CS-639 — Interaction Design Studio

AI as Design Material — Context-Awareness & Adaptation

Professor Bilge Mutlu

Today

— **Welcome back** from spring break

— **W08-W10 recap:** How much should the system do? When should it act? How do human and AI work together?

— **This week:** What does the system **know** — and how should it use that knowledge?

— The last of four material properties — context-awareness completes the framework for A2

Agency sets the level. Timing sets the moment. Collaboration defines the relationship. Context shapes every decision.

W08 → W09 → W10 → W11

	W08: Agency	W09: Proactivity	W10: Collaboration	W11: Context
Core question	How much should the system do?	When should it act?	How do they work together?	What does the system know?
Framework	Parasuraman et al. (2000)	Horvitz (1999)	Johnson et al. (2014)	Dey (2001)
Design tool	Four factors + HAX	Four questions + Act/Ask/Wait	OPD + collaboration spectrum	Context dimensions + SA levels
Key tension	Control vs. convenience	Helpfulness vs. interruption	Autonomy vs. interdependence	Relevance vs. privacy

Part 1: What Is Context?

Defining context — and why it matters for intelligent systems

Defining Context

Dey (2001) provides the foundational definition:

"Context is any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves."

— **Broad on purpose:** anything relevant counts — not just location or time

— **Situation-dependent:** what counts as context changes with the task

— **Includes the user:** your emotional state, expertise, and goals are all context

Three Features of Context-Aware Applications

Dey (2001) identifies three things context-aware applications can do:

Feature	What It Does	Example
Present	Show relevant information based on context	Apple Watch showing workout metrics during exercise
Execute	Trigger actions automatically based on context	iOS Focus Modes silencing notifications in meetings
Tag	Attach context metadata to data for later retrieval	Photos geotagging images for location-based search

These three features connect directly to the agency spectrum — presenting is low agency, executing is high agency, and tagging operates in the background.

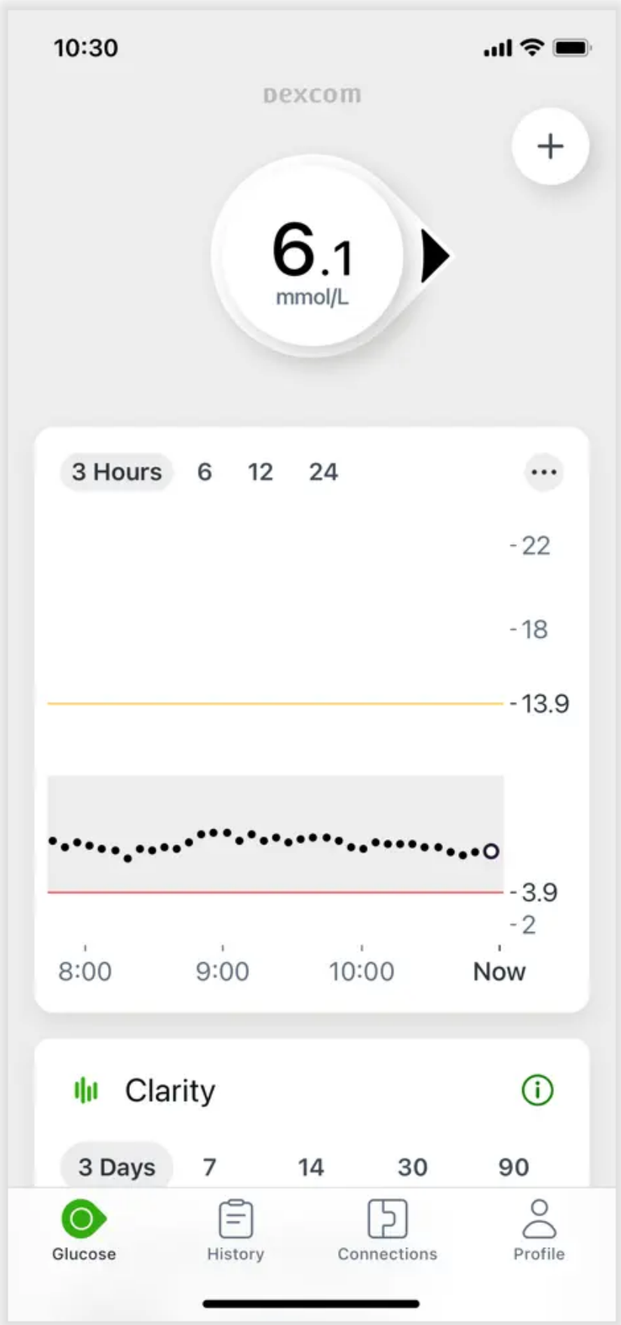
Running Example: Diabetes Management App

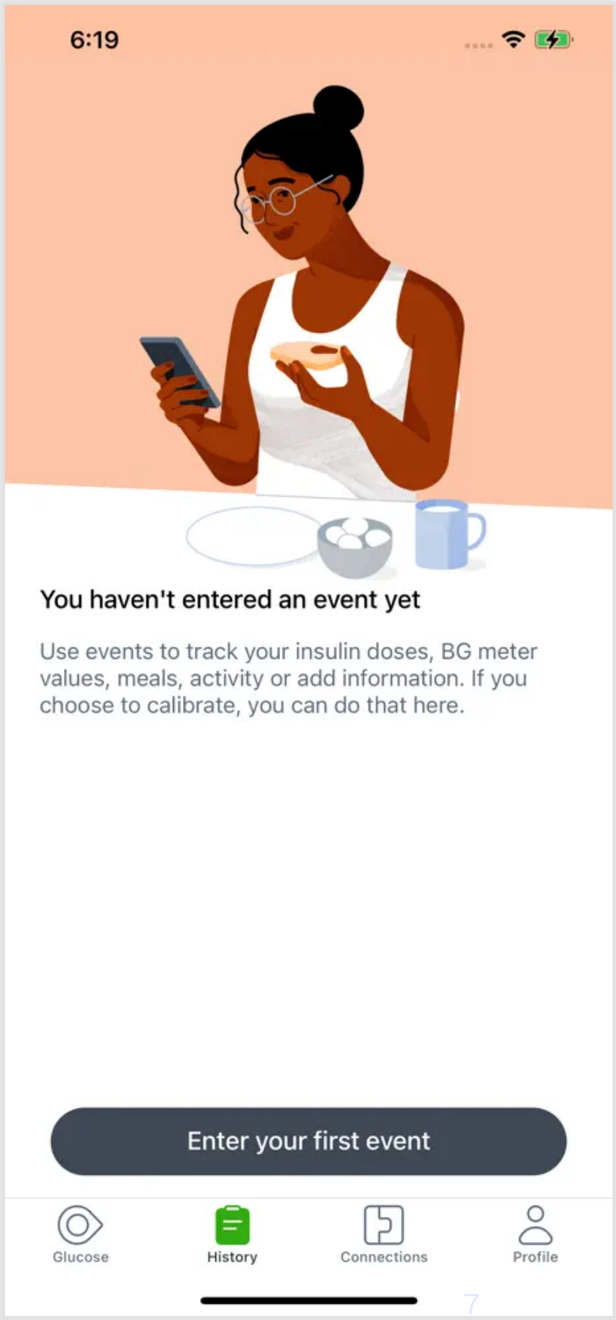
We will use a **diabetes management app** as our running example today — a system that needs all three of Dey's (2001) features:

— **Present:** Show glucose trends during a meal
— **Execute:** Alert emergency contacts when glucose is critically low
— **Tag:** Log glucose readings with meal type, activity, and time for pattern analysis

This is a **high-stakes domain** — wrong context leads to wrong insulin decisions.

This is exactly the kind of domain A2 asks you to design for — where getting it wrong has real consequences.





Context Dimensions

Schmidt et al. (1998) expanded context beyond location into six dimensions:

Dimension	What It Captures	Diabetes App Example
Physical environment	Location, lighting, noise, temperature	At home vs. at gym vs. in a restaurant
User state	Activity, physiology, emotion, attention	Exercising, sleeping, stressed, driving
Social context	Who else is present, social norms	Alone vs. in a meeting vs. on a date
Task context	What the user is trying to accomplish	Preparing a meal vs. giving a presentation
Temporal context	Time of day, duration, recurrence, deadlines	Morning routine vs. post-lunch vs. overnight
Device/platform	Screen size, input method, connectivity	Phone in pocket vs. watch on wrist vs. CGM sensor

Six dimensions, one app — the diabetes manager must track all of them to give the right advice at the right moment.

Context Is Not Just Data

Dourish (2001) offers an important counterpoint:

— Context is not a fixed set of measurable variables — it is **socially constructed**

— The same data means different things in different situations

— A glucose reading of 180 mg/dL means one thing after a large meal, another during fasting, and something else entirely during intense exercise

— Designers cannot simply "capture context" — they must design for **interpretation**

Designing for context means designing for interpretation, not just sensing.

Part 2: From Context to Awareness

Situation awareness — how systems move from sensing to understanding

Situation Awareness for AI Systems

Jiang et al. (2023) adapt Endsley's situation awareness model for human-AI interaction:

Level	Process	System Does	Design Question
SA-1: Perception	Detect and display relevant data	Senses context elements	What data is the system collecting?
SA-2: Comprehension	Interpret what the data means	Understands the situation	What does the system think is happening?
SA-3: Projection	Predict what will happen next	Anticipates future states	What does the system think will happen?

Perception without comprehension is just noise. Comprehension without projection is just reporting. Each level adds inference — and risk.

SA Levels in the Diabetes App

SA-1 — Perception

— Glucose: 180 mg/dL
— Heart rate: elevated
— Time: 2:15 PM
— Location: office

Raw data. Almost certainly correct.

SA-2 — Comprehension

— Glucose rising post-lunch
— Heart rate from walking, not exercise
— Matches typical Tuesday pattern

Interpretation. Could misidentify the cause.

SA-3 — Projection

— Glucose will peak at 210 by 3 PM
— A 1-unit correction now → 160 by 4 PM
— Confidence: moderate

Prediction. Could be dangerously wrong.

Each level adds inference — and risk.

SA Connects W08 → W11

SA Level	W08: Agency	W09: Timing	W10: Collaboration	W11: Context
SA-1: Perception	Show raw data (low agency)	Always available (no timing decision)	Human-led (user interprets)	Physical, temporal, device dimensions
SA-2: Comprehension	Suggest interpretations (mid agency)	Ask when patterns detected	Turn-taking (system explains, user decides)	User state, social, task dimensions
SA-3: Projection	Act on predictions (high agency)	Act when confident + urgent	Shared or AI-led (system anticipates)	All dimensions integrated over time

This is the integration table. Every design decision about an intelligent system sits at the intersection of a SA level and the four material properties.

Part 3: Designing Context-Aware Systems

From frameworks to products — how real systems use context

Spotify Daylist

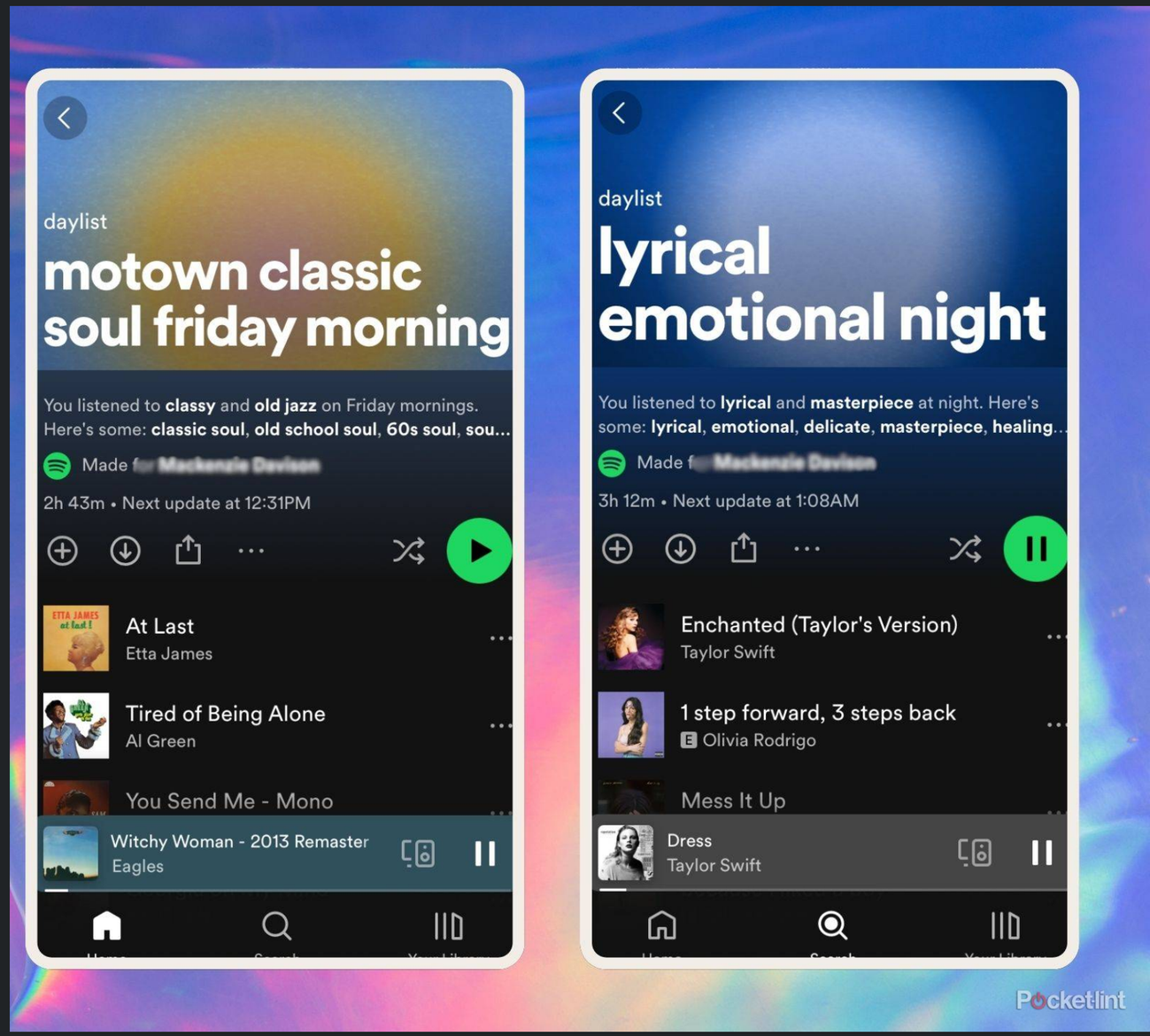
— **Context dimensions:** Temporal (time of day, day of week), user state (listening history, mood patterns), task (working, commuting, exercising)

— **SA level:** SA-2 (comprehension) — interprets your current mood/moment, not just your history

— **Adaptation:** Playlist content and descriptive label change throughout the day

— **Daylist labels** like "cozy indie Monday morning" show the system's comprehension — it is telling you what it thinks your situation is

Spotify does not just know what you played — it understands when and why. That is SA-2 in action.



Apple Watch

- **Context dimensions:** User state (heart rate, movement, pace), physical environment (GPS, elevation), temporal (duration, time of day), device (wrist detection)
- **SA-2 in action:** "It looks like you're running on a track" — the watch combines GPS pattern, pace, and location to **comprehend** your activity, not just report it
- **All three Dey (2001) features:**
  - **Present:** Real-time heart rate and pace (SA-1)
  - **Execute:** Auto-detect workout type and start recording (SA-2)
  - **Tag:** Log route, splits, and conditions for later analysis

"It looks like you're on a track" is SA-2 — the watch interprets your situation, not just your data. That comprehension enables smarter features.

iOS Focus Modes

— **Context dimensions:** Temporal (schedule), social (allowed contacts), task (work vs. personal), physical environment (location triggers)

— **SA level:** SA-1 — user provides the comprehension through rules

— **Adaptation type:** User-defined rules with optional location and time triggers

— **Key insight:** Lower SA but higher user control — the user does the comprehension work

When the user provides the comprehension, the system needs less inference — and earns more trust. Sometimes SA-1 is the right design choice.

Google Maps Commute

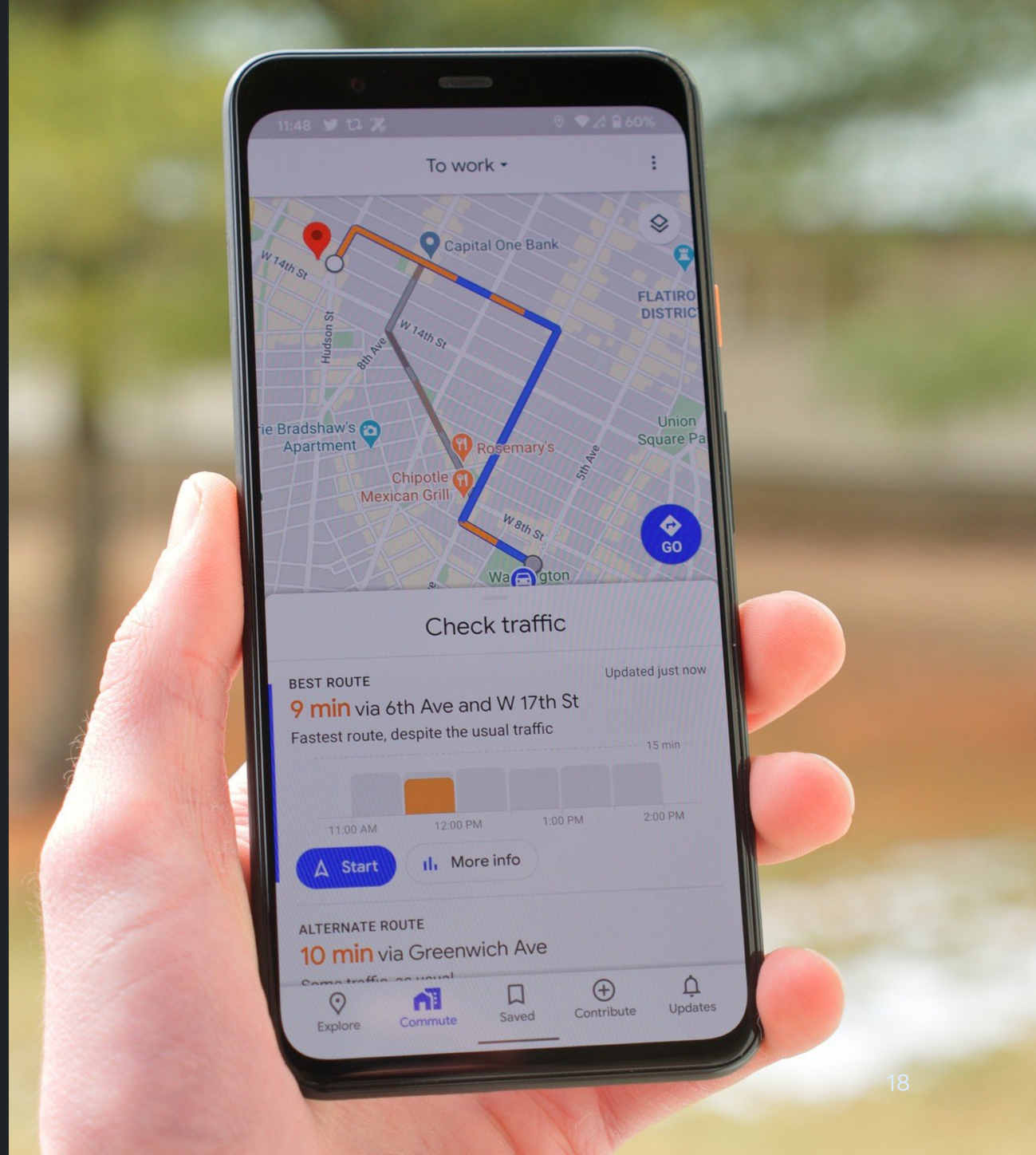
— **Context dimensions:** Physical (location, traffic), temporal (time of day, recurring patterns), user state (home/work routine), task (commuting), social (calendar events)

— **SA level:** SA-3 (projection) — predicts travel time and suggests departure

— **Uses the most context dimensions** of any consumer app: location, traffic, calendar, time patterns, transit schedules, weather

— **Departure time suggestions** are SA-3: "Leave by 8:15 to arrive on time"

Google Maps is SA-3 by default — it projects what will happen and tells you when to act. That level of inference requires deep context integration.



Context in the Diabetes App — Inspired by Real Products

Inspired By	What the App Does	Context Dimensions
Spotify Daylist	Labels the current glucose context: "steady post-lunch Tuesday" — making comprehension visible	Temporal, user state, task
Apple Watch	Continuous monitoring with fall-detection-style emergency alerts for severe lows	User state, physical, device
iOS Focus Modes	User-defined alert rules: "during meetings, only alert if below 70" — user provides comprehension	Social, temporal, task
Google Maps	Predictive dosing guidance: "based on your pattern, glucose will peak at 210 by 3 PM"	All dimensions integrated

Each product teaches a different pattern. The best diabetes app would use all four — at appropriate SA levels.

Contextual Integrity

Barth et al. (2006) reframe privacy as **appropriate information flow in context**, not secrecy:

- Privacy is violated when information flows **outside its expected context** — not when it's collected
- Glucose data shared with a doctor: **appropriate** — medical context expects it
- Glucose data shared with an employer: **violation** — employment context does not expect it
- Two norms govern flow:
  - **Appropriateness:** Is this type of information fitting for this context?
  - **Distribution:** Who can this information flow to, and under what conditions?

Context-awareness requires context data. Contextual integrity asks: who else gets to see it? This is the ethical foundation for A3.

Part 4: Material Properties & Synthesis

Connecting context-awareness to the full W08-W11 framework

Synthesizing W08 → W11

Week	Property	Question	Design Tool
W08	Agency	How much should the system do?	Parasuraman et al. (2000) — levels, factors, HAX
W09	Proactivity & Timing	When should it act?	Horvitz (1999) — four questions, Act/Ask/Wait
W10	Collaboration	How do they work together?	Johnson et al. (2014) — OPD, collaboration spectrum
W11	Context-Awareness	What does the system know?	Dey (2001) — context dimensions, SA levels

These four questions are your framework for A2. Every intelligent system you design must answer all four.

Quick Check: Context in the Wild

In pairs (2 min): Pick an app you both use regularly.

1. **Context dimensions:** Which of Schmidt et al.'s (1998) six dimensions does it use?
2. **SA level:** Is it at SA-1 (perception), SA-2 (comprehension), or SA-3 (projection)?
3. **Contextual integrity:** Identify one piece of context data that would violate Barth et al.'s (2006) norms if shared with the wrong party

Share out: 2-3 pairs report back.

We will use this same lens on Wednesday when you design context-aware interfaces for your A2 domain.

This Week

A2 introduction, reflection, and getting started

Assignment 2: Intelligent System Design

Due Monday, April 20 | 25% of final grade

Design an intelligent system in a **high-stakes domain** — where a wrong action has real consequences.

— Persona with 3+ context scenarios
— All four material properties
— Interaction flows with P1-P12 annotations
— Process documentation + reflection

"High-stakes" does not mean medical. Travel, budgeting, education, cooking for allergies — any domain where getting it wrong matters.

Reflection: Context Dimensions Mapping

Due before Wednesday | Graded: check system

Choose a **product you use daily** and complete the following:

1. **Context dimensions audit:** Map the product against Schmidt et al.'s (1998) six dimensions — which does it use? Which does it ignore?
2. **SA level assessment:** What SA level does each feature operate at? Where does it perceive, comprehend, or project?
3. **Contextual integrity check:** Identify one piece of context data the product collects. Who should and should not have access? Why?

Submit on Canvas with a **screenshot of the product** and your analysis.

This reflection primes Wednesday's studio — you will apply the same analysis to your A2 domain.

Wednesday: A2 Kickoff

No separate studio — everything feeds directly into A2.

— Finalize your domain
— Draft persona with 3+ context scenarios
— Sketch how the interface adapts across contexts

Come to class with your domain chosen.

Wednesday is not a separate assignment — it is A2.

Before Wednesday

— **Submit** the context dimensions mapping reflection on Canvas

— **Choose your A2 domain** — this is the most important task. Come Wednesday ready to work.

— **Optional reading:** Dey (2001), "Understanding and Using Context" — the foundational paper behind today's lecture

— **Think about:** What should your system NOT know? Where is the line between helpful context-awareness and surveillance?

References

Core Frameworks:

— Dey (2001). "Understanding and Using Context" — Personal and Ubiquitous Computing

— Schmidt et al. (1998). "There Is More to Context Than Location" — Interactive Applications of Mobile Computing

— Jiang et al. (2023). "A Situation Awareness Perspective on Human-AI Interaction" — IJHCI

Ethics & Background:

— Barth et al. (2006). "Privacy and Contextual Integrity" — IEEE Symposium on Security and Privacy

— Dourish (2001). "Seeking a Foundation for Context-Aware Computing" — Human-Computer Interaction

— Horvitz (1999). "Principles of Mixed-Initiative User Interfaces" — CHI '99

— Parasuraman et al. (2000). "A Model for Types and Levels of Human Interaction with Automation" — IEEE SMC

Media Sources

Spotify Daylist | Apple Watch Health | iOS Focus Modes | Google Maps Commute | Dexcom CGM