A Boundary Object Model to Analyze Communication Interfaces

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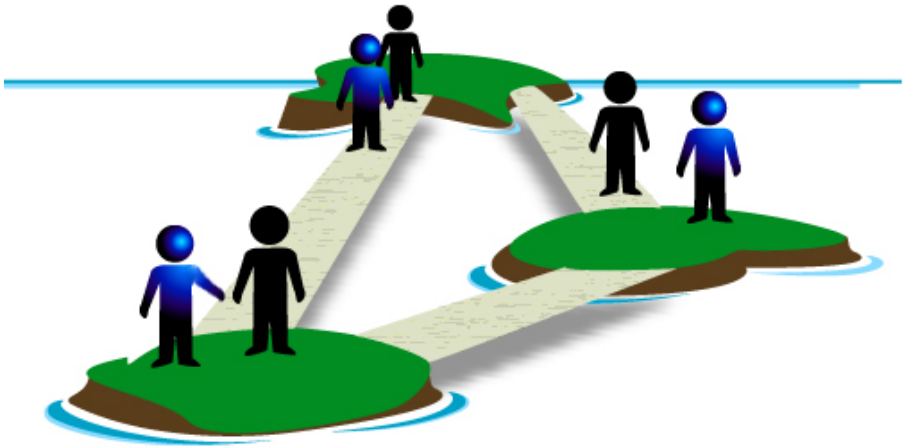

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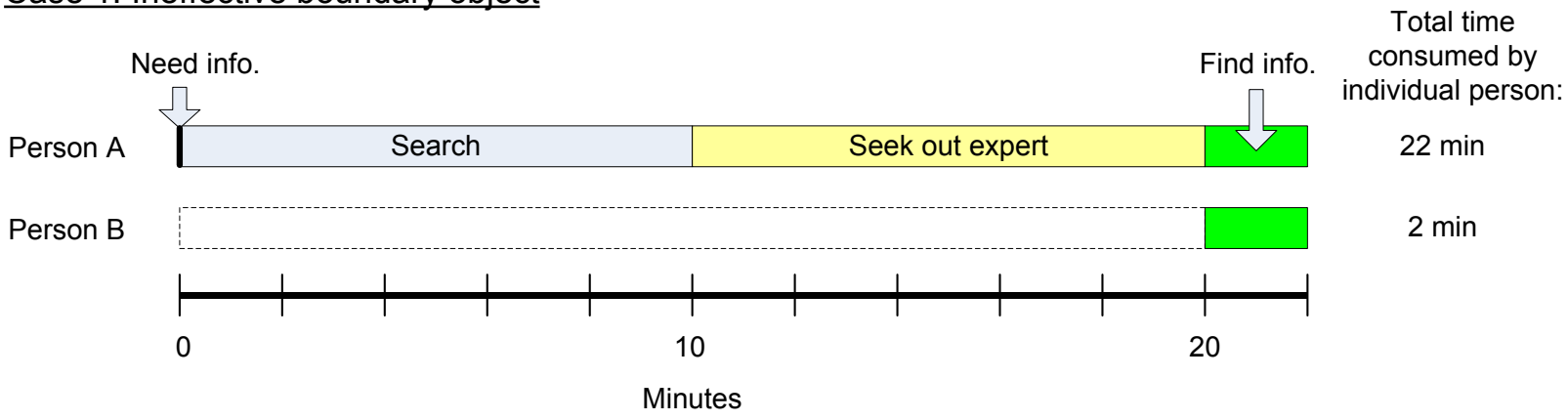
Outline

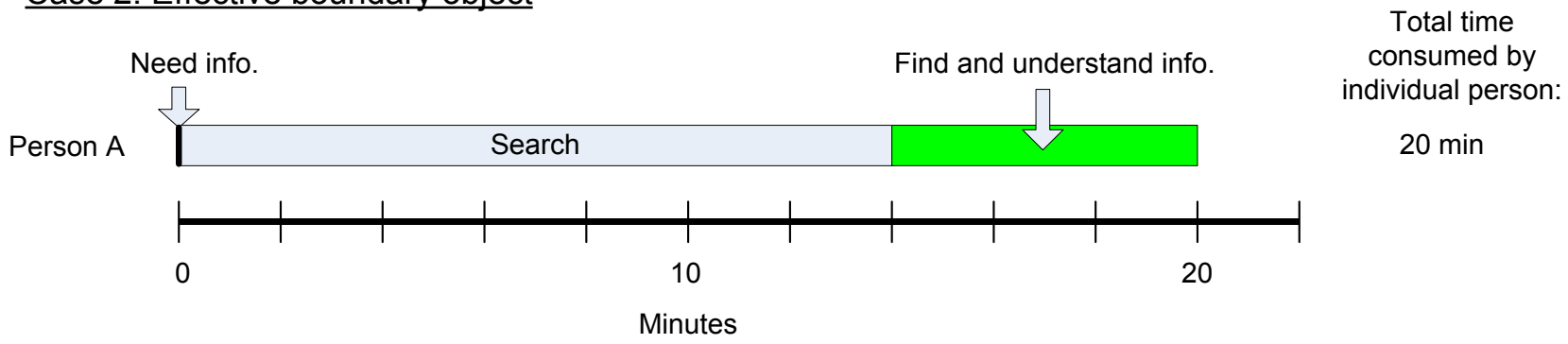
- Problem Statement
- Approach
- Boundary Object Example
- Previous Research Applications
- FCS Case Study
- Development of Boundary Object Framework
- TMOS Case Study
- Results
- Implications
- Recommendations
- Conclusions

Introduction

Case 1: Ineffective boundary object



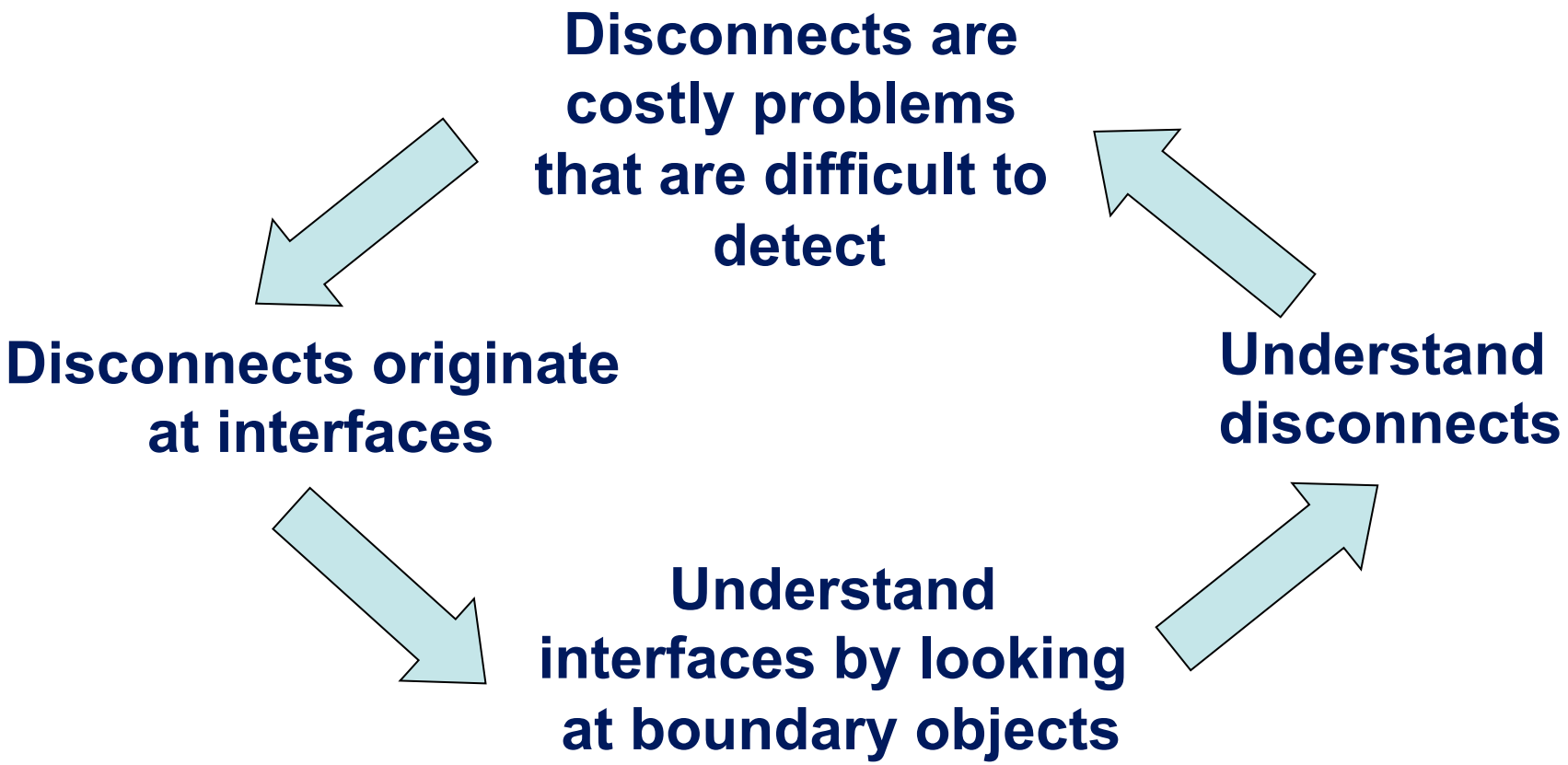
Case 2: Effective boundary object



Problem Statement

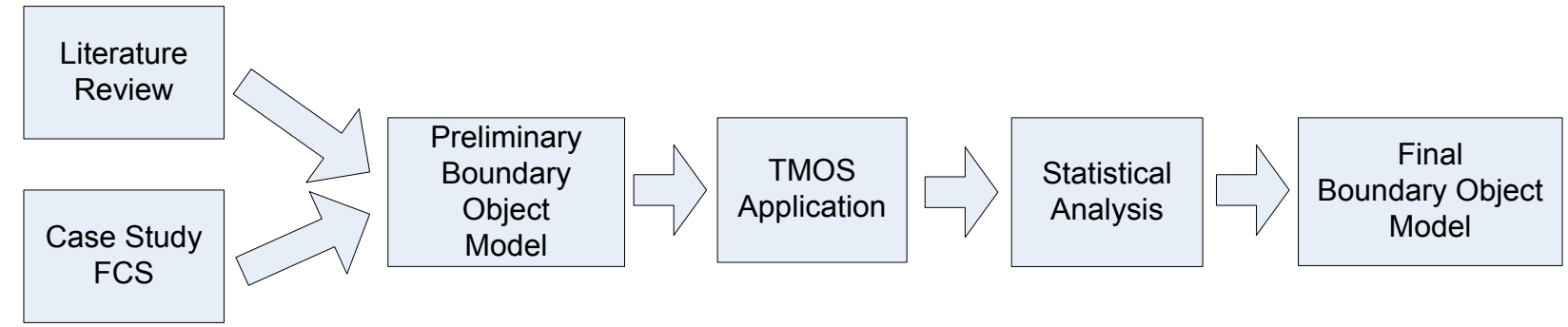
- Interdependencies of technical and organizational interfaces (Sosa, et al 2003; Gultati and Eppinger 1996)
- Programs and projects suffer from "organizational" disconnects
  - Disconnect: Latent differences in understanding among groups that can negatively affect the program should they remain undetected or unresolved (Greer, Black and Adams, 2006)
- Cost of unclear documentations and rework

Organizational Disconnects

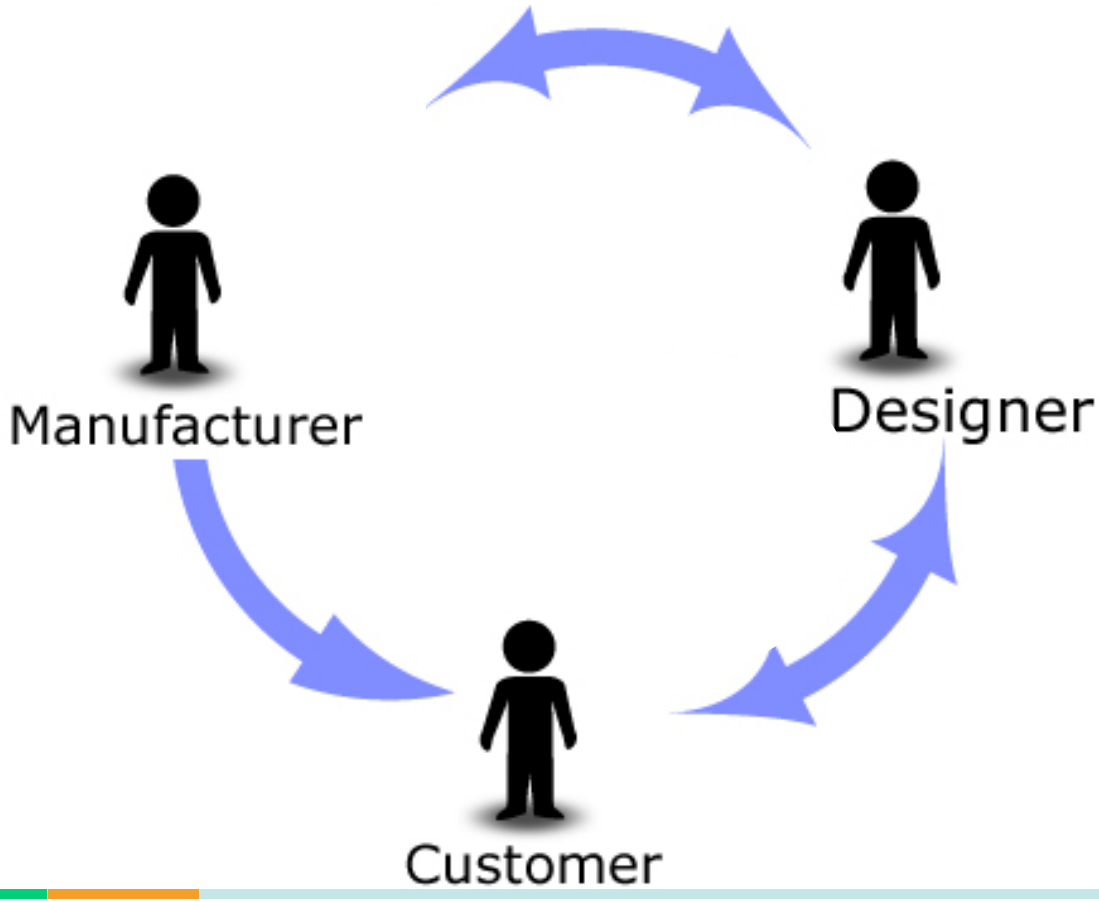


Boundary Objects: Bridge gaps and enables communication, coordination, and collaboration across boundaries

Research Approach



Boundary Object Example



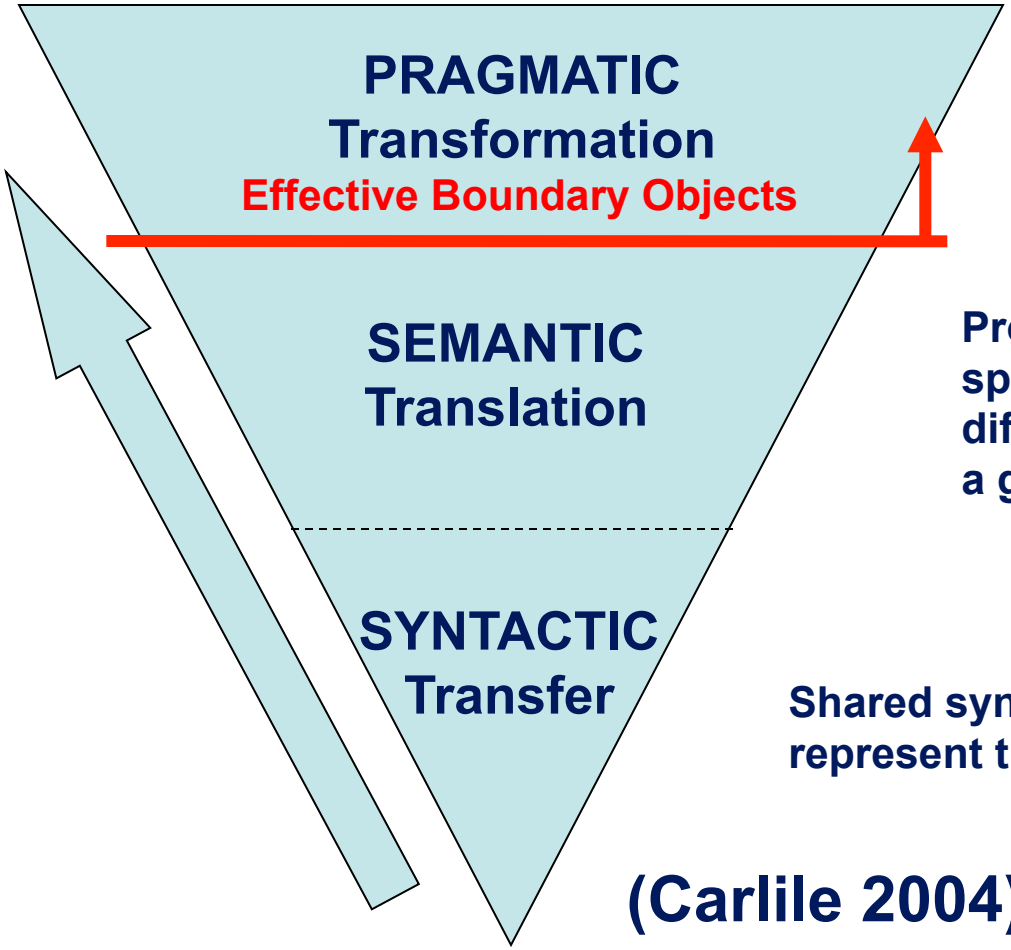
Previous Research Applications

Field	Organization	Boundary object
Social science (Star and Griesemer 1989)	Museum of zoology	Diagrams California map Collecting forms
Design engineering (Henderson 1991)	Engineering firm	Sketches Drawings CAD
Service (Ackerman and Halverson 1999)	Telephone hotline group	Written notes
Product development (Carlile 2002)	Automobile design and manufacturing firm	Drawings Automobile parts Schedule
Software development (Gunaratne et al. 2004)	R&D facility	Storyboard Prototype

FCS Case Study - Results

- Future Combat System
- Organization representatives interviewed
  - Boeing, BAE, Lockheed Martin, CSC, LNXW, IBM, COLSA
- Communication mechanism were primarily Word documents, PPT slides, and Excel graphs
- Local vs global communication objects
- Interorganizational trust is necessary for people to use boundary objects

Criteria for Effective Boundary Objects



Facilitates a process where individuals can jointly transform their knowledge

Provides a means for individuals to specify and learn about their differences and dependencies across a given boundary

Shared syntax or language for individuals to represent their knowledge

(Carlile 2004)

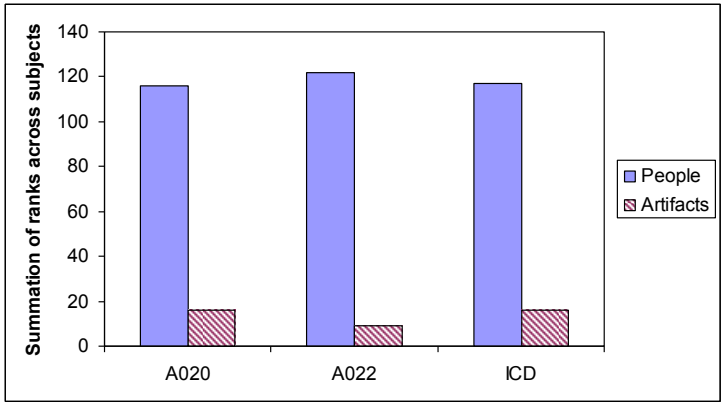
TMOS Case Study

- TSAT Mission Operations System, LA
- Interested in complex system and organizational interactions
- Method
  - Survey 1: Social interaction survey
  - Survey 2
    - Organizational interfaces
    - Understanding information
    - Boundary object attributes
- Data collected
  - Interviews
  - 13 survey responses

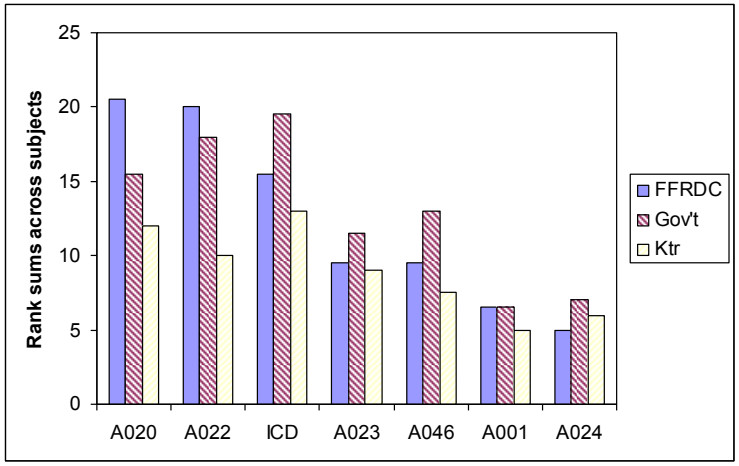
Understanding Information in TMOS

Where do people go for information regarding documents?

All p-values < 0.018



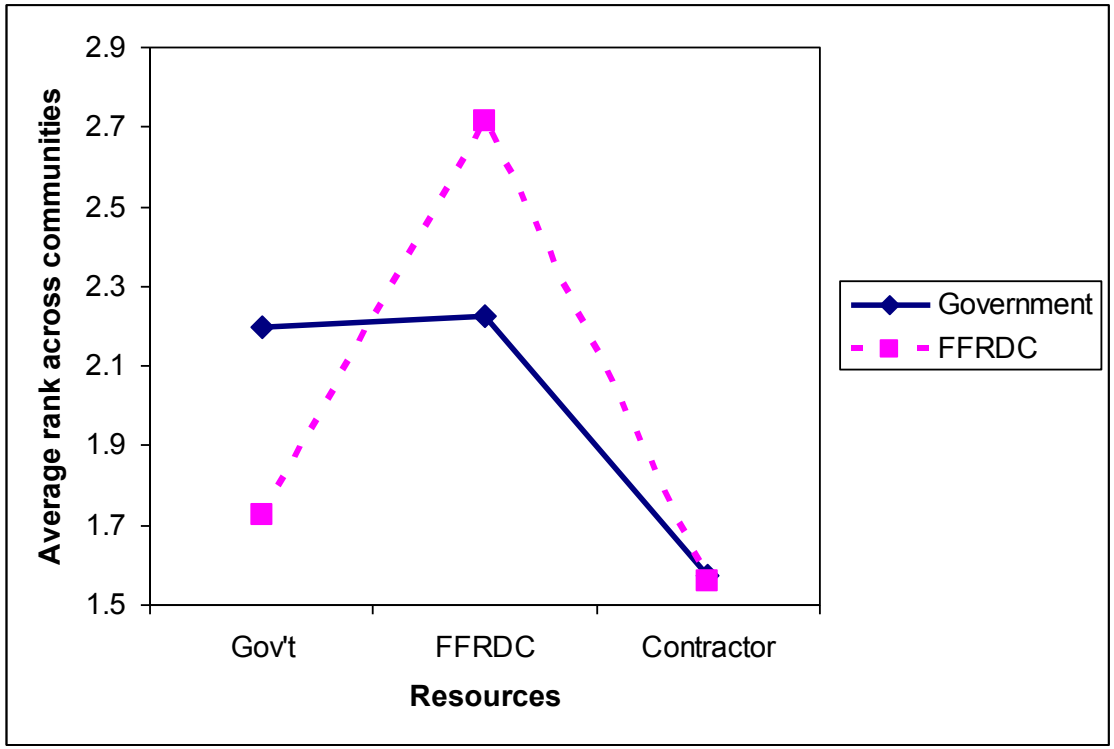
Who do people go to first?



People rely on other people significantly more than artifacts

Reliance on People

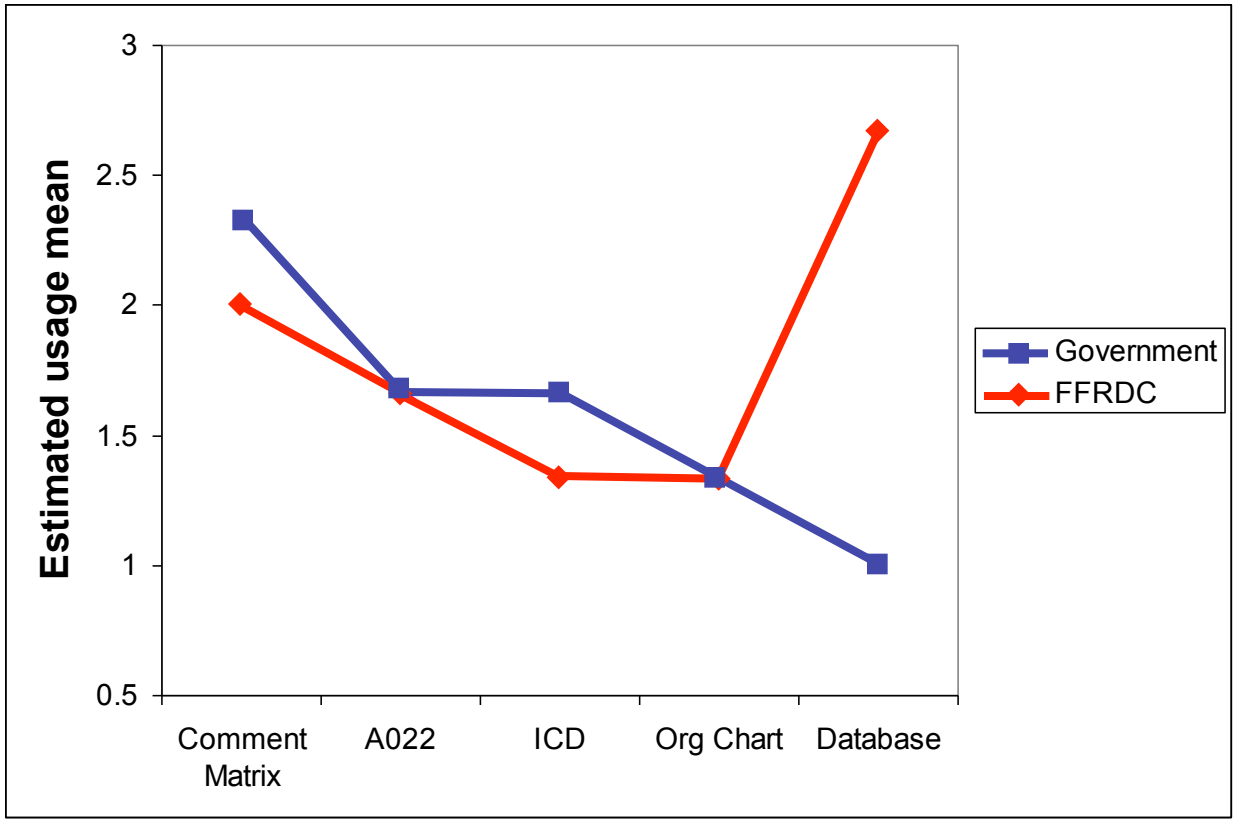
Who turns to whom?



Gov't employees are equally likely to turn to Gov't and FFRDC people while FFRDC employees turn to other FFRDC people first

Database Usage

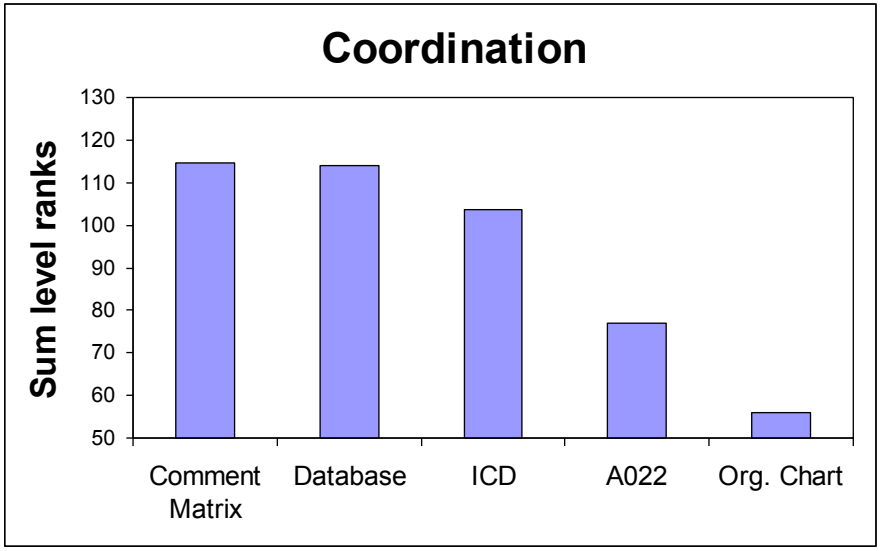
Are there differences in artifact usages?

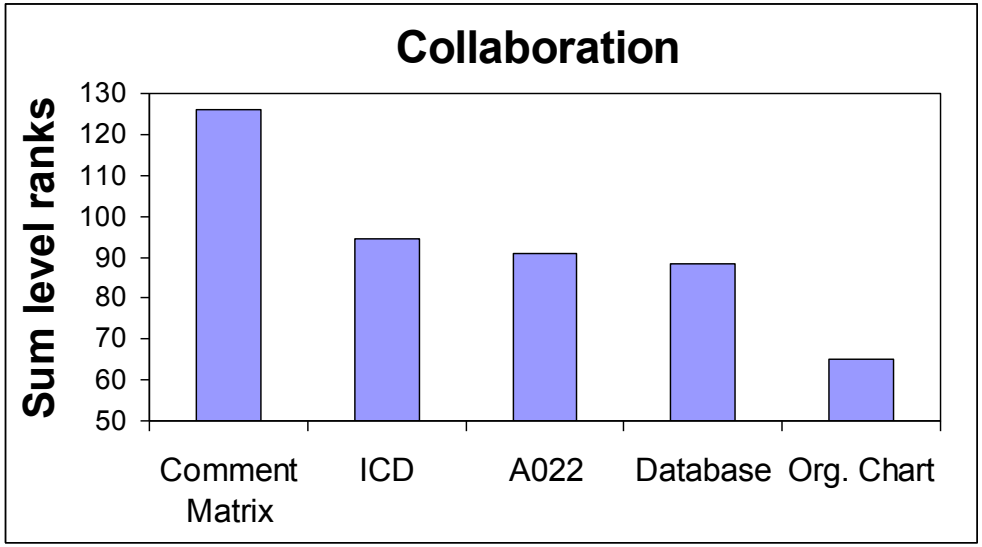


Usage is similar except for Database usage

Organizational Interfaces

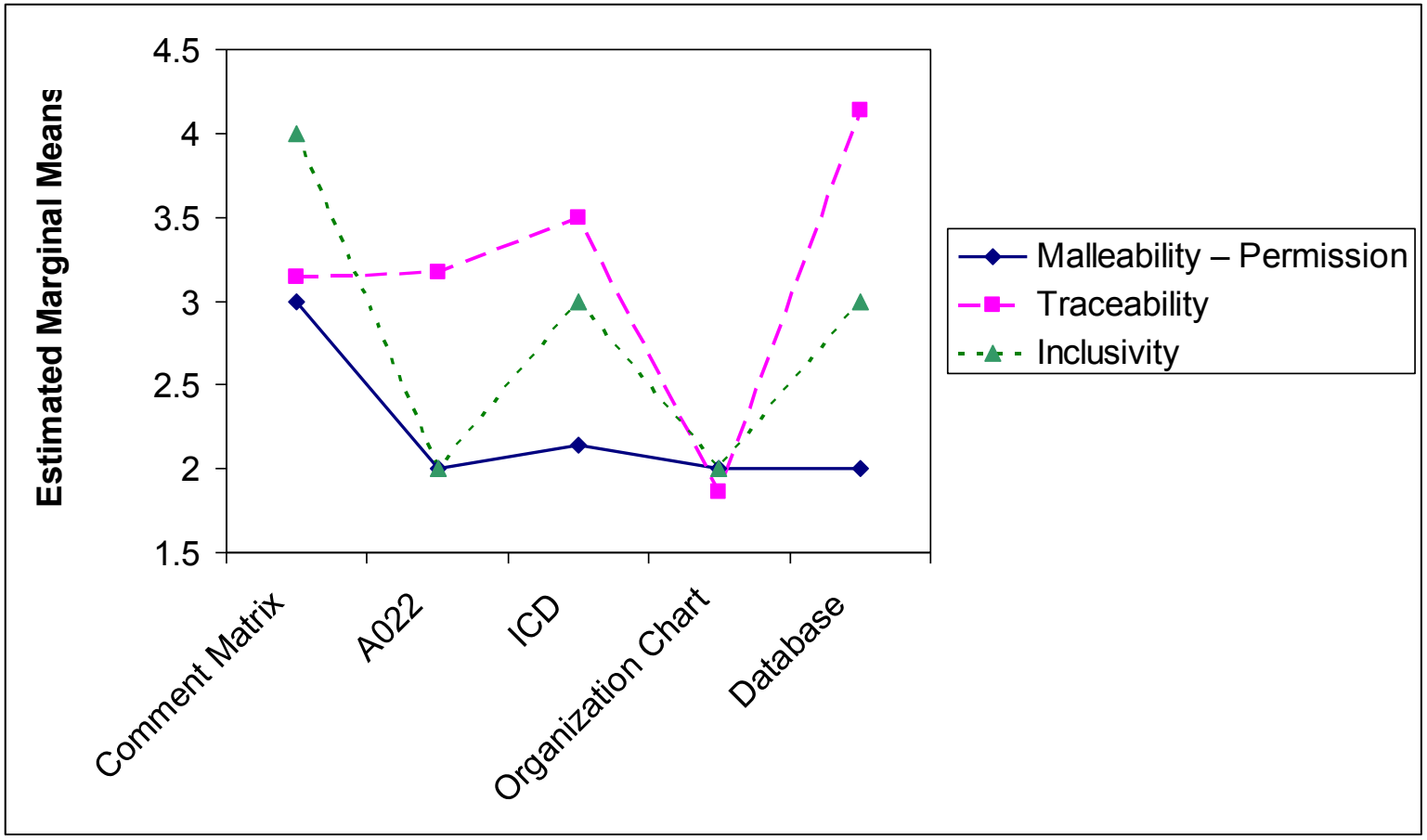
Which artifacts are helpful for coordination and collaboration?





Comment Matrix tends to be more effective as a boundary object

Attributes Results



Traceability and inclusivity are critical attributes

Boundary Object Attributes

- Traceability: level at which users can document and track alterations to the object
- Inclusivity: level of involvement of different stakeholders during the creation and use of the object
- Synchronization: the extent to which duplicates of the same object are linked

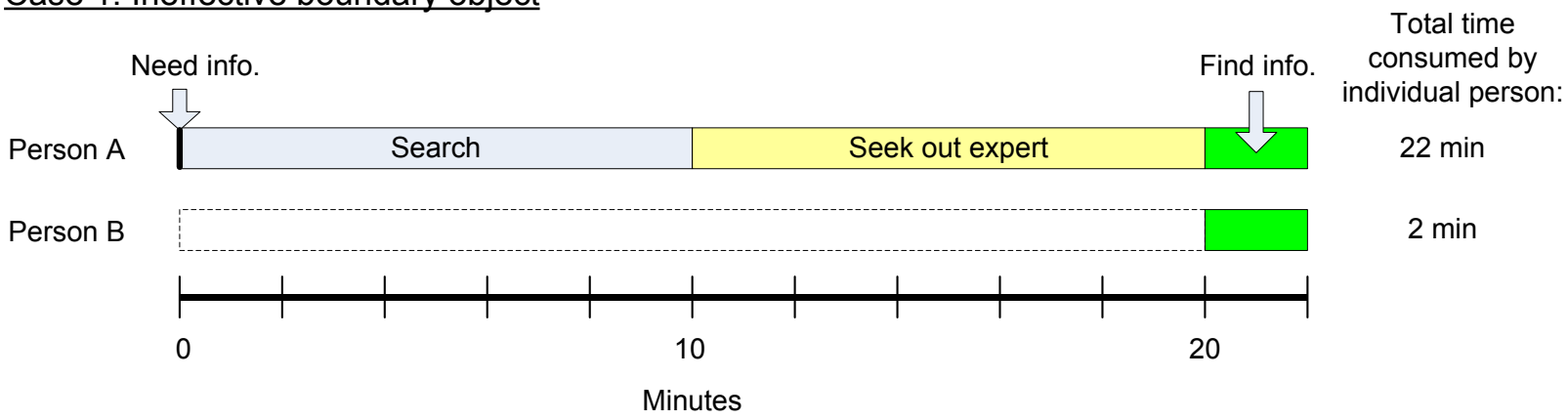
Traceability	Inclusivity
Synchronization	Layers
Freshness	Medium
Granularity	Importance
Malleability	

Recap of Result

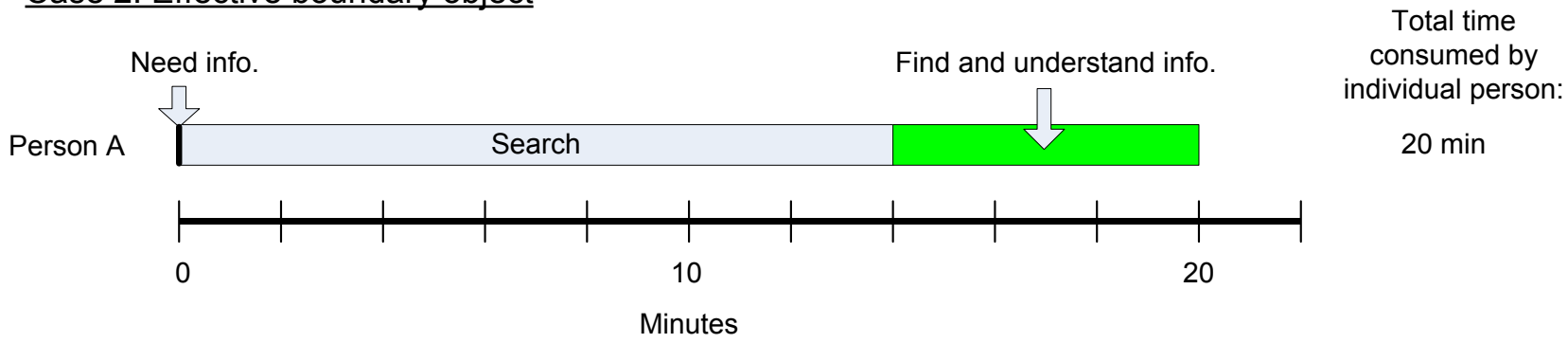
- People rely on other people significantly more than artifacts
- Gov't employees are equally likely to turn to Gov't and FFRDC people while FFRDC employees turn to other FFRDC people first
- Usage of artifacts amongst communities are similar except for Database usage
- Comment Matrix tends to be more effective as a boundary object
- Traceability and inclusivity are critical attributes

Implication: Usage of Boundary Objects

Case 1: Ineffective boundary object



Case 2: Effective boundary object



Over reliance on other people for understanding and clarity of information

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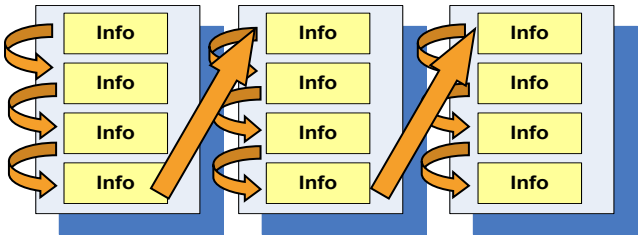
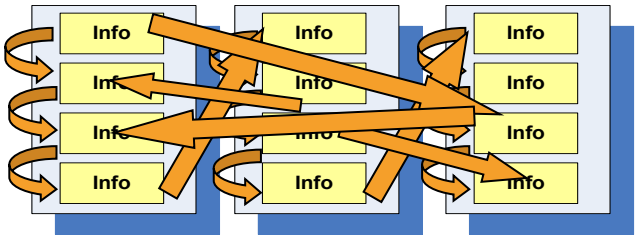
Implications

- Having the right boundary objects with the right attributes are important
- Prioritizing specific attributes and boundary objects can foster more collaboration
- Other organizational mechanisms are needed to maintain collaborative interfaces

Recommendations

- **Do:** Increase understandability by providing different levels of granularity in the artifacts (understandability)
- **Do:** Determine the frequency of freshness for boundary objects and prioritize resources accordingly (freshness)
- **Do:** Generate a sense of ownership amongst the users on the creation of critical boundary objects (inclusivity)
- **Don't:** Separate form from function (granularity and layers)
  - Concept maps as roadmaps for long documents





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Conclusion

- Interdependencies of organizational structure and technical structure
- Relying on people rather than artifacts for information can increase the overall cost of the program
- Not all communication mechanism, or artifacts, are used the same way and have the same effectiveness
- Boundary objects are effective mechanisms that assist in knowledge and value creation through collaborative process
- High traceability and inclusivity are two factors common in effective boundary objects
- If used correctly these boundary objects can serve, with other organizational mechanisms, as the glue that binds and connects different communities together

Acknowledgements

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Thank you

Questions?

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Backup Slides

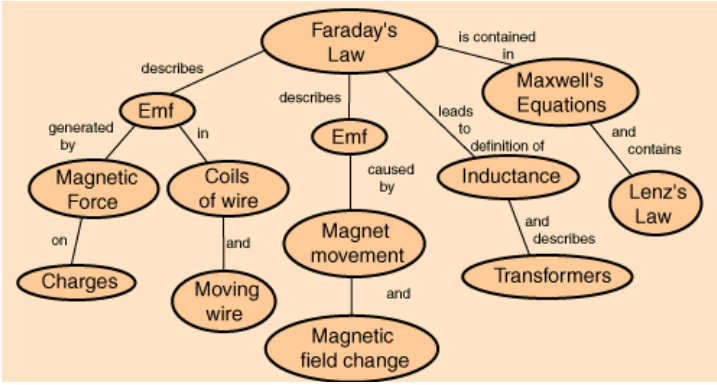
E-mail example

- Difficult to trace e-mails
- Lose of freshness
- Large volume of e-mails
  - Readers are forced to become information filters
- Standardized forms and methods boundary objects have been seen to be more effective in the case study than ideal type boundary objects
- Suggestion of standardized subject line could help users be better filters of information
  - Subject: |LvL 6|Detail 2|Time 2|April 20|

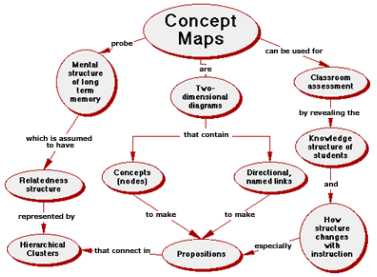
Concept Maps

- **Display information in concept maps**
  - **Useful for brainstorming, ontology, collaboration**
  - **Many different types of concept maps**
    - **Milton Pyramid**
  - **Various software programs to build concept maps**
    - **Viso**
    - **www.smartdraw.com**
- **Incorporate concept maps to documents**
  - **Helps writers and readers understand information better**

Any change in the magnetic environment of a coil of wire will cause a voltage (emf) to be "induced" in the coil. No matter how the change is produced, the voltage will be generated. The change could be produced by changing the magnetic field strength, moving a magnet toward or away from the coil, moving the coil into or out of the magnetic field, rotating the coil relative to the magnet, etc. Faraday's law is a fundamental relationship which comes from Maxwell's equations. It serves as a succinct summary of the ways a voltage (or emf) may be generated by a changing magnetic environment. The induced emf in a coil is equal to the negative of the rate of change of magnetic flux times the number of turns in the coil. It involves the interaction of charge with magnetic field.



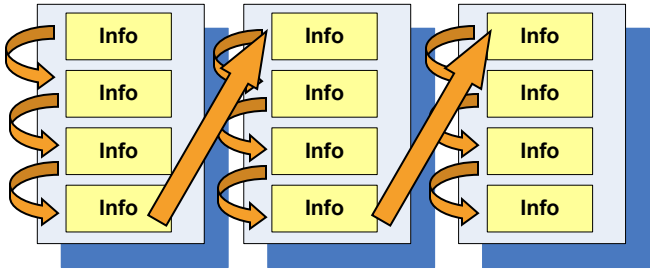
http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/faracon.html#c1

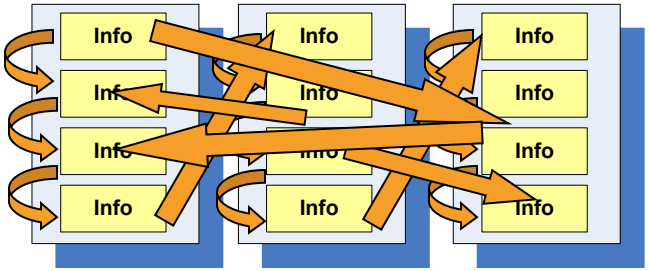


http://www.wcer.wisc.edu/archive/cl1/flag/cat/conmap/conmapf1.gif

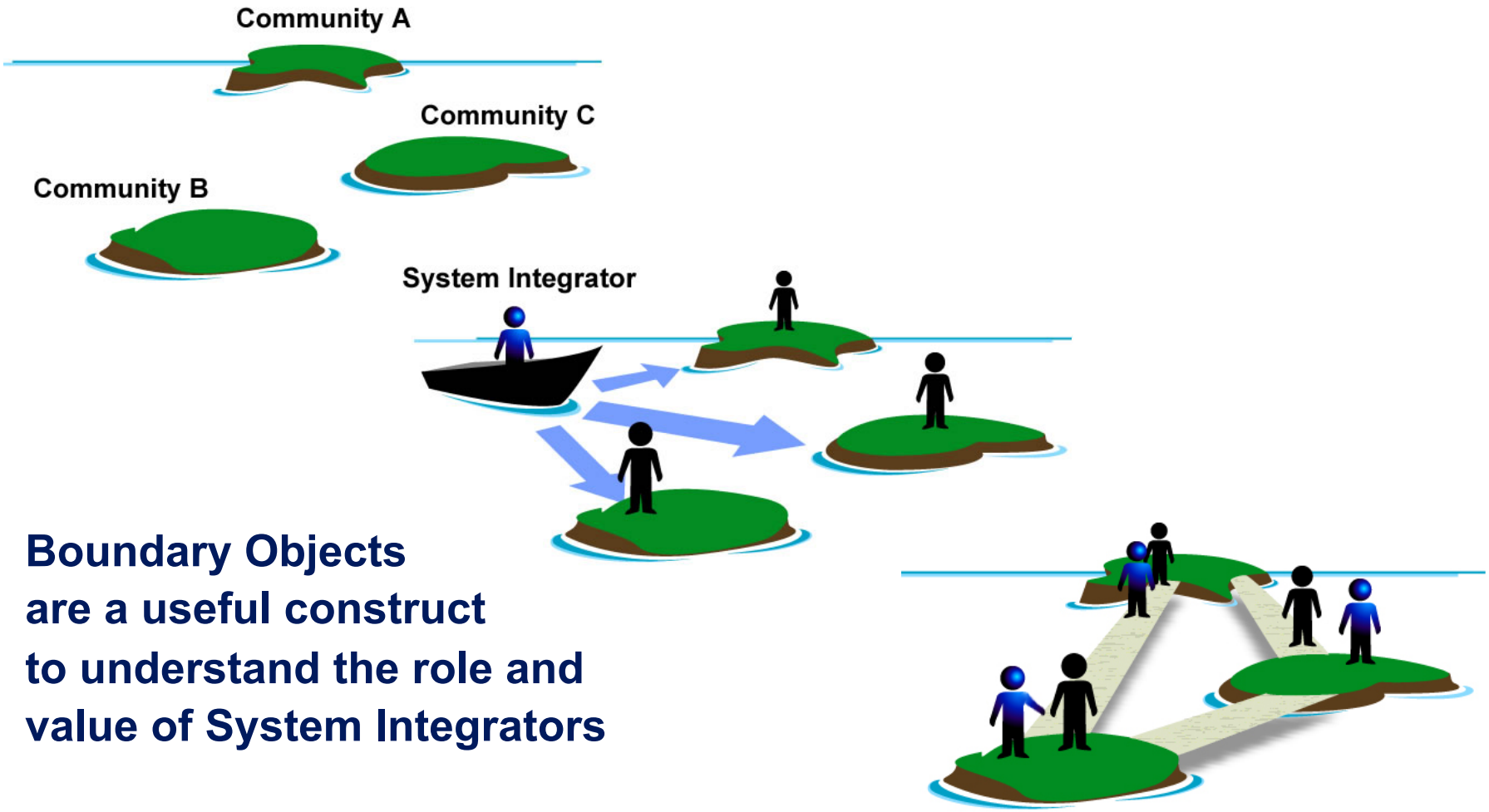
Recommendations for modifying artifacts

- Database synchronization
- Organization chart for expertise
- Addition of useful layers to documents and other objects
- Form of the object following its function
  - Information is rarely related linearly
  - Concept map



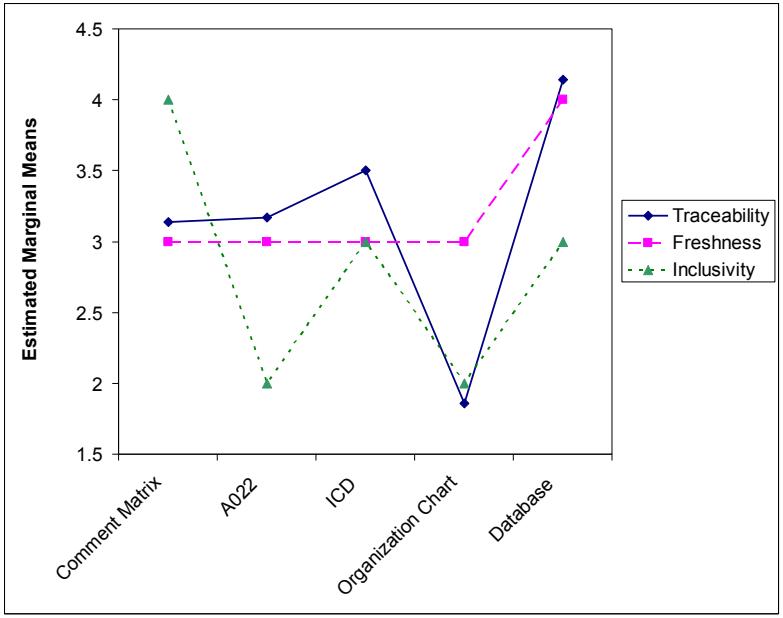


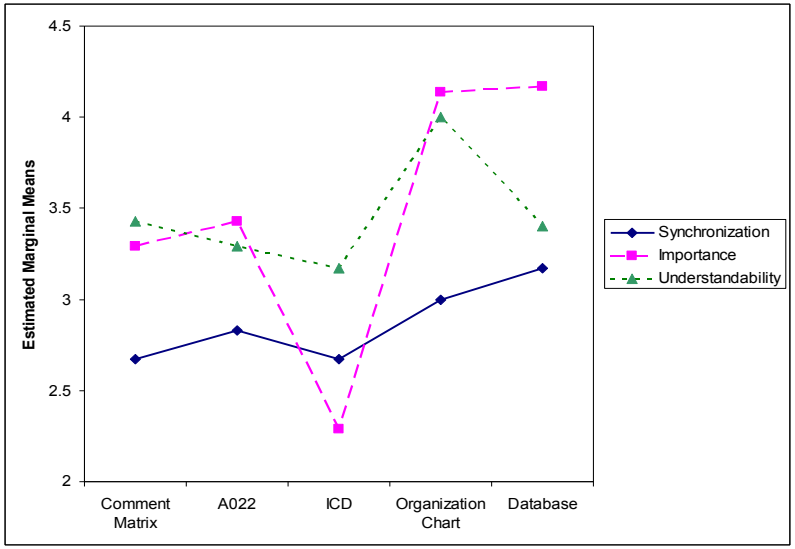
Implication for Systems Integrators

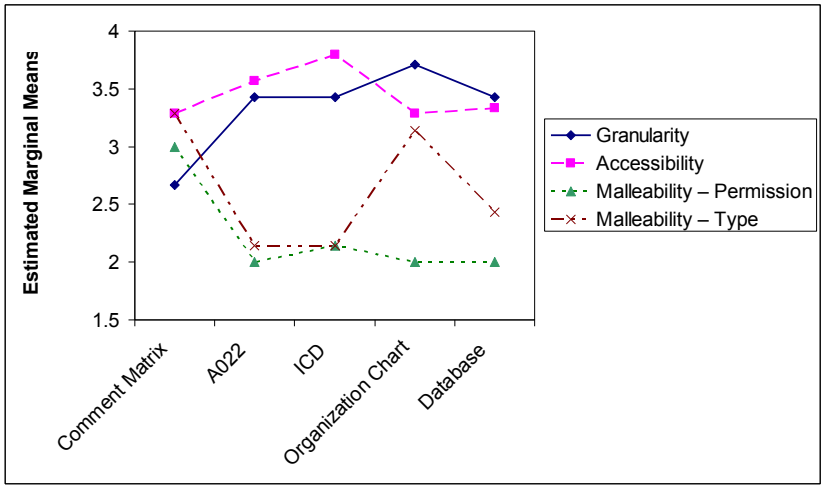


Boundary Objects are a useful construct to understand the role and value of System Integrators

Attributes Results







Boundary Object Attributes

- **Medium: virtual vs physical**
- **Granularity: level of information detail and context**
- **Staleness Factor: how stale the information tends to be**

$$\frac{\text{Average time to update a boundary object}}{\text{Average time between changes in the information}}$$

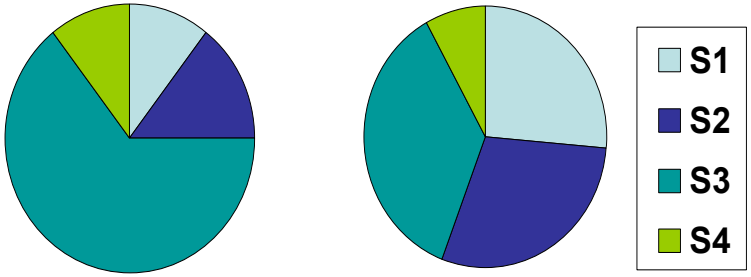
- **Malleability: how easy is it for someone to change, add information, mark up**
  - **Control vs Type malleability**

Definitions

- Community of Practice: Shared understanding of what the community does, of how to do it, and of how it relates to other communities (Brown and Duguid, 1998)
- Boundary Objects: Artifacts that are flexible enough to adapt to local needs yet specific enough to maintain a common identity across different interpretations (Star and Griesemer, 1989)
  - Bridge gaps and enables communication, coordination, and collaboration across boundaries
- Boundaries: gaps or differences in organization structures or entities, political power, relative expertise, knowledge domains, etc. (Greer, Black and Adams, 2006)
- Disconnect: Latent differences in understanding among groups that can negatively affect the program should they remain undetected or unresolved (Greer, Black and Adams, 2006)

Medium, Granularity, Malleability, Inclusivity

- Medium: virtual vs physical
- Granularity: level of information detail and context
- Malleability: how easy is it for someone to change, add information, mark up
  - Control vs Type malleability
- Inclusivity: level of participation



Layers, Traceability, Importance

- Layers: What additional resources you need to understand the information (Swarts, 2004)
- Traceability: ability to track usage and changes, process transparency
- Importance: Criticality, how would you use the information

