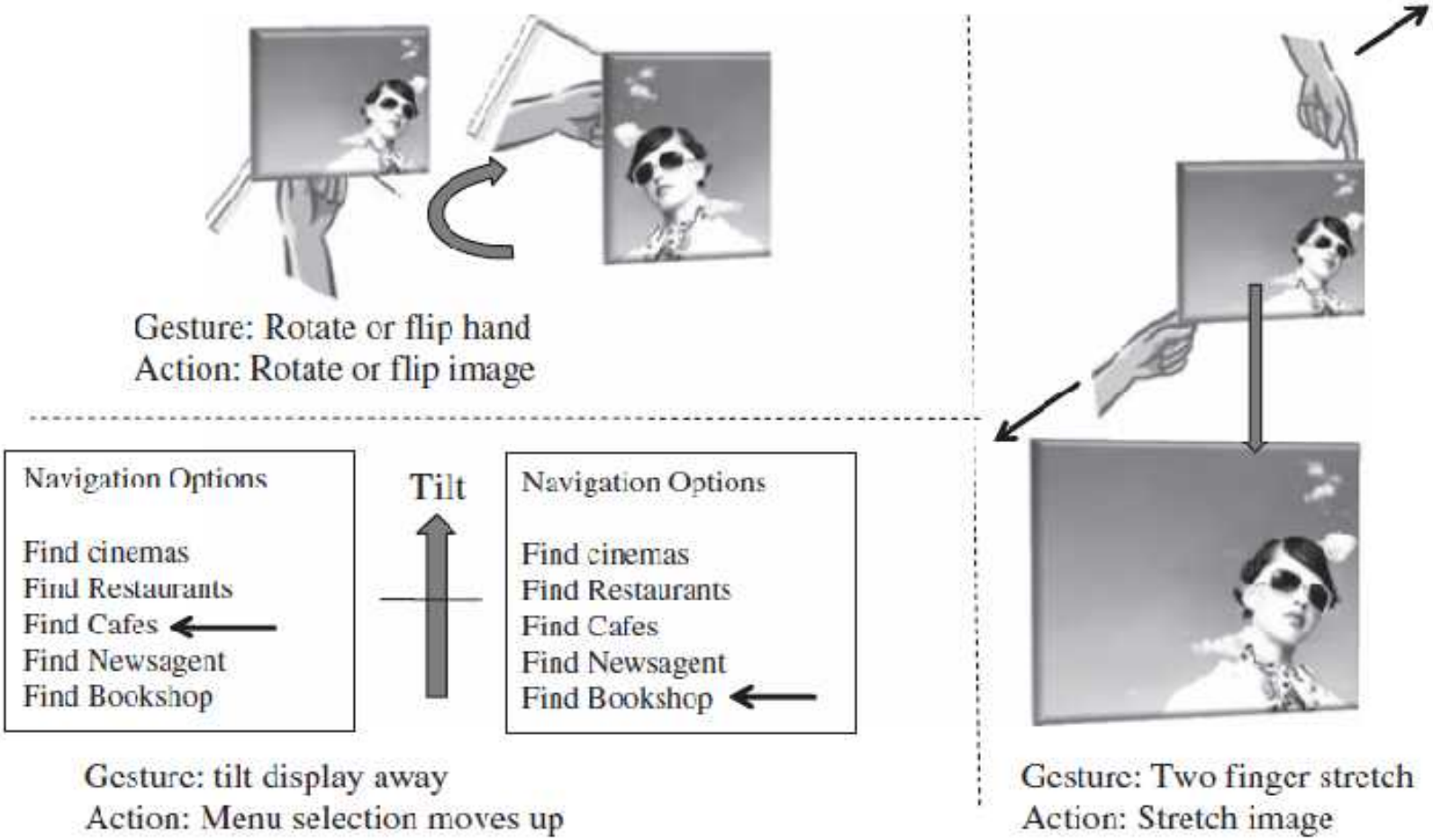

Figure 5.2 Use of rotate, tilt and stretch gestures to control a display

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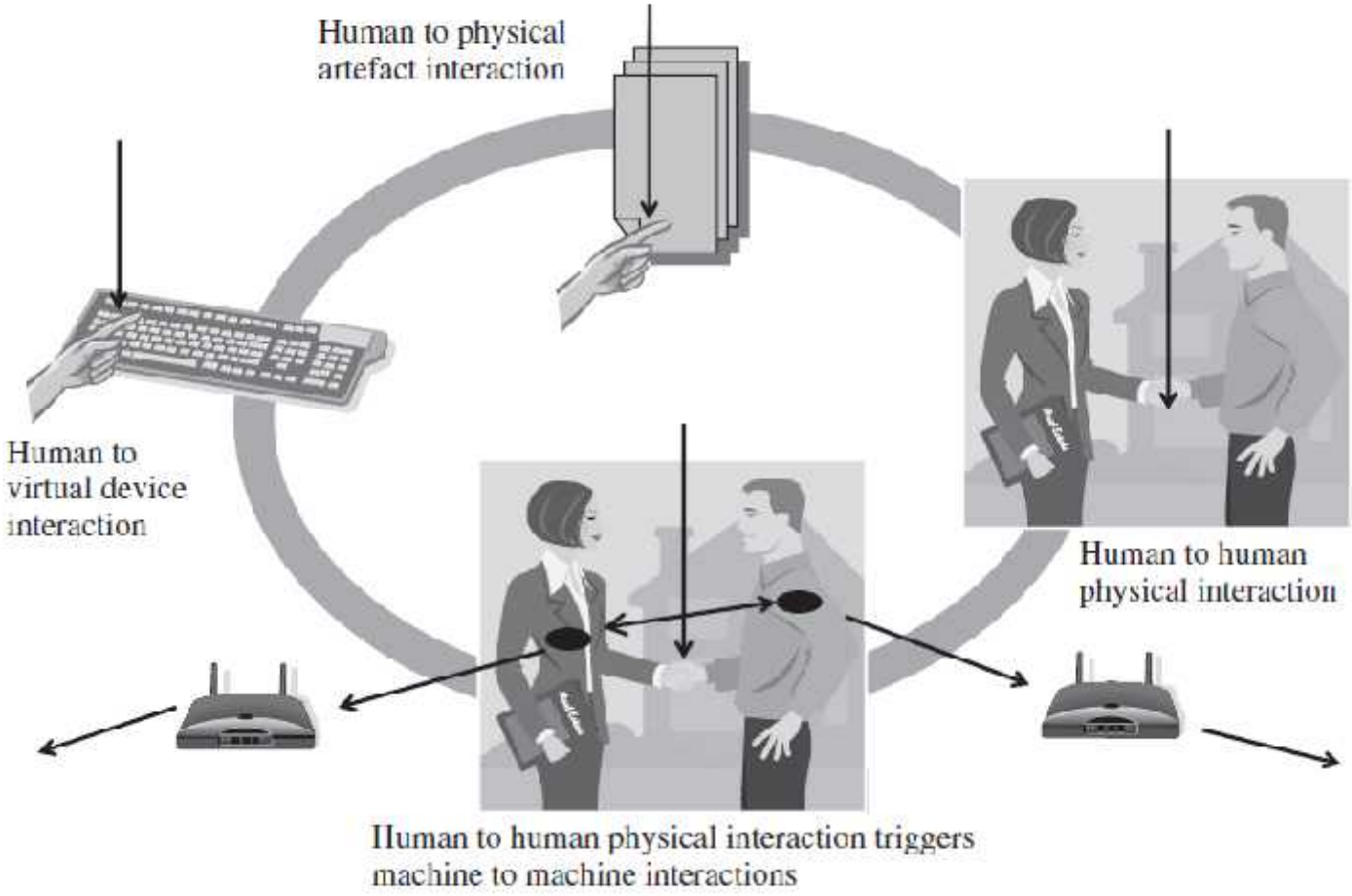

Figure 5.3 Human to virtual device interaction, human to physical device interaction, human to human physical interaction, which can in turn trigger human to virtual device interaction

Reflective Versus Active Displays

- **Ebooks** are light weight, thin, long lasting powered, pocket sized devices with touch screens enabling pages to be turned by touch.
- A key difference between computer displays and ebooks is the type of display used.
- Ebook screens are designed to be more like paper, reflecting rather than transmitting light, requiring no energy to reflect light, to be readable in direct sunlight and equally viewable from any angle.
- The current material of choice to realise ebooks is based upon **Electrophoretic Displays or EPDs**
- EPDs are **reflective displays** using the electrophoretic phenomenon of charged particles suspended in a solvent
- EPD particles are actually contained in thousands of microcapsules deposited onto a substrate.
- Microcapsules contain negatively charged black particles and positively charged white particles suspended in a clear fluid.

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- When a positive electric field is applied to the bottom of the substrate, the black particles move to the top of the microcapsule, causing that pixel to appear black and when a negative field is applied, the pixels move to the top and that appears white.

- Microcapsules are designed to be bi stable. Once the field has been applied to attract the particles to form black or white areas on the substrate, it can be removed.

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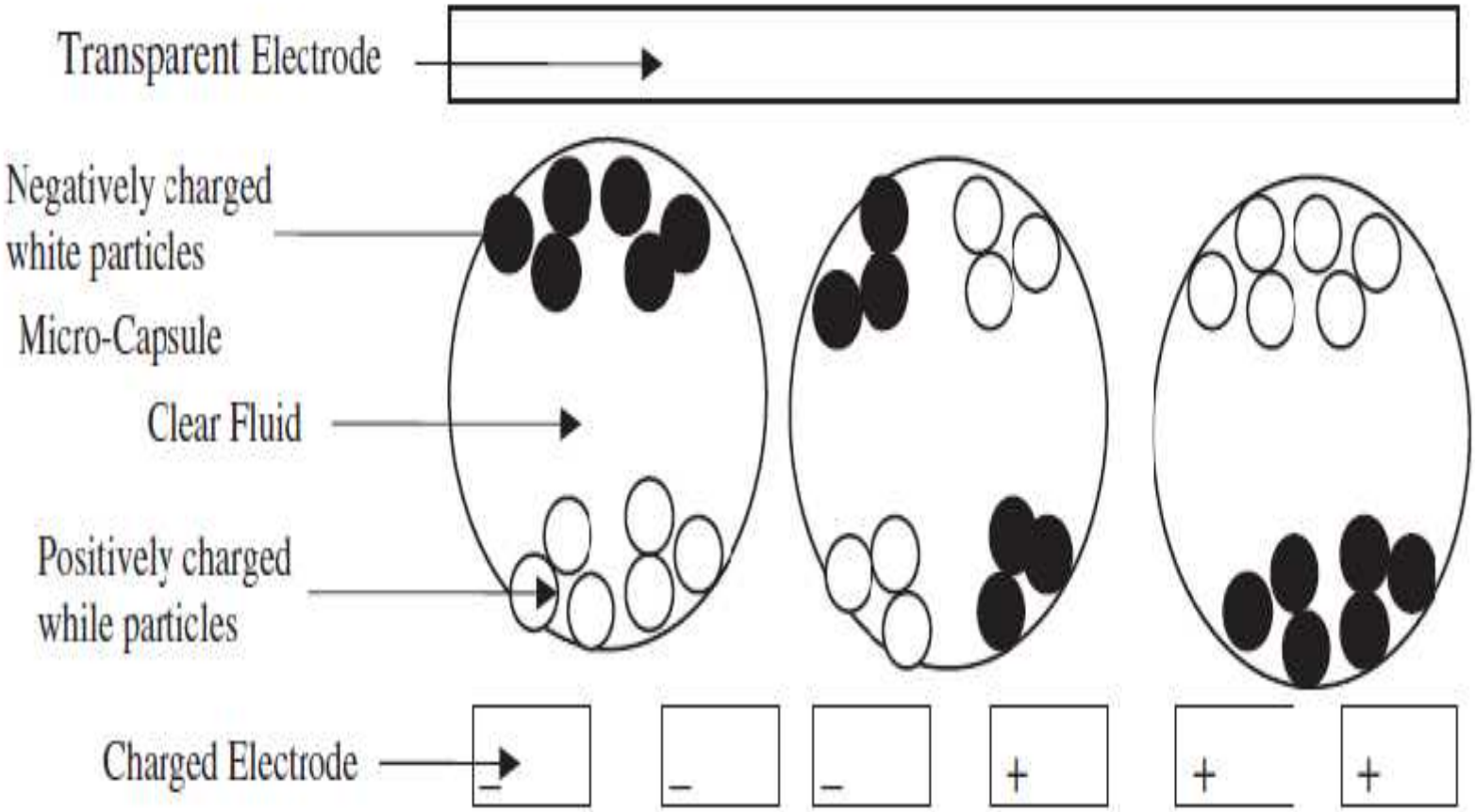

Figure 5.4 Electrophoretic displays are reflective type displays using the electrophoretic phenomenon of charged particles suspended in a solvent

Combining Input and Output User Interfaces

- **Touch screens :**One of the earliest combinations of user input and output devices is the touch screen where the user can touch the display in order to activate a selection on the screen.
- **Tangible Interfaces :Is** a user interface in which a person interact with digital information through the physical environment.
- **Organic Interfaces :** the terms organic and organic interaction for such interfaces, because they more closely resemble natural human physical and human interaction such as shaking hands and gesturing.
- **Organic Light Emitting Diode (OLED) displays :** are based on organic polymer molecules that compose emissive and conductive layers of the display structure melded together through a form of printing
- **OLED displays** have several benefits compared to LCDs. OLED displays do not require backlighting (saving power)

- **Auditory Interfaces:** Auditory interfaces have the benefit of supporting hands free input and output which can be used as an additional interaction modality when the visual senses are already being consciously used.
- **Natural Language Interfaces:** Generally, interaction can be more easily processed and understood if it is defined using an expressive language that has a well defined syntax or grammar and semantics but this requires that users already know the syntax
- **Assuming users** have been educated to read and write, users could use the languages they already use to converse with each other to converse with machine, i.e., **use a natural language interface (NLI),**
- **Natural language commands can be given in three forms:** it can be **typed,** it can be **hand written** and it can be **spoken.** The latter two forms require additional pre processing to transform handwriting to text and speech to text respectively.

Hidden UI Via Wearable and Implanted Devices

- **Posthuman Technology Model:** can be used to extend a person's normal conscious experience and sense of presence, across space and time.
- **Virtual Reality and Augmented Reality:** Most computers currently present visual information in two dimensions,
- **Although simple three dimensional** or 3D effects can be created by using shadows, object occlusion and perspective. These are an important element of games consoles which heightens user satisfaction in the main group of users.
- **Virtual reality** seeks to immerse a physical user in a virtual 3D world whereas **augmented reality** seeks to make interaction in the physical world more virtual by digitally enabling relevant objects in the real world
- **Both virtual reality and augmented** reality seek to enable humans to interact using a more natural interaction than humans use in the real world such as using voice and gestures, rather than using the keyboard mouse interface of the PC.

Wearable Computer Interaction

- The essence of wearable computing is to embed computers into anything that we normally use to cover or accessories our bodies.

- This includes clothes, jewellery, watches, eye wear, teeth wear, ear wear, headwear, footwear, and any other device that we can comfortably attach to our bodies and allow to behave as hidden computers.

- Head(s)-Up Display (HUD)
- Eyetap
- Virtual Retinal Display (VRD)
- Clothes as Computers

Computer Implants and Brain Computer Interfaces

- This represents the **ultimate natural interface**, **thought control** instead of motor control of devices.

- Brain Computer Interfaces (BCI) or Brain Machine Interfaces (BMI), in contrast to Human Machine Interfaces or Human Computer Interfaces which support **indirect interfaces from the human brain via human actuators**

- i.e., haptic interfaces and machine sensors, are direct functional interfaces between brains and machines such as computers and robotic limbs.

Human-Centred Design (HCD)

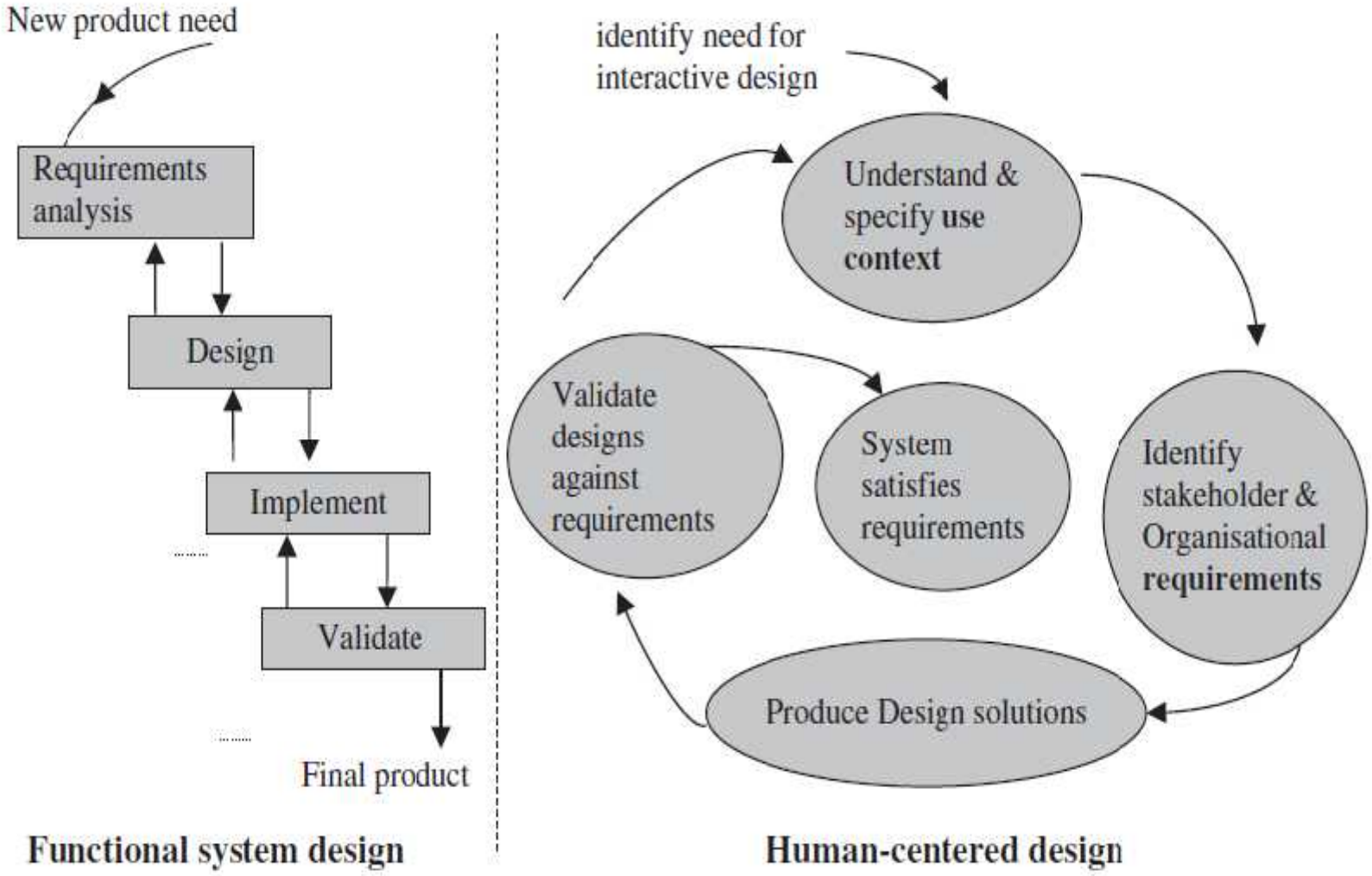

Figure 5.5 Comparison of a conventional functional system design approach with a human centred design approach

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- Human-Centred Design Life-Cycle
- Methods to Acquire User Input and to Build Used Models:
- Direct interaction techniques
- Inspection or heuristic (discovery)evaluation
- Cognitive walk through : is a usability evaluation method in which one or more evaluators work through a series of tasks and ask a set of questions from the perspective of the user to understand the system's learn ability for new or infrequent users.
- Observing
- Predictive models

Defining the Human Environment Use Context and Requirements

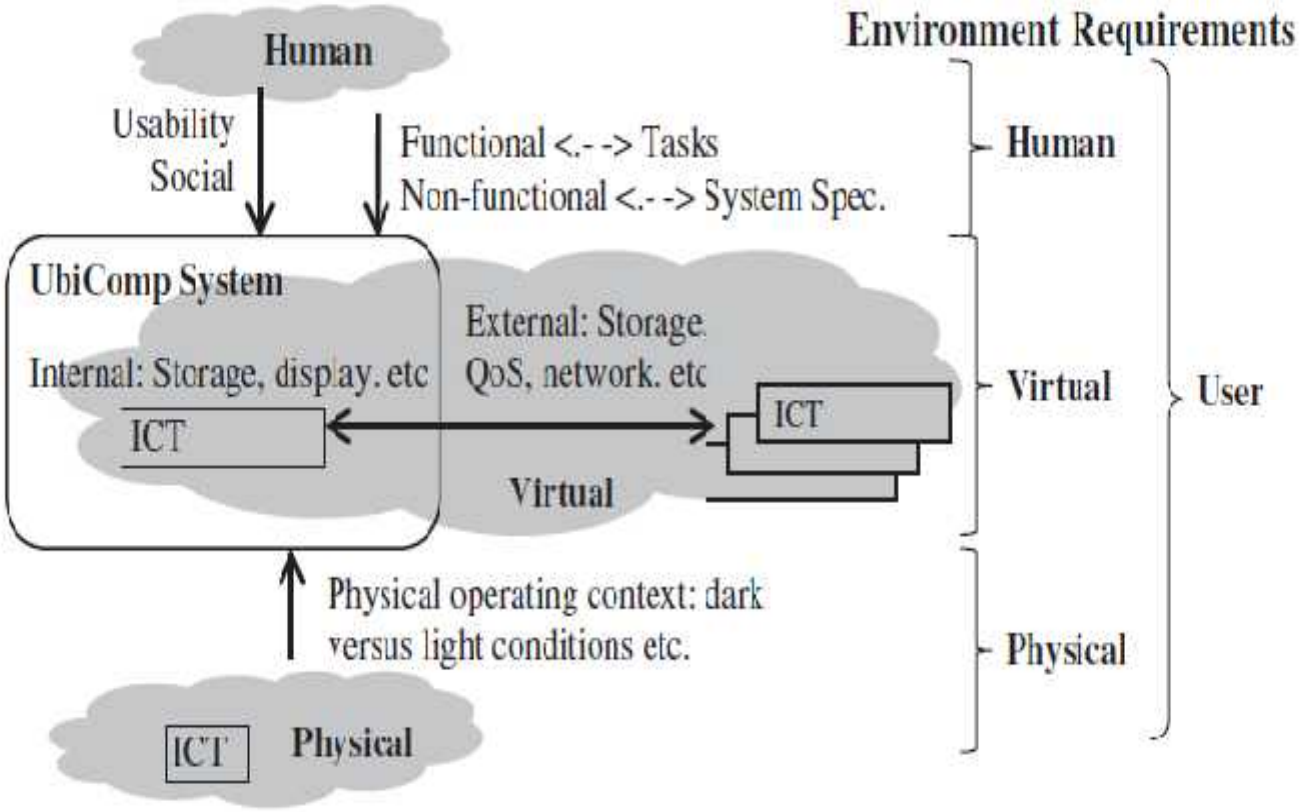

Figure 5.6 Requirements for interactive design considers a wider set of requirements beyond functional and non functional requirements

User Models: Acquisition and Representation

- User context models can be viewed from two perspectives: **users models of systems** and **systems models of users.**
- Users have a (mental) model of the UbiCom system, of how the user understands how the system works, to facilitate their eHCI interaction with it
- Implicit vs. explicit models
- User instance (individual) modelling versus user (stereo)type modelling
- Static versus dynamic user models
- Generic versus application specific models, Content based versus collaborative user models

- Indirect User Input and Modeling
- Direct User Input and Modeling
- User Stereotypes
- Modelling Users' Planned Tasks and Goals

Modeling Users' Planned Tasks and Goals

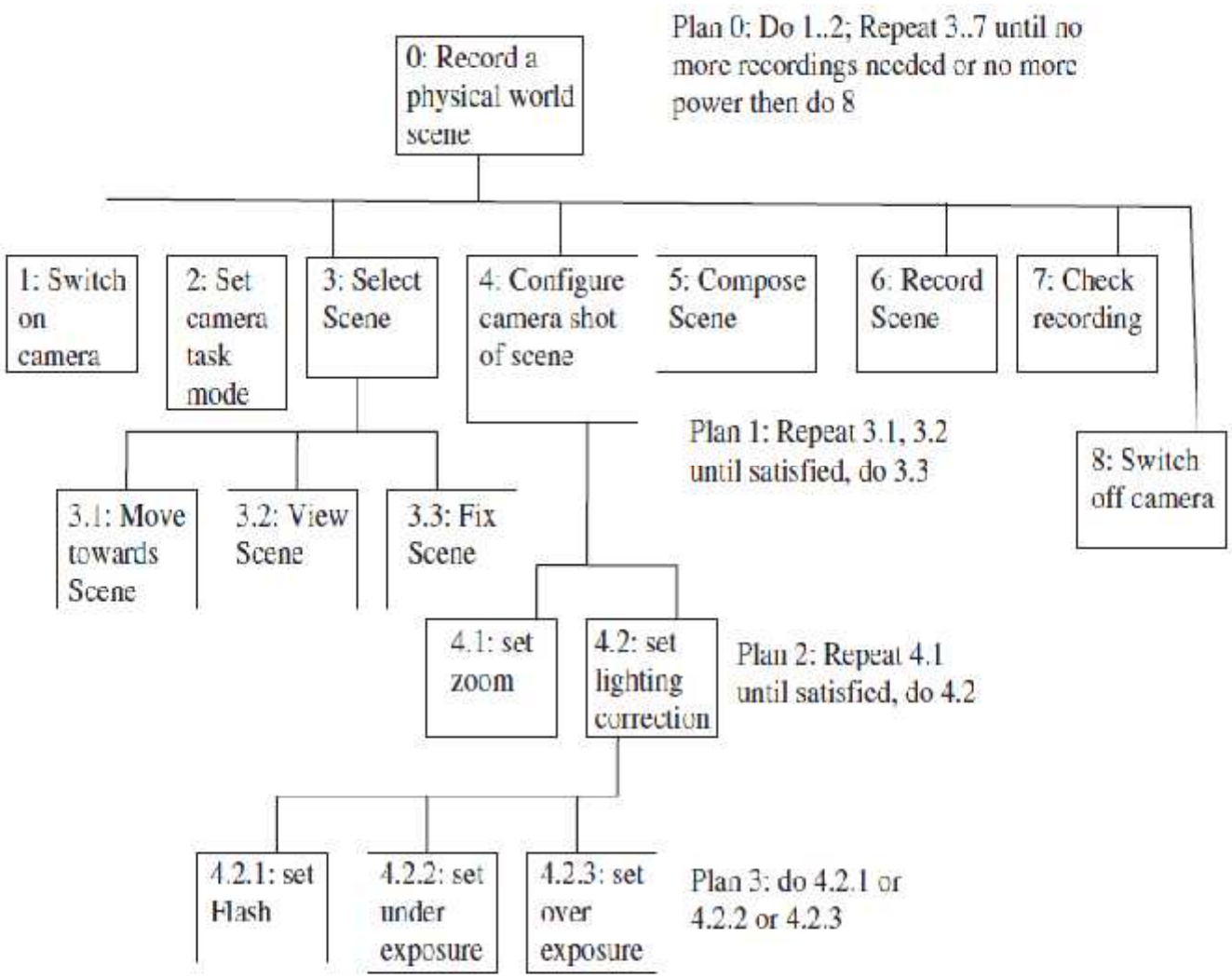

Figure 5.7 A Hierarchical Task Analysis (HTA) model for part of the record physical world scene from the PVM scenario in Section 1.1.1

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- Users usually interact purposely with a system in a **task driven way**, to achieve a particular goal.
- There are several ways to analyze and model user tasks.
- Hierarchical Task Analysis or HTA is a technique to decompose a user's goal into a hierarchy of actions.

Multiple User Tasks and Activity-Based Computing

- User activities rarely have a clear beginning or end
- Interruptions are to be expected
- Multiple activities operate concurrently
- Contexts such as time are useful for filtering and adaptation
- Associative models of information are needed
- Situation Action Versus Planned Action Models

iHCI Design

iHCI Model Characteristics

- **Natural (human computer) interaction** can use a wide variety of physical artifacts, situated throughout the physical world, implicitly linked to virtual computer artifact interaction.
- **User models** can be used to anticipate user behavior based upon: * models of past individual user interaction which can be used to anticipate future user behavior.
- models of individual user interaction may be grouped into stereotypes of users to anticipate
- user behavior based upon the group the individual belongs to.
- **User context awareness**.

User Context-Awareness

- User context awareness can be exploited to beneficially lessen the degree of explicit HCI needed.
- The user context awareness and context adaptation can range from passive to active modes.
- In a passive mode, the system provides shortlists of tasks and their user constraints which are relevant to the current situation.
- In the active modes, the system performs the adaptation, e.g., it automates the remainder of a task and lessens users' involvement in the completion of the task.
- Users' contexts specify any physical, ICT and human environment context constraints in relation to a user task goal, e.g., to watch a movie.
- A user context can include the following properties:

A user context can include the following properties:

- Users' physical characteristics and capabilities for HCI e.g., how easy they find interacting with a particular type of UI such as a pointing device.
- User presence in a locality or some detected activity within some application context.
- User identity
- User planned tasks and goals
- Users' activity situated tasks, which may be spontaneous and unplanned, may be concurrent, may involve composite tasks and may be spread across multiple devices
- User emotional state (Section 5.7.5), e.g., repeatedly, pressing a key may indicate impatience.

More Intuitive and Customized Interaction

- MTOS based devices tend to use a desktop UI metaphor coupled with the use of a filename as an index to organize information.
- In order to start work on documents, users must remember how they categorised their documents in terms of the name of files and the name of folders and the devices they stored the files in.
- There are several limitations to this approach. Information does not neatly fall into a category as categories overlap and are fuzzy
- Moran and Zhai (2007) present a wider analysis of surveyed approaches to support more powerful personalised information.

Zhai propose seven principles to develop the desktop information model

- From Office Container to Personal Information Cloud
- From desktop to a diverse set of visual representations
- From interaction with one device to interaction with many
- From mouse and keyboard to greater set of nteractions and modalities
- Functions may move from applications to services
- From personal to interpersonal to group to social
- From low level tasks to higher level activities

Personalization

- Personalization involves tailoring applications and services specifically to an individual's needs, interests, and preferences.
- It can also involve adaptation of a consumer product, electronic or written medium, based on personal details or characteristics provided by or on behalf of a user
- Or consumer in the form of a user profile, e.g., a favorites list for viewing AV content.
- The profile may not necessarily be provided by the user subject but be gathered by observing a user's interactions without their knowledge.
- There are several prominent uses of personalization including targeted marketing, product and service customization, information filtering and personalized customer relationship management (CRM).

Affective Computing: Interactions Using Users' Emotional Context

- One important human trait used in human interaction is the ability to recognize, interpret, process and share human emotions.
- In 1995, Picard at MIT proposed the idea of affective computing that relates to, arises from, or influences emotions.
- Affective computing applications included computer assisted learning, perceptual information retrieval, arts and entertainment, and human health and interaction.
- Emotional responses make a core contribution to human behavior.

Design challenges

- The range of means and modalities of emotion expression is very broad
- People's expression of emotion is so idiosyncratic and variable
- Cognitive models for human emotions are incomplete (little real progress has been made with cognitive modeling)
- The sine qua non of emotion expression is the physical body but computers are not embodied in the same way
- Emotions are ultimately personal and private
- There is no need to contaminate purely logical computers with emotional reactiveness

Design Heuristics and Patterns

- UI design should seek to support a system conceptual model based upon HCI principles which supports good usability and which maps to a clear user's mental model.
- The design heuristics summarized in Table 5.2 can also be used to partially support designs for implicit interaction.
- This is termed partial support for iHCI because support for some characteristics of implicit interaction, such as users' emotional context, users' understanding and physical characteristics have not yet been modeled in terms of design patterns.
- Activities across a multiplicity of devices and applications are supported by the design patterns: safe exploration, satisfying, changes in midstream, deferred choices, incremental construction, habituation or unification, constituted actions and UI proxy

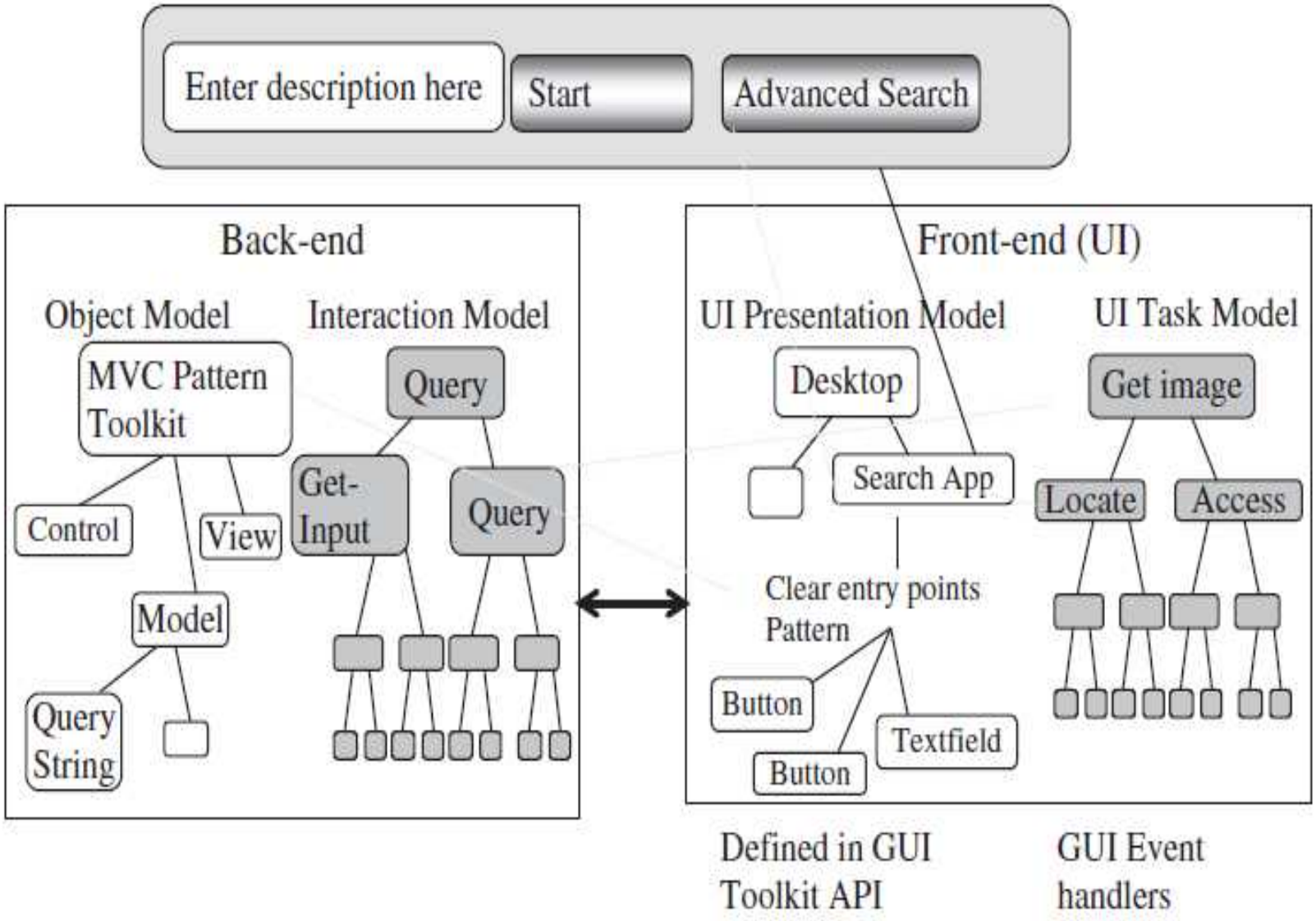

Figure 5.8 Relating the HCI design heuristic