Distributed Cognition

Fundamentals of Human-Centered Computing

Distributed Cognition

One of the first "revolutions" in HCI research since Norman

And it had a profound impact on cognitive science and HCI practice as well!

Today we will cover:

- What problems does Distributed Cognition try to solve?
- How does Distributed Cognition solve these problems
- How can we apply Distributed Cognition?
- What are good and bad aspects of Distributed Cognition?

The problems

What problems does Distributed Cognition try to solve?

The problem

Cognitive research is too general

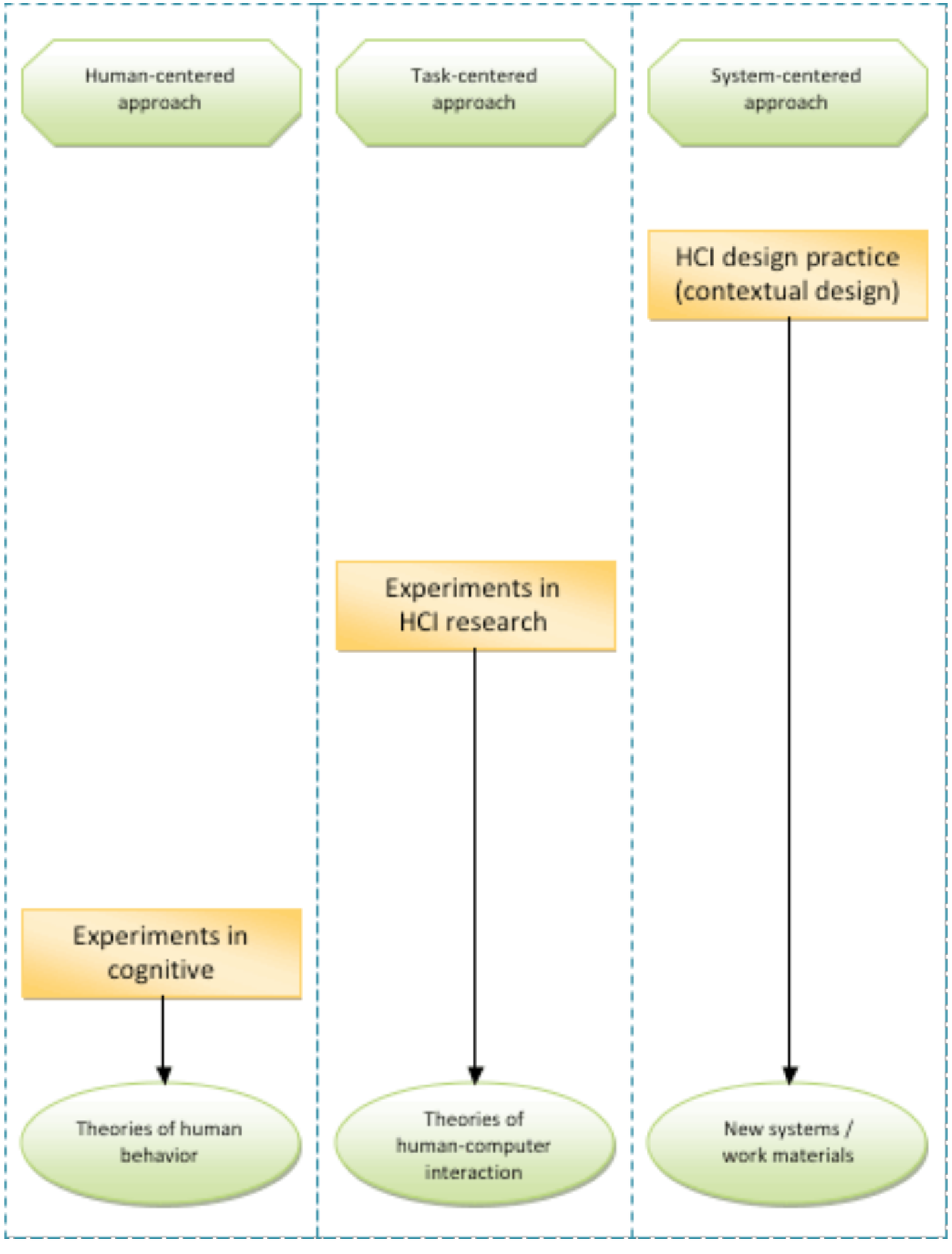
- Studies the mind outside the context of the real world

HCI practice is not couched in theory

- Practitioners study specific contexts, but do not couch their design improvements in HCI research findings

HCI research is not the “middleware” it is supposed to be

- No strong connection to cognitive psychology, no strong influence on practice


Human-centered approach
Task-centered approach
System-centered approach
HCI design practice (contextual design)
Experiments in HCI research
Experiments in cognitive
Theories of human behavior
Theories of human-computer interaction
New systems / work materials

Intermezzo

Contextual design consists of:

- **Contextual Inquiry:** Gather data from users while they do their work
- **Work modeling:** Use data to build models of work that are explicit and sharable
- **Work redesign:** Use data and models to design a new way of doing the work

Intermezzo

Contextual Inquiry is like an ethnography, but more practical

- Direct goal: To understand the work through observation in context
- Final goal: To help define the requirements and design of a new system that supports the work

Unlike an ethnography, there is an explicit entering focus

- Set of pre-conceived assumptions & beliefs
- Helps keep conversation on useful topics

Intermezzo

Work modeling is a guided method for interpreting contextual inquiry data

For each interview, create 5 work models

Then, consolidate the models of all your interviews

Intermezzo

Flow model: how work is coordinated among people

Cultural model: the culture which defines expectations, desires, the approach to work

Sequence model: the order of work tasks over time

Artifact model: the tangible (and virtual) things people create and use to get their work done

Physical model: the constraints of the physical environment

Intermezzo

Work redesign is the process of developing a vision of the future system that supports the work on the work models

Good visions support the work as it is done, and solve as many breakdowns as possible

Visions support the system design process

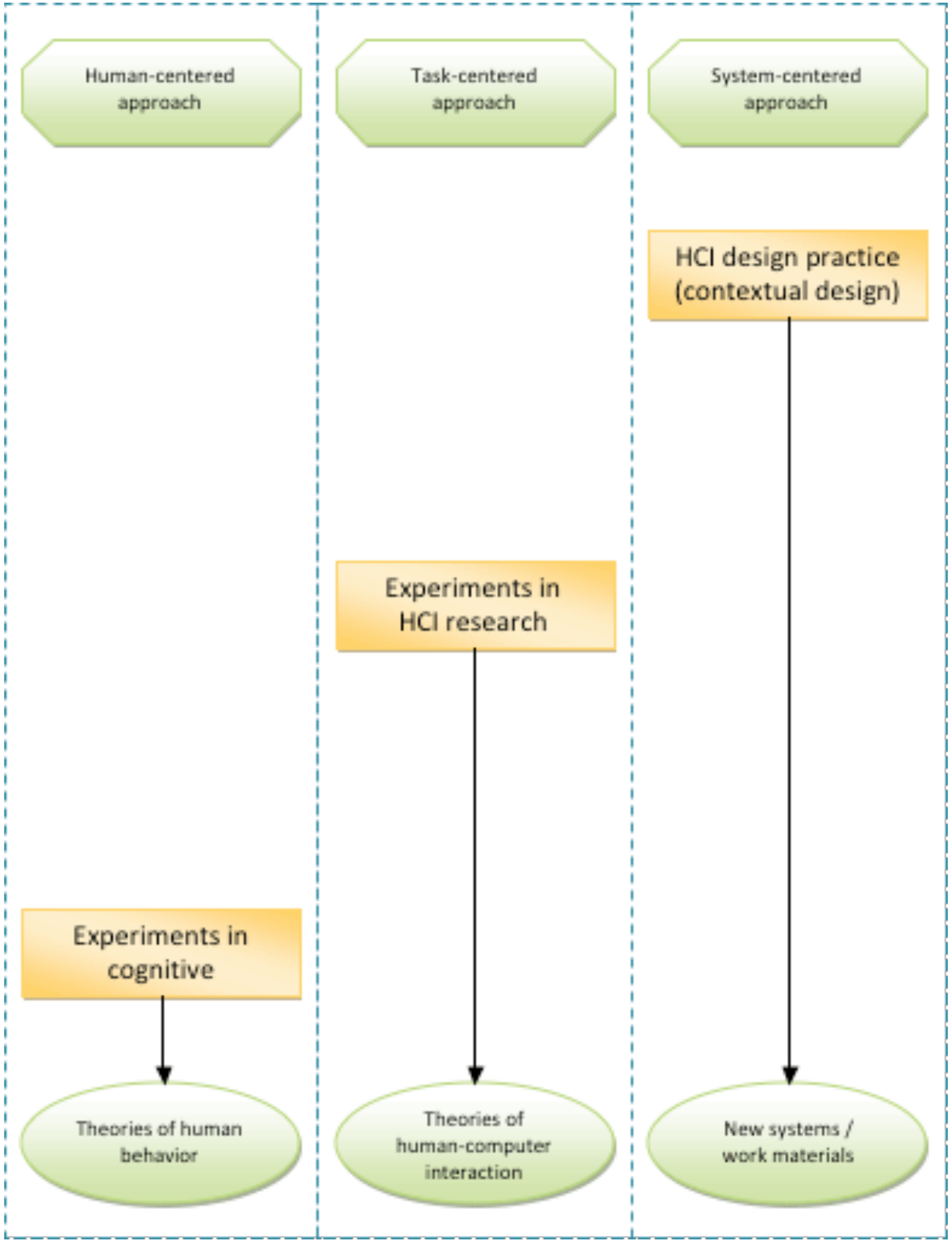
They can be turned into storyboards, wireframes, prototypes, and actual systems

Intermezzo

Criticism of Contextual Design: Where is the science?

Cognitive psychology is barely represented in these work models

There are no concrete ways of leveraging HCI research in the Contextual Design process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The solution

How does Distributed Cognition solve these problems?

The solution

Distributed Cognition bridges the gap between cognitive psychology and HCI research by introducing a **distributed approach**

Distributed Cognition bridges the gap between HCI research and HCI practice by employing **cognitive ethnography**

Distributed cognition

Communication is a **distributed** form of thinking

Combination of people, systems, and artifacts is a cognitive system

Paper and computer hard-drives are part of our distributed memory

The tools we use (screens, keyboards, pens, calculators) are part of our distributed perceptual-motor system

These artifacts play an active role in cognition

Distributed cognition

We can study communication through **ethnography**

More theoretical focus than contextual inquiry

Longitudinal in-depth studies that focus on how information flows through a system at different levels of granularity

More generalizable

Generalizations are the result of analyzing the collective manipulation of artifacts, and the transformation of representations as they permeate through the system

Rationale

Why study cognition at this level?

Only looking at the individual is a form of reductionism

Human cognition is not something that only happens in the head

It is distributed people, tools, information sources

"There should be a single theory that covers cognition as it occurs in all settings"

Rationale

Distributed Cognition provides a formal analysis of artifacts and how they are used

Distributed Cognition produces comparative data across settings

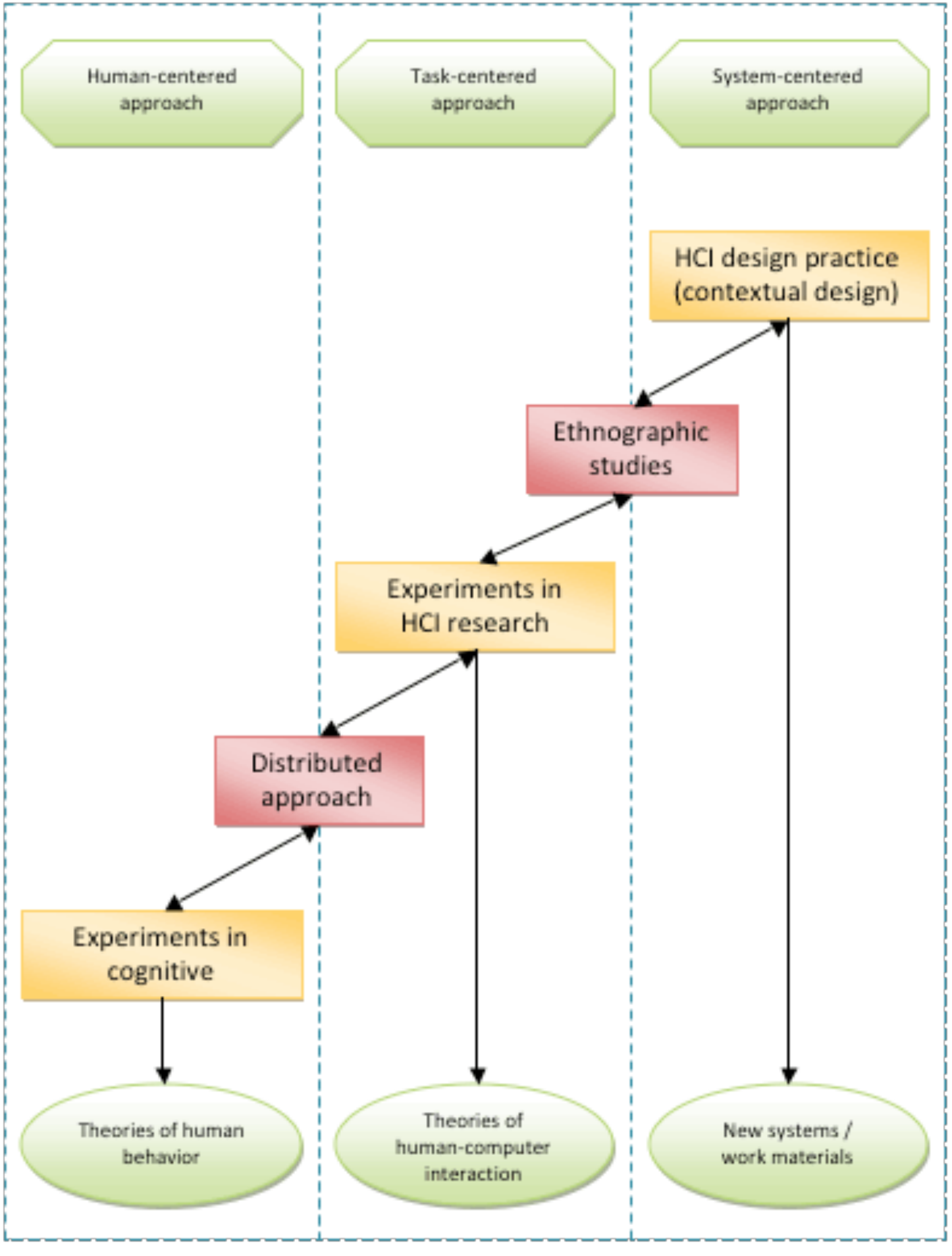
Rationale

Potential to bridge the gap between cognitive science and HCI research

> Reconciling the results of human-centered and task-centered studies in a single comprehensible framework

Potential to bridge the gap between task-centered (HCI) research and system-centered design

> Ethnography integrates the various aspects of human behavior related to the task, thereby integrating HCI research, and linking it to HCI practice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The method

How can we apply Distributed Cognition?

The method

Ethnography

Study how information flows through a system at different levels of granularity

Focus on:

Planning and problem-solving

Communication (both verbal and non-verbal)

Coordination (rules, procedures)

Knowledge creation and sharing (through artifacts, training, communication)

Flexible artifacts

Artifacts take an active role

They are not just stimuli or work output

Most successful examples of DCog show how people exploit the flexibility of the digital world

Look for secondary usage patterns

Consider representations as both abstract forms as well as the thing that is being represented

E.g. a form on my desk can be both a tool and a reminder

Memory as a process

Organizational memory resides in several individuals, objects and systems within an organization

- Both explicit and implicit

Memory can be viewed as both an entity and a process

- Memory processes are the transition of knowledge between humans and artifacts
- E.g. teaching a method, having a project meeting, assigning a task, writing down rules

Context

Knowledge transition happens through (mediated or direct) communication

Communication (especially when mediated by technology) results in reinterpretation and loss of context

- For efficiency reasons, the sender decontextualizes the information
- The receiver then has to recontextualize the information
- This process is not infallible, since contexts may be different for sender and receiver

Breakdowns

Result of this de- and re-contextualization? Breakdowns!

This makes it difficult to reuse knowledge

As a result, reuse is often limited to simple, familiar and frequently used pieces of information

Goal of a good information system: maintain context!

Reflection

What are good and bad aspects of Distributed Cognition?

Reflection

Criticism: Distributed Cognition is mainly an idea

A clear methodology (beyond "apply ethnography") is lacking

Response 1: There are guiding principles

- Focus on planning and problem-solving, communication, coordination, and knowledge creation and sharing
- Show how people exploit the flexibility of the digital world
- View memory as both an entity and a process
- Look for breakdowns in knowledge transition

Reflection

Criticism: Distributed Cognition is mainly an idea

A clear methodology (beyond "apply ethnography") is lacking

Response 2: Combine with Contextual Design

- Contextual Design gives a step-by-step description on how to deal with ethnographic data
- Distributed Cognition provides theoretical grounding
- Allows for both theory and design ideas

Questions

Do all cognitive rules that apply to our brains also apply to larger cognitive systems (i.e. organizations)?

Can an organization have a goal? Or is it just the goal of its people?

How do organizations survive as a cognitive entity? How are their goal established and upheld?

How does learning occur? Does an organization have explicit and tacit knowledge?

Questions

What are good examples of breakdowns due to the de- and re-contextualization of information in knowledge transition?

How can we preserve context in these communications?

How would you build those ideas into a system?