



Faculty of Design

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## Hierarchy-in-flux: Co-evolving a distributed user interface for orbiting robots

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# Hierarchy in Flux

# Scenario: Retrieve a airplane Blackbox

- \* Tele-operated robot with toolkit (controlled by umbilicus 6sec delay)
- \* Robot operators in control room (video, telemetry, sensor arrays)
- \* “Dry” testing environment



# Sociotechnical System



Leaders



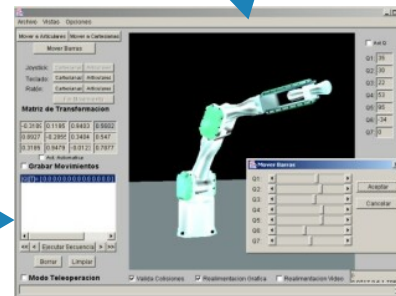
Robot operators



Tele-operated robot



Dry-testing



Interface



# Emergence: higher scale effects

- Strong Emergence  
“effects you could not anticipate or deduce”

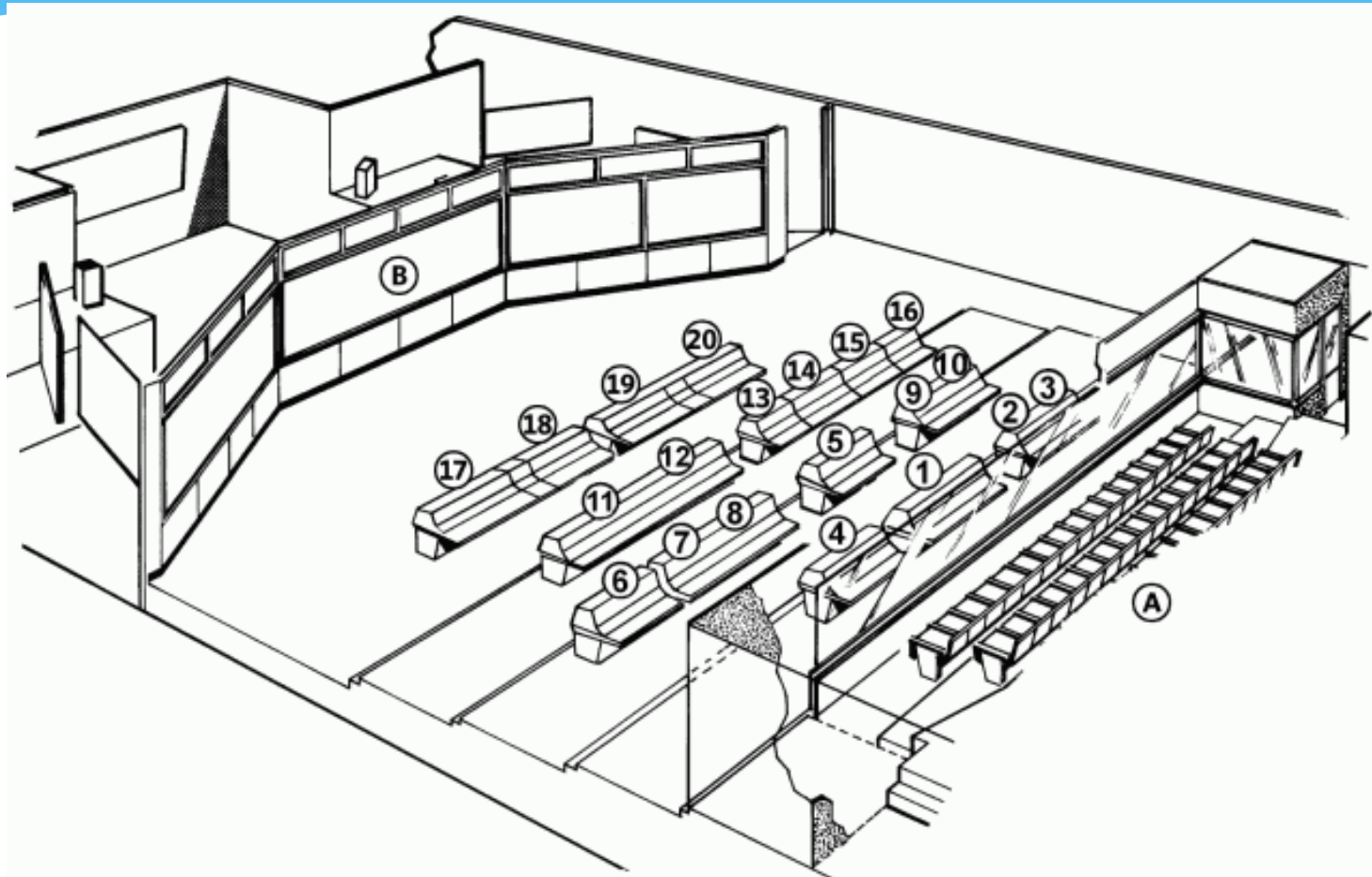
- Weak Emergence  
“predictable collective action”



# Engineering Emergence

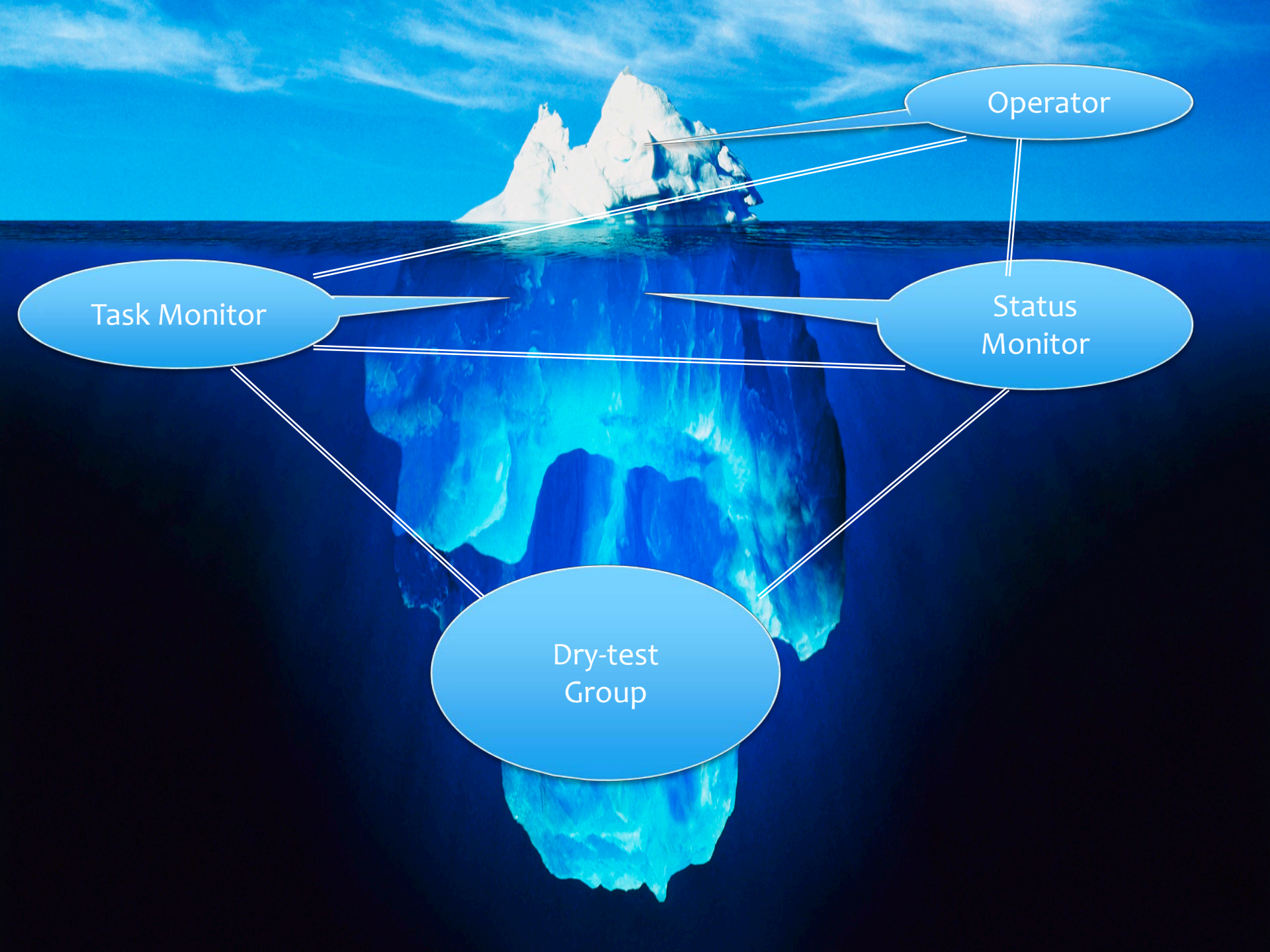
- \* Maximize Weak Emergence
- \* Minimize (eliminate) strong emergence
- \* Limit interaction between parts of the system

# An Analogy



<http://arstechnica.com/science/2012/10/going-boldly-what-it-was-like-to-be-an-apollo-flight-controller/>







# Why does this work?

- \* Every role is specialized
  - \* Every specialist is focused on one small set of tasks
  - \* Every task is clearly defined
  - \* Inputs and outputs only go up or down one level
- \* It's a rigid and well-defined hierarchy that minimizes interaction and organizes the flow of communication and control
  - \* It is engineered not self-organizing

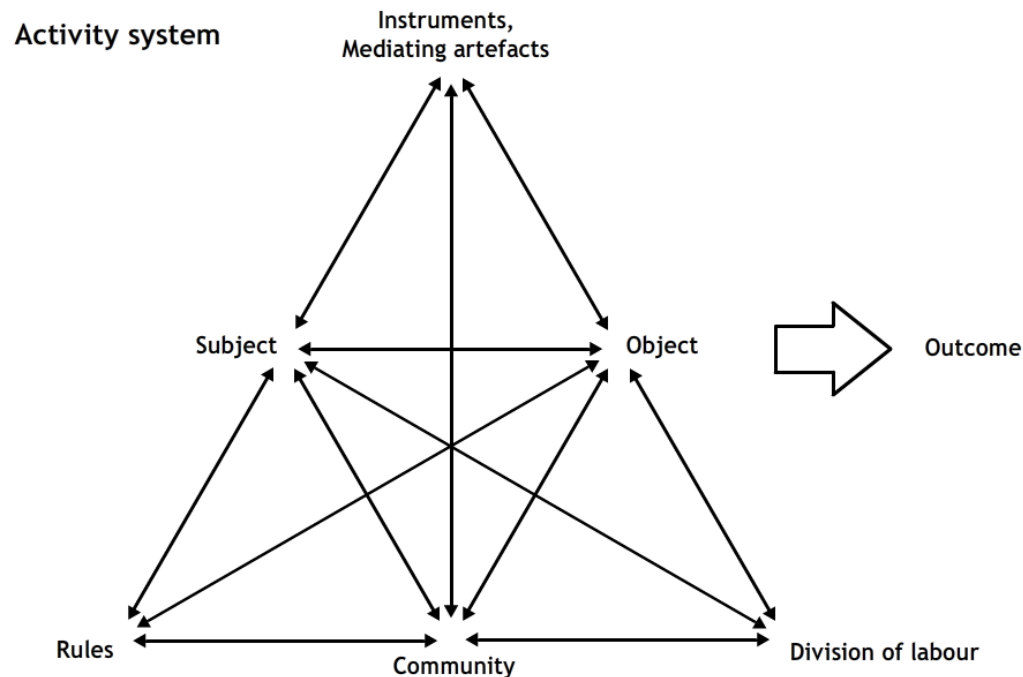


# Wave Theory of HCI

- \* 1 – Human Factors
  - \* Emphasizes human-machine coupling
  - \* Treats user as blackbox with inputs and outputs
- \* 2 – Cognitivist
  - \* Emphasizes the work/task context
  - \* Supports the user as an intentional agent
- \* 3 – Phenomenological
  - \* Emphasizes emergent uses of technology
  - \* Understands the user as a source of meanings

# Activity Theory

- \* Decomposes activity into “Activity, Action, Operation” hierarchy.
- \* These closely map to Knowledge, Rules, and Skills, respectively.



# Reconfiguring the Social Hierarchy

- \* How do we turn the rigid engineered system into a lightweight adaptable one?
- \* Parsimony *with* variety
  - \* Co-locate personnel (from iceberg to ice cube)
  - \* Redundancy and variability of roles (flexibility of interface)
- \* Automate skills (build them into the robot)
  - \* Dry-testing and modeling



# What does this have to do with interface design?

- \* Understanding context is important, but there is a problem with the unit of analysis (level of description)
  - \* We've designed a context but not an interface
  - \* More like a waterfall than co-evolution
- \* When we begin to look at the design of the interface itself a new set of dynamics begin to dominate
  - \* Perception, reasoning, situated-ness, communication



# How do we bridge the gap?

