Human-Computer Interaction

Design Guidelines and Multimedia

Interaction Description Tools

dialogs and scripts

Dialog: a sequence of information tokens exchanged between two or more agents
Script: a program which controls the exchange of tokens among agents

state transition diagram

a model which maps a token and a current state to a next state
Components:
finite number of states
set of transitions \( f(\text{current state}, \text{token}) \rightarrow \text{next state} \)
special state: Start
special state(s): End

object and process graphs/hierarchies

object-oriented inheritance systems
calling sequences (functional hierarchy)
parse trees
cause and effect chains

concept modeling (entity-relation graphs)

Entities: data which represents a single person, thing, concept, idea, or event (nouns)
Relations: associations between entities, including structure and organization,
constraints, and invariants. Primary examples:
IsSameAs (equivalence)
IsA, Generalizes (typing)
IsPartOf, Contains (hierarchy)
IsMemberOf (sets)

grammars

Components:
finite set of terminal symbols, representing semantic units
finite set of non-terminal symbols, representing sub-trees
set of production rules defining nonterminals
Standard form: BNF Example:
\[
\begin{align*}
  \text{<integer>} & ::= \text{<digit> | <digit><digit>^*} \\
  \text{<digit>} & ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 \\
\end{align*}
\]
context-free when nonterminal substitution has no dependency on adjacent nonterminals
rules, constraints, and inference

Components: a graph with two types of nodes
slots: types and values for the attributes of an object
rules: a transformation which generates a slot value from other slot values

Types of rules:
upper or lower bound constraint
enumeration of acceptable values constraint
procedure invocation
selection between several slot values
function for calculating new slot value

multiple agents and communication models

shared memory: single records with regulated access
event handlers: continuous processes which respond to input events
event executive: process which prioritizes event handling (conflict resolution)
multithreaded dialogs
petri nets (information locations, synchronized transitions, arcs)

behavior modeling

task analysis: mapping the component steps/processes in a task
protocol analysis: mapping the component activities while doing a task
self-report: end user description and narration while doing a task
clinical diagnosis and remediation: single subject trouble shooting
controlled experiment: factoring the task into manipulated and measured variables

Visual Design (Mullet and Sano, Designing Visual Interfaces)

Elegance and simplicity

Qualities
approachability, recognizability, immediacy, usability

Principles
unity, refinement, fitness

Common errors
clutter and visual noise
interference between competing elements
using explicit structure as a crutch
belaboring the obvious
overly literal translation
excessive detail and embellishment
gratuitous dimensionality

Techniques
reduce a design to its essence
regularize the elements of the design
combine elements for maximum leverage
Human-Computer Interaction

**Scale, contrast, and proportion**

*Qualities*
contrast, proportion, differentiation, emphasis, activity, interest

*Principles*
clarity, harmony, activity, restraint

*Common errors*
insufficient contrast
excessive contrast
visual interference
spatial tension
overextension
awkward dimensions

*Techniques*
squint test
establish perceptual layers
sharpen visual distinctions
integrate figure and ground

**Organization and visual structure**

*Qualities*
unity, integrity, readability, control

*Principles*
grouping, hierarchy, relationship, balance

*Common errors*
haphazard layout
conflicting symmetries
ambiguous internal relationships
aligning labels but not controls
alignment within but not across controls
false structure
excessive display density
all of the above

*Techniques*
use symmetry to ensure balance
use alignment to establish visual relationships
optical adjustment for human vision
shape the density with negative space

**Module and program**

*Qualities*
structure, predictability, efficiency

*Principles*
focus, flexibility, consistent application

*Common errors*
arbitrary component positions
arbitrary component dimensions
random window sizes and layouts
unrelated icon sizes and imagery
inconsistent control presentations
inconsistent visual language

Techniques
reinforce structure thorough repetition
establish modular units
create grid-based layout programs

Image and representation

Qualities
identification, expression, communication

Principles
immediacy, generality, cohesiveness, characterization, communicability

Common errors
misleading syntax
poorly integrated structure
dominant secondary elements
using type as image
using images for abstract concepts
images based on obscure allusions
culture or language dependencies
offensive or suggestive imagery

Techniques
selecting the right vehicle
refinement through progressive abstraction
coordination to ensure visual consistency

Style

Qualities
emotion, connection, context

Principles
distinctiveness, integrity, comprehensiveness, appropriateness

Common errors
unwarranted innovation
combining unrelated elements
partial fulfillment
internal and external inconsistency
incompatible concepts

Techniques
mastering a style
working across styles
extending and evolving a style
Cyberspace, Hypertext and the Web (R. Horn, Information Mapping)

Paper metaphors for hypertext

- library card catalogues
- footnotes
- cross-reference
- sticky notes
- commentaries
- indexes
- quotes
- anthologies

Computer metaphors for hypertext

- linked note cards
- popup notes
- linked screens or windows
- stretch text and outlines
- semantic nets
- branching stories
- relational databases
- simulations

Hypertext Links

system-supplied
- command and control pathways
- table of contents
- history tracking
- automated profiling

user-created
- detours and shortcuts
- notes, commentary, reminders
- analogical links
- new text
- links to other knowledge bases

author-created
- links to prerequisite knowledge
- hierarchical classification
- chronological structures

Kinds of links

- hierarchical: building a tree
- keyword: building an array
- referential: building a pointer list
- cluster: building a struct
Wayfinding in cyberspace (these don’t work very well)

- show all connections
- go back to the beginning
- show history of behavior

Node sizes

- one sentence
- text of arbitrary size (article, monograph)
- index card size
- screen size
- scroll of any length
- variable record sizing
- variable size, precisely and flexibly chunked

Information types

- structure
- concept
- procedure
- process
- classification
- principle
- fact

Information Blocks

- chunking: small, manageable hunks (blocks, maps)
- relevance: one main point per chunk, based on purpose or function to reader
- consistency: similar words, labels, formats, organization
- labeling: label every chunk based on specific criteria

Common types of information blocks

<table>
<thead>
<tr>
<th>analogy</th>
<th>example</th>
<th>parts table</th>
</tr>
</thead>
<tbody>
<tr>
<td>block diagram</td>
<td>fact</td>
<td>prerequisite</td>
</tr>
<tr>
<td>checklist</td>
<td>flow chart</td>
<td>principle</td>
</tr>
<tr>
<td>classification table</td>
<td>flow diagram</td>
<td>procedure table</td>
</tr>
<tr>
<td>classification tree</td>
<td>formula</td>
<td>purpose</td>
</tr>
<tr>
<td>comment</td>
<td>input-procedure-output</td>
<td>rule</td>
</tr>
<tr>
<td>cycle chart</td>
<td>non-example</td>
<td>stage</td>
</tr>
<tr>
<td>decision table</td>
<td>notation</td>
<td>synonym</td>
</tr>
<tr>
<td>definition</td>
<td>objectives</td>
<td>theorem</td>
</tr>
<tr>
<td>description</td>
<td>outlines</td>
<td>when to use</td>
</tr>
<tr>
<td>diagram</td>
<td>parts-function table</td>
<td>worksheet</td>
</tr>
</tbody>
</table>
Types of hypertrail, path

- prerequisite
- classification
- chronological
  - sequence of events
  - storyline
  - natural development
- geographic
- project
- structural
- decision
- definition
- example

How readers behave

- novices stop reading too soon
- novices are mislead by superficial features
- novices rarely seek non-linear information
- readers construct a hierarchical mental representation
- readers remember the top level of information better
- readers depend on repetition of keywords

Reading cues

- hierarchical text organization
- explicit transitions
- sequence signals
- contrast and similarity cues
- pronouns as cohesiveness cues
- metaphors
- content schemas

Document titles

- just right: not too general, too specific, too long, too short
- common language for the intended audience
- itemize all possible readers and use lowest common denominator
- no cuteness or silliness
- no vague, mislabeled topic headers
- same words in contents, titles, pages, and references
Virtual Reality (W. & M. Bricken)

The VR Paradigm Shift

We adapt to digital processes ==> digital processes adapt to us.

The VR shift from formalism to friendliness

- physiological naturalness: responsive to human physiology
- cognitive ease: responsive to human thinking patterns
- environmental familiarity: transparent, responsive, interactive
- whole body involvement: multisensory interface
- embedded functionality: task-oriented affordances
- behavioral information: spatial and experiential information

Design Paradigm Shifts (M. Bricken, No Interface to Design)

- Interface to inclusion
- Mechanism to intuition
- User to participant
- Visual to multimodal
- Metaphor to virtuality

Varieties of Meaning

- physical semantics: map between digital representation and activity in the physical world
- virtual semantics: map between digital representation and perceived virtual world activity
- natural semantics: hiding the digital layer, map between physical activity and virtual consequence

Component Technologies

- behavior transducers: map behavior onto computation and back
- inclusive computation: software for management of environments
- intentional psychology: integrate information, cognition and behavior
- experiential design: unifying inclusion and intention feels good

VR functional integration of

- realtime operating systems
- sensor fusion
- dynamic adaptive control
- distributive and parallel processing
- dynamic database management
- coordination and communication techniques
- biological/environmental modeling
- physical dynamics
arbitrary interactivity
physiological and cognitive modeling
design of experience

VR operating system requirements

realtime interactive programming
multiple participants
parallel decomposition model
distributed, heterogeneous processing
arbitrary i/o mappings

System-oriented programming extends oop

Every entity is an autonomous operating system, controlling its own
attributes
resources (memory, processes, i/o)
communication
timing
Entities follow biological/environmental models, using commands such as
enter
perceive
react
persist
Spaces and environments are first-class
behavior is situated and contextual

Viewpoint transformations

turn head
fly (interactive, 3-space functional curve, constrained pathway)
jack into location (instantly transport)
ride vehicle
inhabit
grasp world
multiple concurrent views
projection (over dimensions, abstractions)

The Wand

A position sensor on a laser pointer. The virtual form changes with function.
Viewpoint control
sight (attach ray to head orientation) jack (teleport)
move faster/slower scale (travel in size)

Object manipulation
grasp
normal (make object perpendicular to ray)
come (bring object to participant)
connect (construct a port on the object)
cut (the ray is a knife)
feel  (tactile feedback ray)

Information gathering
identify pointed at object
measure distance
count/compute environmental complexity

Other uses
Draw
light  (the ray is a flashlight beam)
select
baton  (direct sound events)

Divergent Worlds

Physical reality
Experience is unique for each person.
We perceive only instances.
Matter dictates consensus.
We negotiate differences.

Virtual reality
Form is unique for each participant.
We perceive possibilities.
Choice dictates consensus.
We negotiate communality.

Multiple participant group space
build mutual context rather than global truth
each participant is unique
credibility rather than validity
comprehension rather than consistency
inconsistency maintenance and uniqueness enforcement

VR bumper stickers
Psychology is the Physics of VR.
Our body is our interface.
Computation is in your hands.
One experience is worth a trillion bits.
The virtual is more than real.
VR is the first empirical tool of metaphysics.

Issues
ownership information wants to be free
ethics how is access and behavior controlled
fluid self our virtual body is ethereal
intoxication cognitive remodeling and dreaming in polygons
consistency unique, private, interpenetrating worlds
post-symbolism semantics takes a back seat
embedded virtuality enhanced sensorium and private filters
rights of programs self-reference and autonomy
actual or virtual the line is very fuzzy