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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



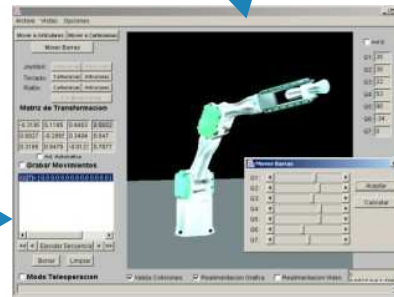
Robot operators



Tele-operated robot



Dry-testing



Interface



Emergence: higher scale effects

- Strong Emergence

“effects you could not anticipate or deduce”

- Weak Emergence

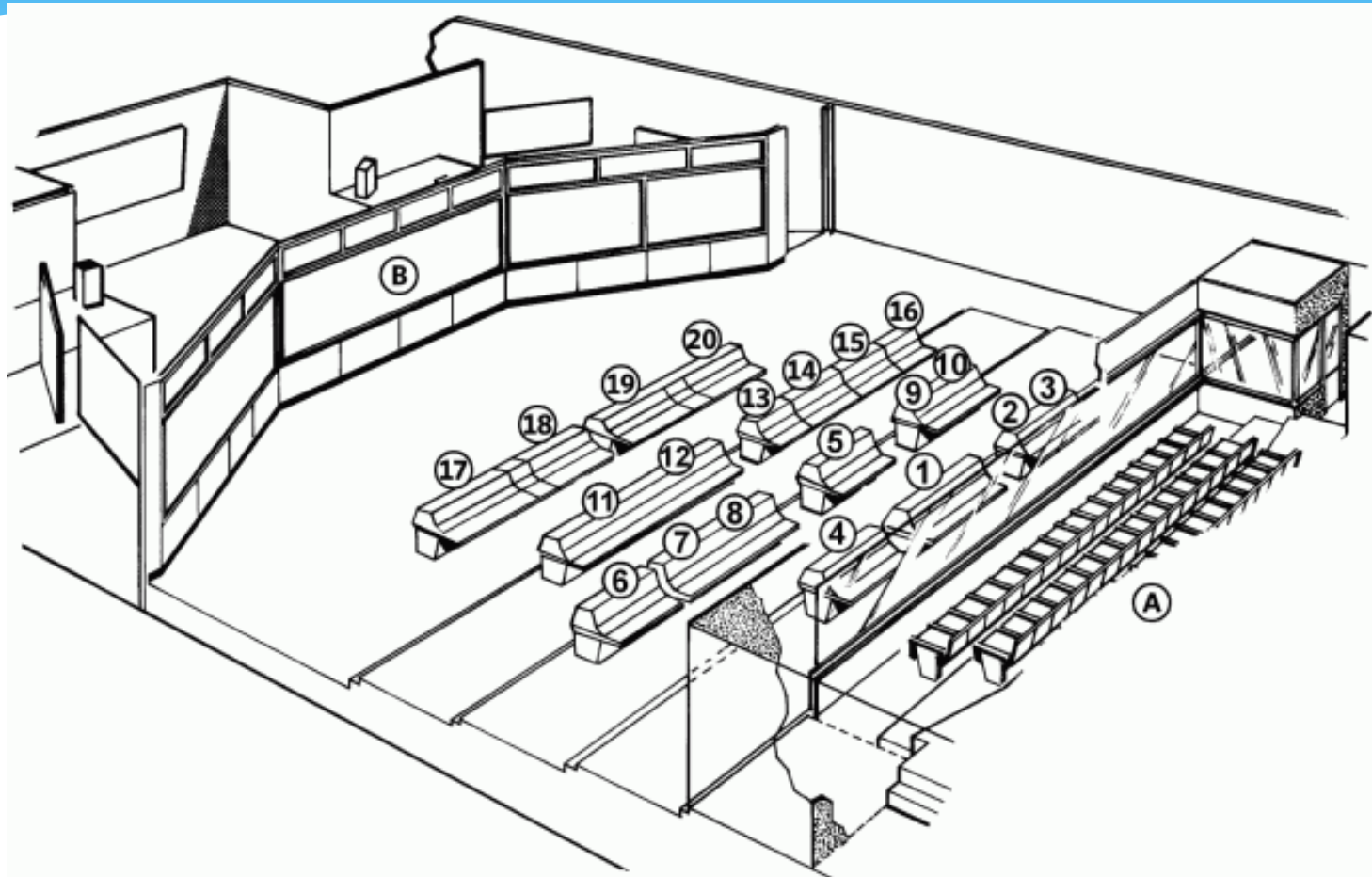
“predictable collective action”



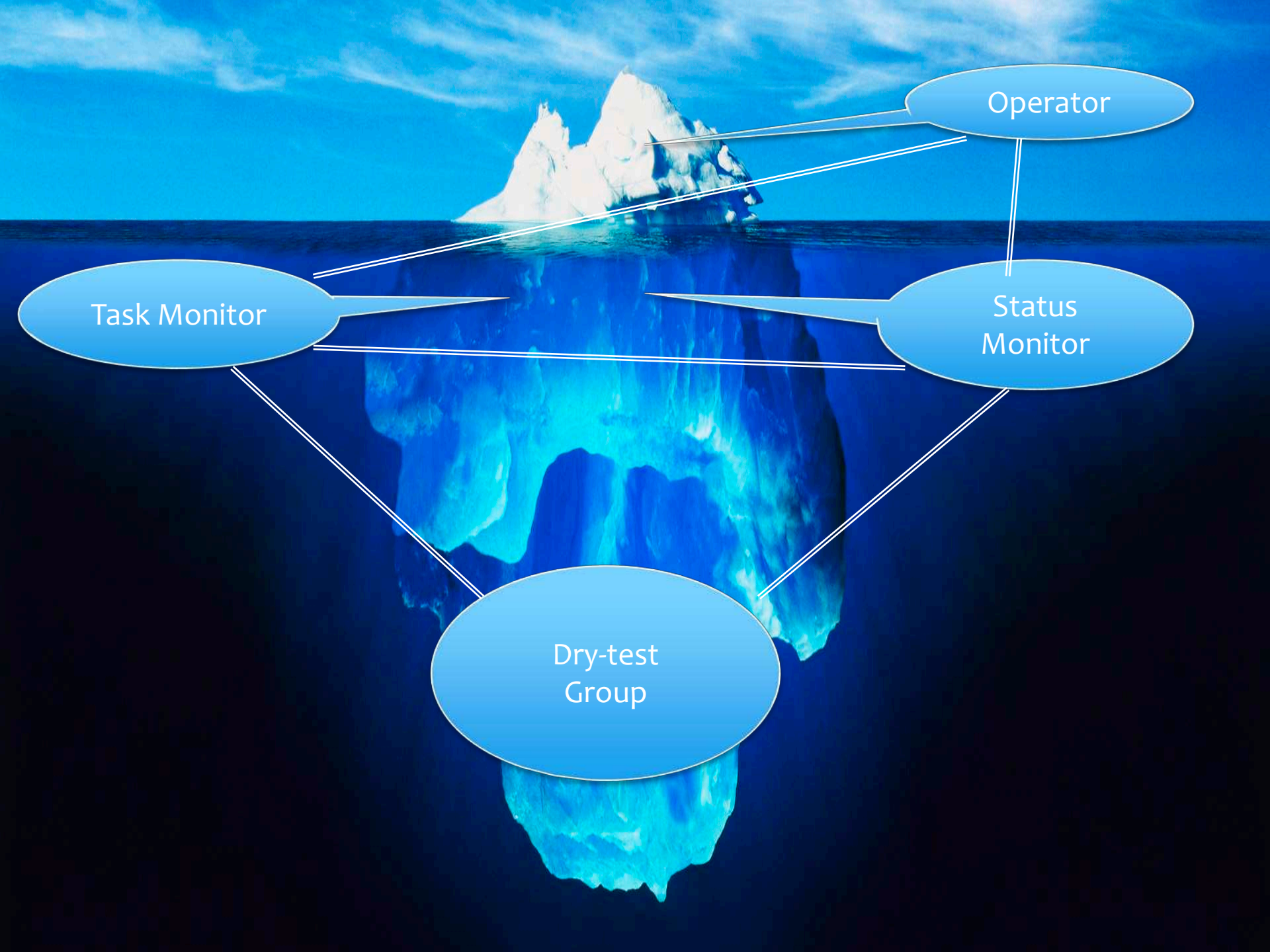
Engineering Emergence

- * 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/>



Operator

Task Monitor

Status Monitor

Dry-test Group

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

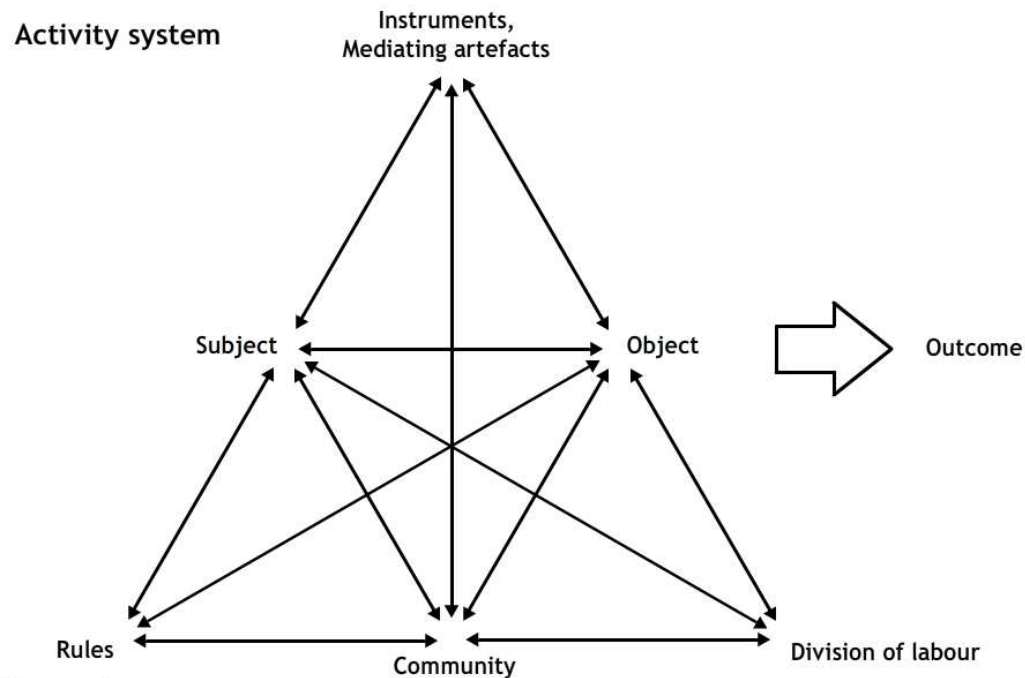


Wave Theory of HCI

- * 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?

