

CS 6750 Human-Computer Interaction - Quiz 2 Study Guide

Lessons 2.3 Direct Manipulation & Invisible Interfaces • 2.4 Human Abilities • 3.4 Design Alternatives • 3.5 Prototyping • Direct Manipulation Interfaces reading

2.3 Direct Manipulation and Invisible Interfaces

Core idea: direct manipulation makes the user feel as though they are acting on the task object itself rather than issuing instructions through an interface. The closer the interface gets to the user's goals and natural actions, the more it can seem to disappear.

Concept	What it means	Example / quiz connection
Direct manipulation	The user acts on visible representations of task objects with actions that feel closely connected to the desired result. It narrows the gulfs of execution and evaluation.	Dragging a file into a folder feels more direct than typing a command to move it.
Desktop metaphor	Computer files, folders, trash cans, and desktops borrow familiar real-world concepts so users can transfer existing knowledge.	Pick up and drag a file just as you would move a paper on a desk.
Invisible interface	The user spends little or no conscious attention on the interface; attention stays on the task.	An experienced driver operates pedals and steering without consciously thinking about each control.
Invisibility through learning	A once-visible interface becomes cognitively invisible through repeated practice and proceduralization.	Keyboard shortcuts or driving controls become automatic.
Invisibility through design	The interface is designed so naturally that little learning is required in the first place.	Pinch-to-zoom maps the physical gesture closely to enlarging an image.

Two forms of distance

Concept	What it means	Example / quiz connection
Semantic distance	Distance between the user's goal and the meaning available in the interface language. Ask: How hard is it to express what I want?	High: writing a complex query to filter products. Low: choosing 'Price: \$0-\$50'.
Articulatory distance	Distance between an intended expression and the physical form/action needed to execute it. Ask: How hard is it to physically do what I know to do?	High: awkward multi-key shortcut. Low: tapping or dragging the object.
Execution side	Semantic distance largely affects identifying intentions/actions; articulatory distance affects executing the action.	Knowing 'rotate' exists but hunting through menus is semantic; executing an awkward gesture is articulatory.
Evaluation side	Distance also exists when interpreting system output: the output must clearly express what happened and what it means.	A file visibly moving into its destination makes the result easier to interpret.
Cognitive effort	The feeling of directness decreases as the cognitive effort required to manipulate and evaluate the system increases.	If the user must translate goals into obscure commands and decode cryptic output, the interface feels indirect.

QUIZ TRIGGER: If a question gives you an interface and asks why it feels direct/indirect, discuss semantic distance + articulatory distance + feedback/direct engagement, not just 'it is easy to use.'

Direct engagement

Concept	What it means	Example / quiz connection
Direct engagement	The representation behaves as though it <i>is</i> the object, producing a first-person feeling of acting in the represented world.	Dragging a document icon changes the actual document's location.
Conversation metaphor	The user tells the system what to do through a command language.	Typing a command such as 'move file A to folder B.'
Model-world metaphor	The system presents a world of objects that users manipulate directly.	Files, folders, windows, icons, sliders, maps.
Trade-off	Direct manipulation is not automatically best for every task; abstraction and automation can outperform manual manipulation for complex or repetitive work.	Dragging 1,000 files one-by-one is 'direct' but worse than a batch command.

2.4 Human Abilities

Core idea: HCI begins with the human. Treat the person as an information-processing system with **input (sensation/perception) -> processing (cognition/memory) -> output (action)**. Interfaces should fit human capabilities rather than forcing humans to compensate for poor design.

Input: sensation and perception

Concept	What it means	Example / quiz connection
Central vs. peripheral vision	Central vision is strongest for detail and color; peripheral vision is especially useful for detecting motion.	Put important text/detail near the focus of attention; peripheral motion can attract attention to an alert.
Color	Color perception varies; color blindness means color should not be the only carrier of meaning.	Use an icon/label plus red for an error, not red alone.
Visual attention	Seeing something is not the same as attending to it. Competing stimuli can cause important information to be missed.	A subtle warning can disappear in a visually crowded dashboard.
Hearing	Auditory information can reach users without requiring them to look at a specific location; it can complement visual information.	A navigation system speaks the next turn while the driver watches the road.
Multiple modalities	Different sensory channels can complement one another, but redundant or competing information can also overload the user.	Visual map + spoken directions can divide work across modalities.

Processing: cognition, memory, and learning

Concept	What it means	Example / quiz connection
Working memory	Temporary workspace for active information; capacity is limited, commonly treated in this course as only a few chunks at once.	A long sequence of unlabeled steps forces users to keep too much state in their head.
Visual-spatial sketchpad	Working-memory component for visual and spatial information.	Remembering where an icon or object is located.
Phonological loop	Working-memory component for speech/sound-based information.	Holding a short spoken instruction in mind.
Episodic buffer	Integrates information from multiple sources into a coherent episode or representation.	Combining what you see, hear, and already know while following directions.
Recognition over recall	Recognition is easier because the interface provides cues; recall requires retrieving information from memory without those cues.	Menu of visible commands is easier for novices than memorizing command names.
Declarative learning	Knowledge of facts or 'what is true'; can often be explained explicitly.	Knowing what a toolbar icon means.
Procedural learning	Knowledge of how to perform an action; often becomes automatic and is harder to verbalize.	Touch-typing or using a familiar gesture.
Cognitive load	Mental effort imposed by the task/interface. Good interfaces offload unnecessary work and avoid making users remember what the system can remember.	Show recent files rather than forcing the user to remember exact filenames.

Output: action and motor ability

Concept	What it means	Example / quiz connection
Motor output	Cognition ultimately becomes physical action; interface controls must fit human speed, reach, precision, and coordination.	Tiny touch targets demand more precision and increase errors.
Speed-accuracy trade-off	Faster actions often sacrifice accuracy; demanding both extreme speed and precision is poor design.	A tiny moving button is harder to hit quickly than a large stable one.
Design implication	Make frequent/important actions easy to acquire and execute; reduce unnecessary physical precision.	Large touch targets for common mobile actions.

QUIZ TRIGGER: For a human-abilities scenario, organize the answer as input -> processing -> output. Identify the human limitation, explain how the design violates it, then propose a design that offloads or accommodates that limitation.

3.4 Design Alternatives

Core idea: after needfinding, do not immediately build the first idea. Explore the design space broadly enough to avoid **tunnel vision**, then use user/task knowledge to narrow the alternatives worth prototyping.

Brainstorming

Concept	What it means	Example / quiz connection
Design space	The range of plausible ways the interface could support the task. Exploring it reduces premature commitment.	Audiobook controls could be touch, voice, gesture, hardware buttons, automatic, or combinations.
Tunnel vision	Fixating on the first promising idea can prevent discovery of substantially better alternatives.	Immediately building a touch UI may prevent noticing that hands-free interaction better fits runners.
Individual first	Generate ideas independently before group discussion so each person develops ideas without being anchored by the group.	Each team member sketches many alternatives before the meeting.
Quantity first	Early brainstorming values many ideas rather than polishing a few. The goal is divergence before convergence.	Aim for roughly 20 ideas, including strange ones, before choosing.
Group brainstorming	Combine independent ideas, build on one another, and broaden the space after individual work.	Team members merge a gesture idea with automatic audio-pausing.

Group brainstorming rules

Concept	What it means	Example / quiz connection
Expressiveness	Make ideas concrete enough that others can understand and build on them.	Sketch or briefly explain the interaction instead of saying 'make it smarter.'
Non-evaluation	Do not criticize or rank ideas during idea generation; judgment causes people to self-censor.	Save 'that won't work' for the convergence phase.
Quantity	Generate many alternatives; unusual ideas can lead to useful combinations.	Ten imperfect concepts may reveal a direction one polished concept would miss.
Building	Use others' ideas as raw material: extend, combine, invert, or adapt them.	Voice control + physical gesture becomes a multimodal design.

Representing users and alternatives

Concept	What it means	Example / quiz connection
Persona	A concrete representation of a user type grounded in needfinding, used to reason consistently about needs and behavior.	Anika enjoys exercise and wants uninterrupted listening; Paul dislikes exercise and needs motivation.
User profile	Describes relevant characteristics of a user/user group without necessarily creating a full narrative character.	Experience level, goals, context, abilities, constraints.
Timeline	Shows a relatively general routine over time, including what the user is doing, thinking, or feeling and where the interface fits.	Before run -> start audiobook -> exercise -> interruptions -> finish.
Scenario	A specific situation/event used to test how a design alternative behaves.	A fire engine passes while Morgan runs and she misses 30 seconds of audio.
Storyboard	A sequence of drawings/frames that depicts a scenario and interaction over time.	Frames show Morgan running, noise interruption, rewind interaction, and recovery.
Video prototype	A scenario/storyboard expressed through video to show an interaction or experience that may not yet be implemented.	Film a person acting out a future interface behavior.

IMPORTANT DISTINCTION: Timeline = general routine. Scenario/storyboard = specific person + specific event + specific interaction. Use scenarios to expose where one design alternative fails under real contextual constraints.

3.5 Prototyping

Core idea: a prototype is not just a rough version of the final product. It is a tool for answering a design question. Build only enough fidelity and functionality to get the feedback you need, then iterate.

Prototype dimensions

Concept	What it means	Example / quiz connection
Representation	The medium used to express the design: words, sketches, paper, wireframes, video, software, etc.	A verbal description and a clickable wireframe can represent the same concept differently.
Fidelity	How closely the prototype resembles the eventual interface in appearance/behavior. Low fidelity is faster to change; high fidelity supports more detailed testing.	Paper sketch vs. polished interactive mockup.
Interactivity	How much the user can actually act on the prototype and receive responses.	Static screen mockup vs. clickable navigation.
Evaluation intent	Prototype detail should match the question being tested. Do not build features irrelevant to the current question.	To test navigation labels, you do not need a real recommendation algorithm.
Scope	How much of the system is represented and how deeply individual functions work.	Horizontal = many features shallowly; vertical = one/few features deeply.

Horizontal vs. vertical prototypes

Concept	What it means	Example / quiz connection
Horizontal prototype	Broad coverage of the interface with little depth. Good for testing overall structure, navigation, and feature organization.	Most screens exist, but buttons may only move between mock screens.
Vertical prototype	Narrow slice implemented in depth. Good for testing one interaction, workflow, or technical behavior realistically.	One search/recommendation feature works end-to-end while the rest is absent.
Choosing scope	Choose based on the research question, not on which prototype looks more impressive.	Test information architecture horizontally; test a complex gesture vertically.

Prototype types and trade-offs

Concept	What it means	Example / quiz connection
Verbal prototype	Very low fidelity; describe the idea to get rapid early reactions. Fast but vulnerable to misunderstanding, expert blind spot, and social-desirability effects.	'Imagine the app automatically pauses when outside noise becomes too loud.'
Paper/card prototype	Low fidelity and easy to revise, even during a session. Keeps attention on structure rather than polish.	Swap paper screens when a participant taps a drawn button.
Wireframe	More structured visual representation of layout/navigation; can be static or clickable.	Clickable Figma-style screens test where users expect controls.
Wizard of Oz	A human secretly performs functionality that appears automated, allowing testing before the underlying technology exists.	A 'voice assistant' appears intelligent while a researcher manually selects its replies.
Functional/high-fidelity prototype	More realistic appearance and behavior; useful for detailed usability/performance questions but expensive and harder to change.	Working interface used to measure task completion and interaction problems.
Video prototype	Shows an envisioned interaction in context without implementing the actual system.	A filmed gesture-controlled audiobook demonstrates how the interaction would unfold.

Why start low fidelity?

Concept	What it means	Example / quiz connection
Cheap change	Early designs are uncertain, so expensive implementation creates waste and attachment.	Redraw a paper screen in minutes instead of rewriting software.
Earlier feedback	A rough prototype can reach users before the team has committed to architecture or visual polish.	Test the concept this week rather than after months of development.
Focus feedback	Low fidelity can keep users focused on task flow and concepts rather than fonts, colors, and polish.	Participants critique navigation instead of button shadows.
Iterate upward	Increase fidelity as questions become more specific and confidence increases.	Concept -> paper -> clickable wireframe -> functional slice.

QUIZ TRIGGER: If asked what prototype to use, name the question you are trying to answer, then justify the prototype's representation, fidelity, interactivity, and scope. 'Higher fidelity is better' is not the rule.

Reading Spotlight - Hutchins, Hollan & Norman: Direct Manipulation Interfaces

The paper gives a cognitive explanation for why some interfaces feel direct. It argues that directness comes from **two underlying phenomena: distance and direct engagement**.

Concept	What it means	Example / quiz connection
Distance	Information-processing distance between the user's intentions and the facilities provided by the machine. Less distance means less effort to accomplish the goal.	A visible 'rotate' control is closer to the goal than remembering a command syntax.
Semantic distance	Relationship between the meaning of an interface expression and what the user wants to say/do. Ask whether the interface supports the user's conception of the task and whether it can be expressed concisely.	'Delete this file' maps naturally to moving the file to Trash.
Articulatory distance	Relationship between the meaning of an expression and its physical form. Lower distance means the form naturally corresponds to the meaning/action.	Turning a steering wheel to steer has lower articulatory distance than typing a direction command.
Input & output languages	The user must express actions through an input language and interpret system state through an output language; both can create distance.	A command may be easy to issue but cryptic output can still create a large evaluation gulf.
Direct engagement	Representations behave as though they are the objects themselves; the user becomes engaged with the represented world rather than with a command language.	Manipulating an icon changes the represented object immediately.
First-personness	The interface supports the feeling of acting directly in the task world rather than talking to an intermediary.	Dragging, resizing, and arranging visible objects.
Not automatically superior	Direct manipulation has costs and limitations; some tasks benefit from symbolic languages, automation, or abstraction.	Batch operations and complex transformations may be more efficient as commands.

Connections you should be able to explain

Concept	What it means	Example / quiz connection
Distance ↔ gulfs	Semantic/articulatory distance refine the earlier idea of the gulfs of execution and evaluation.	Lower distance makes intentions easier to express and outcomes easier to understand.
Directness ↔ cognitive load	More cognitive effort makes interaction feel less direct; good direct manipulation reduces translation work.	Visible objects and natural actions reduce remembering commands.
Direct engagement ↔ feedback	Continuous, visible effects help the user perceive the relationship between action and result.	Dragging an object and seeing it move continuously provides immediate feedback.

ONE-SENTENCE TAKEAWAY: Direct manipulation feels direct when users can express goals with little semantic/articulatory translation and interact with representations that behave like the task objects themselves.

Quiz 2 - What I would memorize

- 2.3:** direct manipulation; invisible interfaces; invisibility by learning vs. design; semantic vs. articulatory distance; direct engagement; model-world vs. conversation metaphor.
- 2.4:** input -> processing -> output; central/peripheral vision; multimodal design; working-memory limits; visual-spatial sketchpad, phonological loop, episodic buffer; recognition over recall; declarative vs. procedural learning; cognitive load.
- 3.4:** why multiple design alternatives matter; tunnel vision; individual before group brainstorming; expressiveness, non-evaluation, quantity, building; persona/profile; timeline vs. scenario/storyboard.
- 3.5:** prototype as a question-answering tool; representation, fidelity, interactivity, evaluation intent, scope; horizontal vs. vertical; verbal, paper, wireframe, Wizard of Oz, functional, video; why low fidelity comes first.
- 5. Reading:** distance + direct engagement; semantic vs. articulatory distance on both execution/evaluation; interface input/output languages; first-personness; direct manipulation has disadvantages as well as advantages.

Likely short-answer prompts

- Explain semantic and articulatory distance and apply both to a concrete interface.
- Explain how an interface can become invisible through learning versus through design.
- Given a human-abilities problem, analyze it using input, processing, and output limitations.
- Explain why recognition is generally preferred over recall and connect it to cognitive load.
- Describe a strong brainstorming process and explain how it avoids tunnel vision.
- Differentiate personas, timelines, scenarios, and storyboards and explain what each contributes.

- Choose a prototype for a stated research question and justify its fidelity and scope.
- Compare horizontal and vertical prototypes and give a situation where each is appropriate.
- Explain the paper's two aspects of directness: distance and direct engagement.
- Explain why direct manipulation is not necessarily the best interaction style for every task.