Mind the Gap: Human Decision Making and Information Fusion

Licentiate Thesis
2008

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Outline

- Information fusion and human decision making
- Research aim and approach
- Initial studies
- Results
- Conclusion
- Summary of Contributions
- Future work

Complex Decision Making

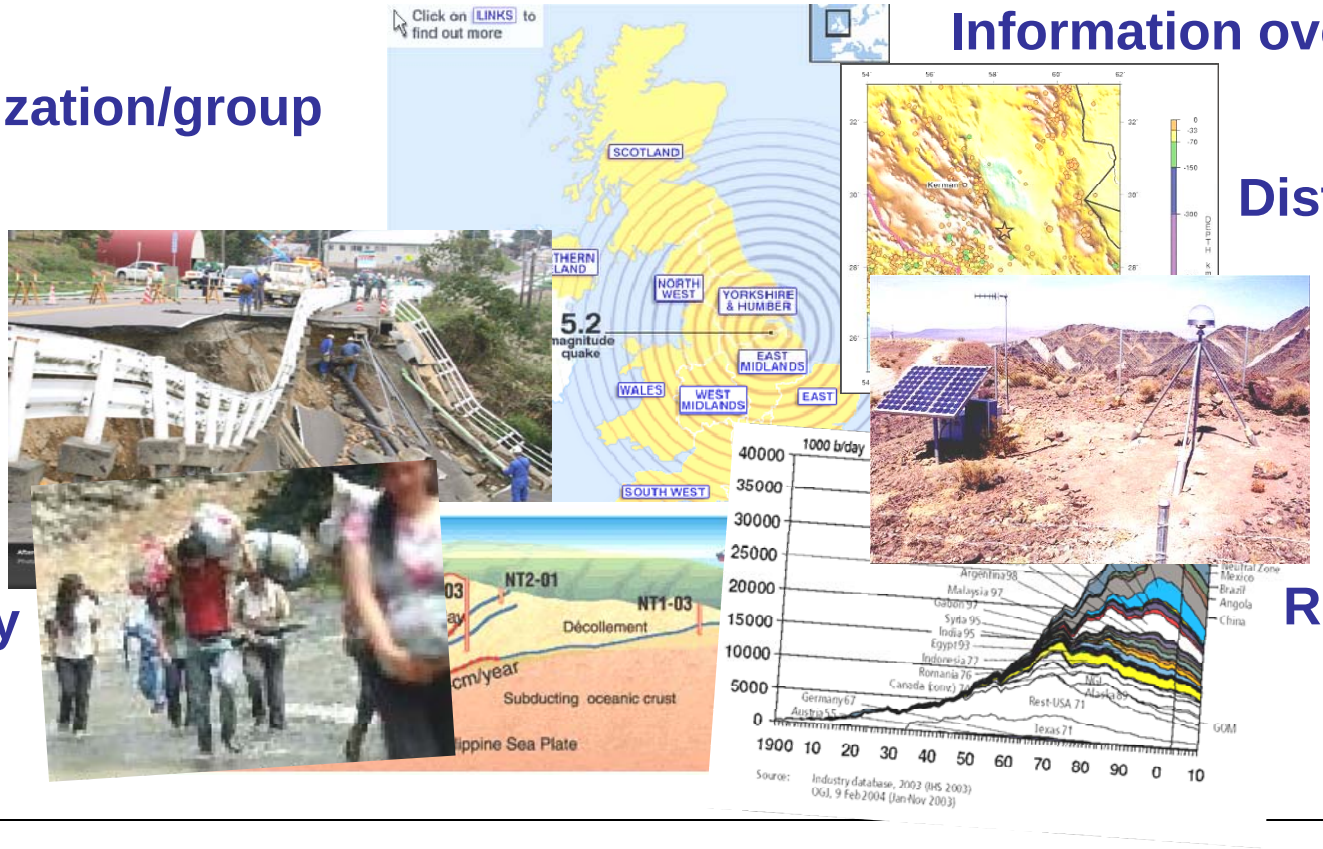
- Task: allocate ambulances after an earthquake

Organization/group

Dynamism

Real-time

Complexity



Information overload

Distributed

Uncertainty

Risk/Trust

Information Fusion

- **"The study of efficient methods for automatically and semi-automatically transforming information from different sources and different points in time into a representation that provides *effective support for human* or automated decision making"**

  (Boström et al, 2007)

cf. page 2

Decision Maker's point of view

- What information should be fused
- When does the decision maker have enough information
- How, and what information should be represented
- What information (sources/fused) should be accessed
- What implications does interacting with a representation of the world have for decisions
- How many information sources can be dealt with simultaneously
- What is good/bad decision/ support

cf. page 22

Research Aim

- Analyze the relation between human decision making and information fusion
  - What are the interdependencies between human decision making and information fusion systems/processes?

➢ Contribute to information fusion research domain

"Where data fusion models lack detail is when they address issues relating to situation awareness and decision-making"

(Hall et al, 2007, p. 6) ;

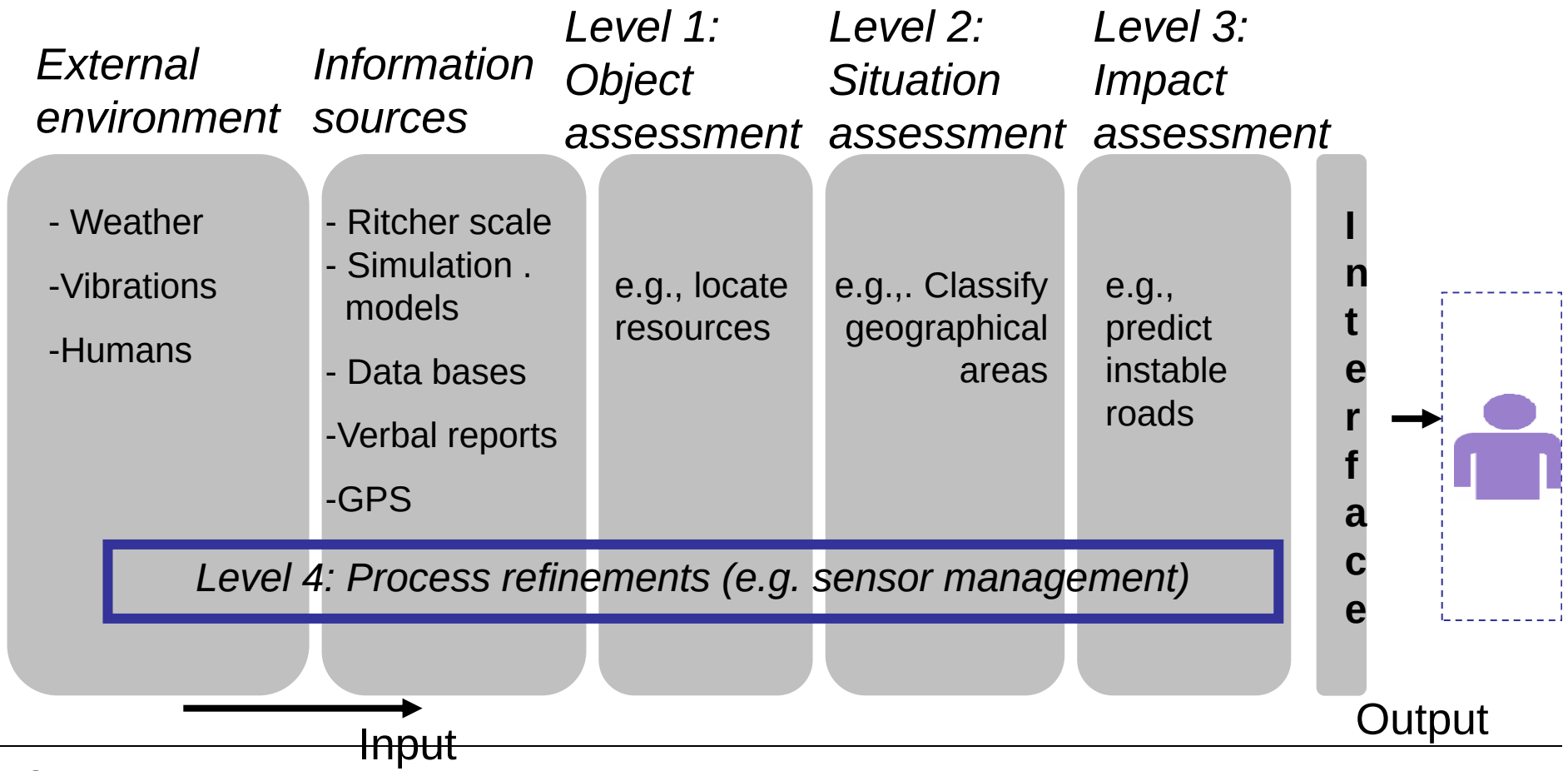
"an increase in sensors and the complexity of the network …. does not necessary mean that officers using that data will make better decisions"

(Bolia et al., 2007, p. 191)

cf. page 3

Information Fusion Model

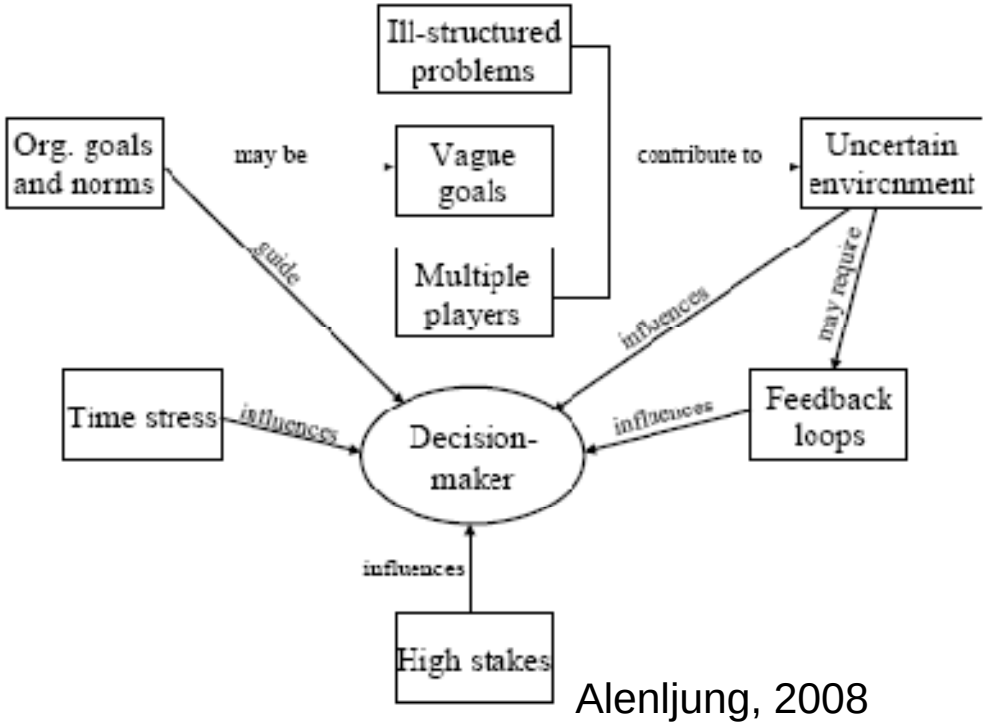
- JDL model



cf. page 10

Decision Making Model

- Naturalistic decision making (expert decision making)



Alenljung, 2008

cf. page 24

Research Approach

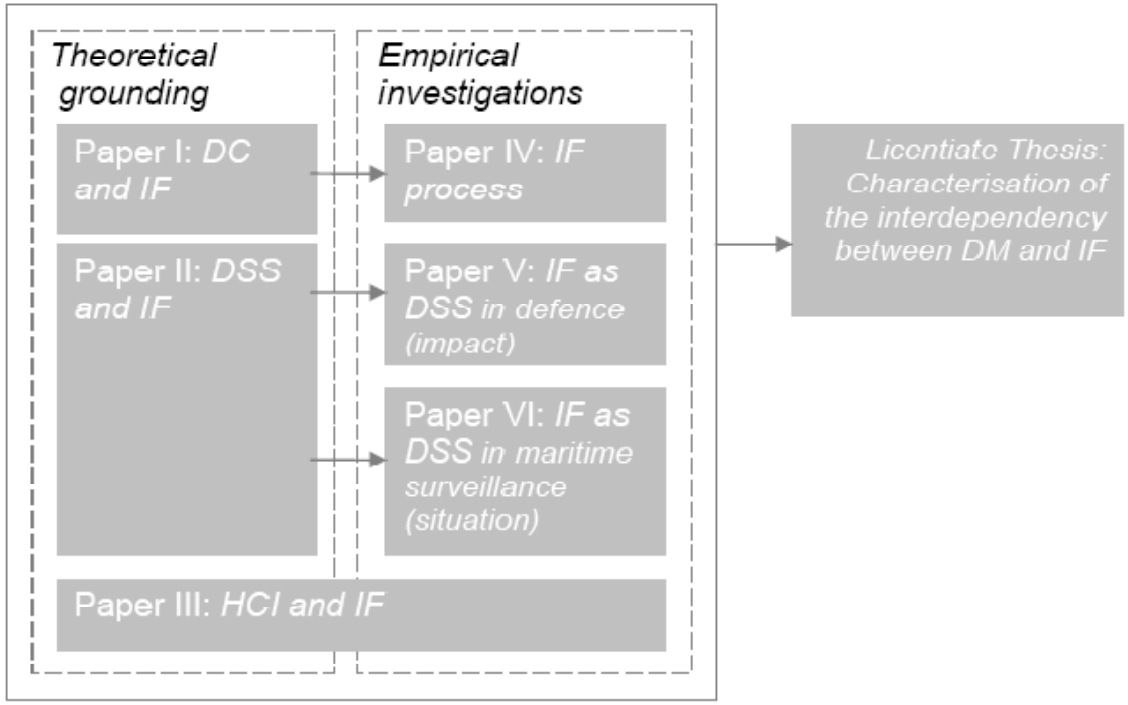
What are the interdependencies between human decision making and information fusion systems/processes?

- Qualitative research
  - Identify: existing models and concepts
  - Investigate: the relationship between human decision making and IF
  - Develop: new or adopt old models
- Assessment of qualitative research
  - Credibility, transferability, dependability, confirmability

cf. page 38

Research Approach

- Theoretical grounding
- Empirical investigation



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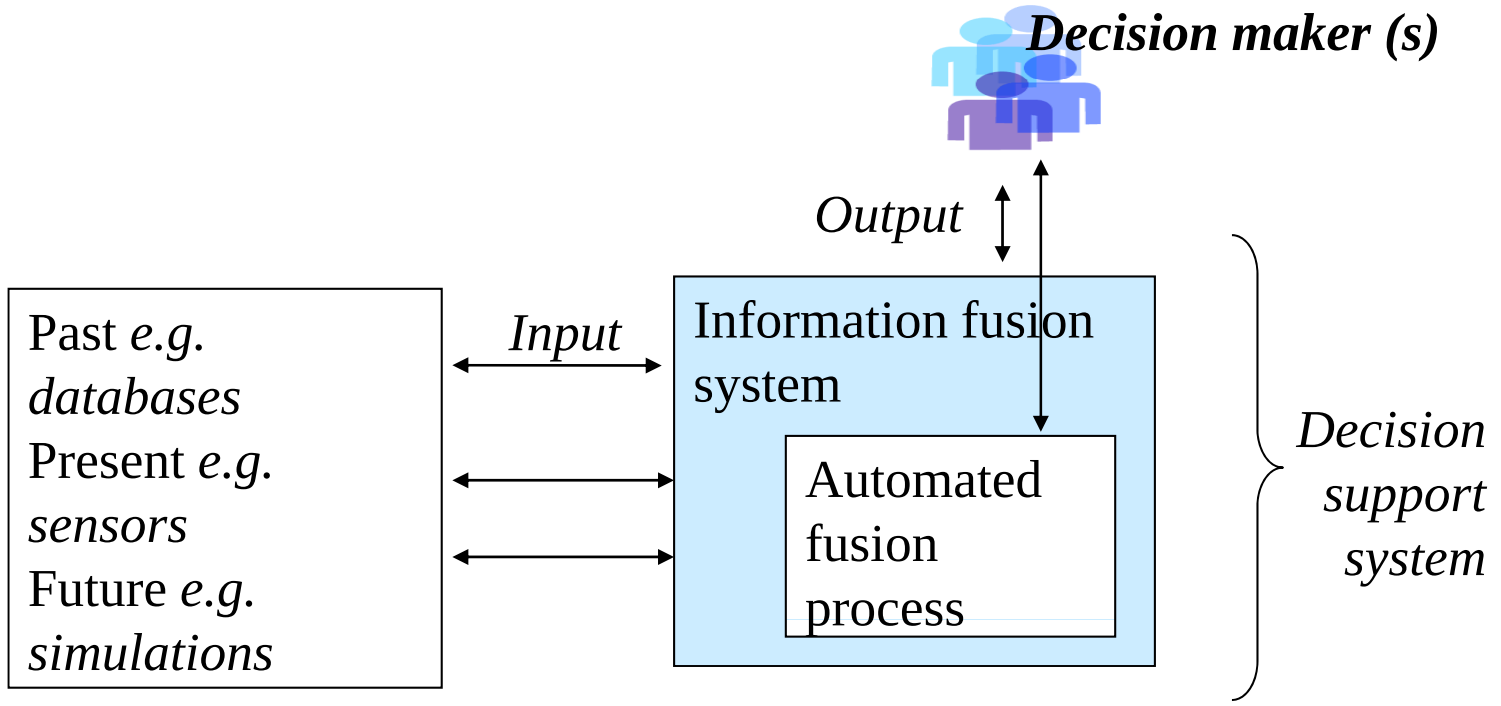
IF as Decision Support: Theoretical Grounding

- IF driven decision support systems

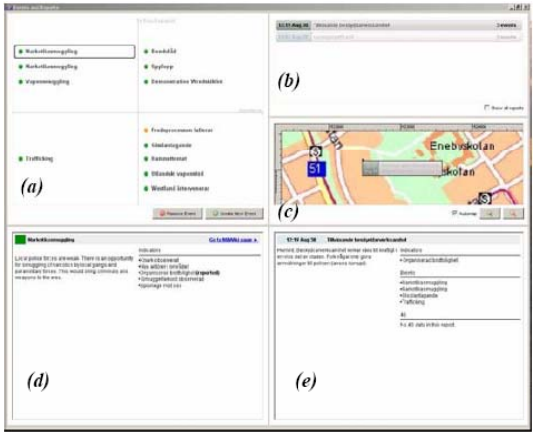


IF as Decision Support: Empirical Investigations

Impactorium

- *Background*: a tool supporting commanders by presenting probabilities of future events to support proactive decision making

- *Method*: explorative evaluation, 4 interviews

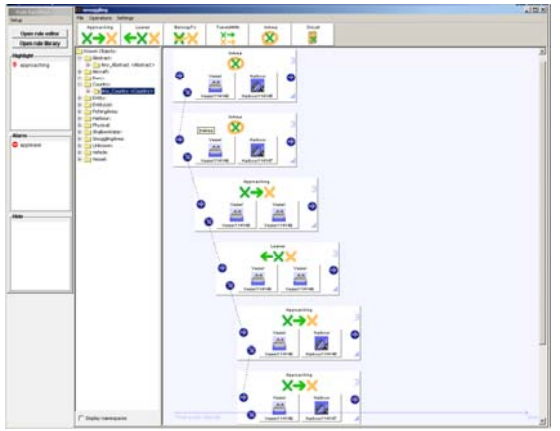


- *Result*: long-term decision frames; importance of the situation map; when to take action?

IF as Decision Support: Empirical Investigations

Maritime awareness

- *Background*: a tool using expert knowledge to support operators by alerting interesting events
- *Method*: capturing experts knowledge by participatory observations of 7 experts
- *Result*: decision rules emerging from individual, organizational or group thinking



Results: Definitions

IF driven decision support system consist of:

- information from different resources (sensors, humans, databases, information technology),
- providing both automatic and semi-automatic fusion processes,
- enabling complex decision making from large amounts of information

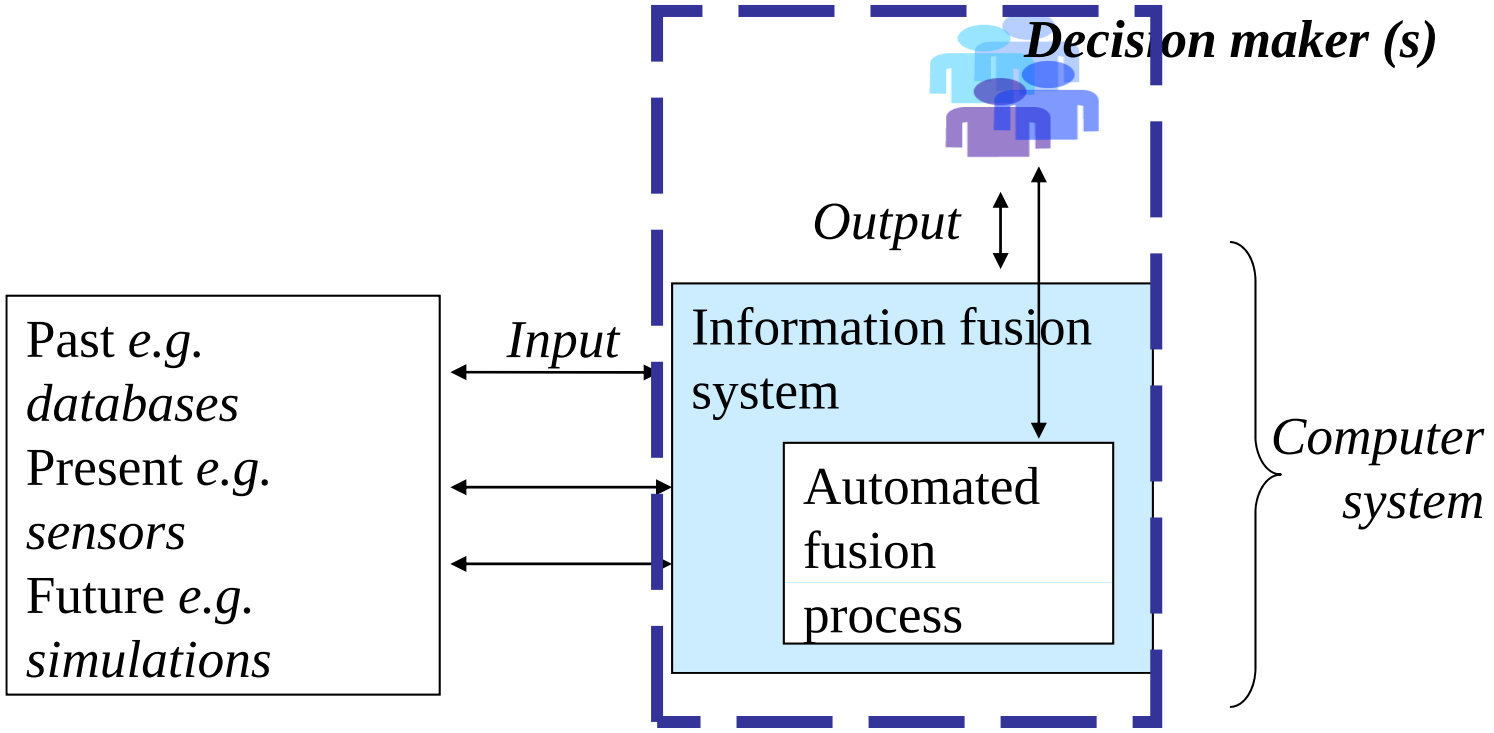
(cf., decision support classes by Power, 2002)

(IF process:

- a fusion process can be characterised as consisting of transformations of representational states
  - mediated by technology and humans)

Results: Models

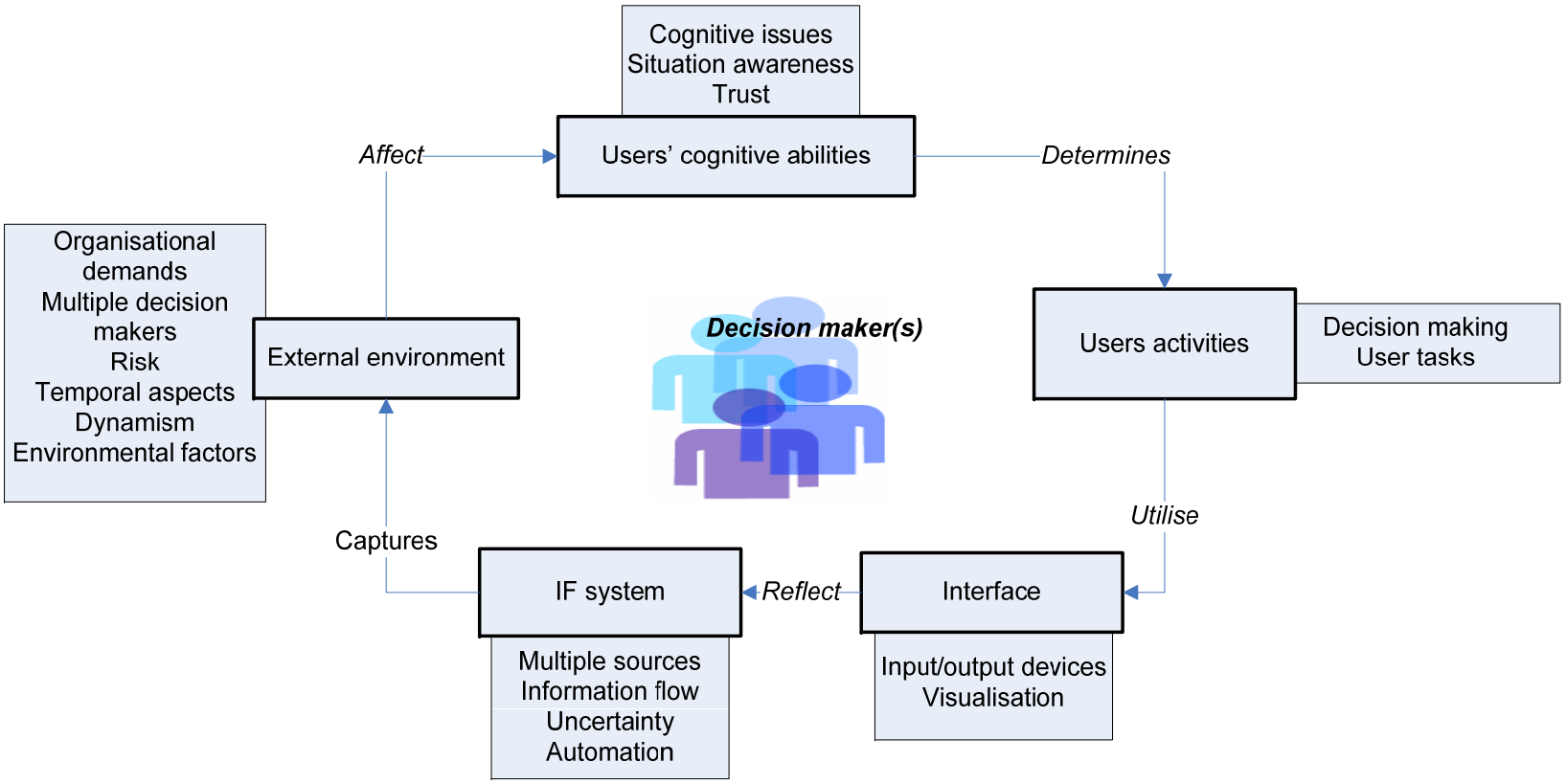
- Characterizing IF driven decision supports



Information fusion process

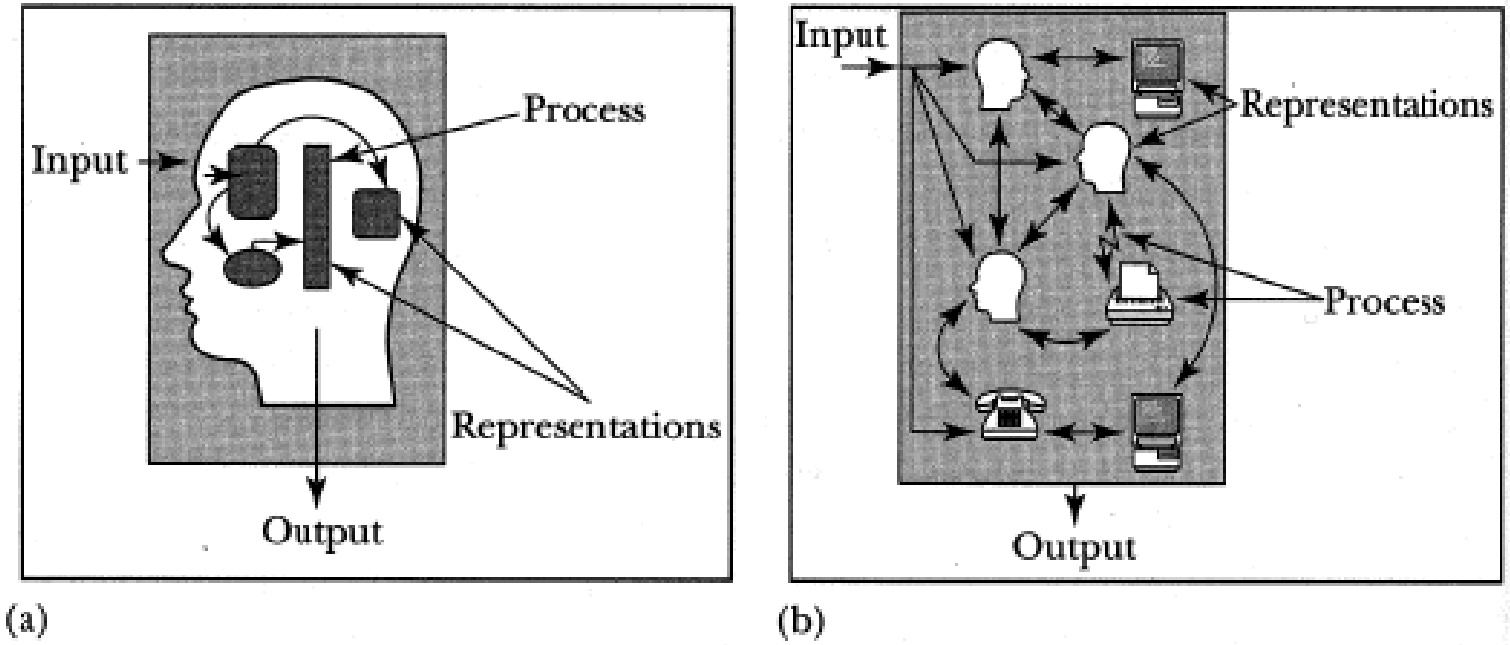
Results: Models

- Characterizing an IF decision maker's environment



IF as a Distributed Process: Theoretical Grounding

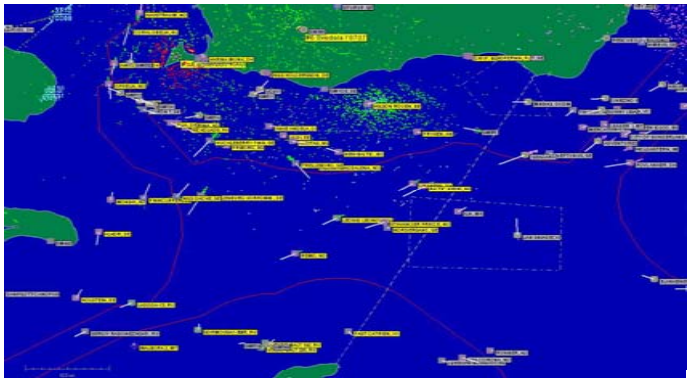
- Distributed cognition as an approach to capture information fusion processes



(a) Mental cognition, (b) Distributed cognition.

IF as a Distributed Process : Empirical Investigation

- *Background*: characterise the active role of users in IF processes

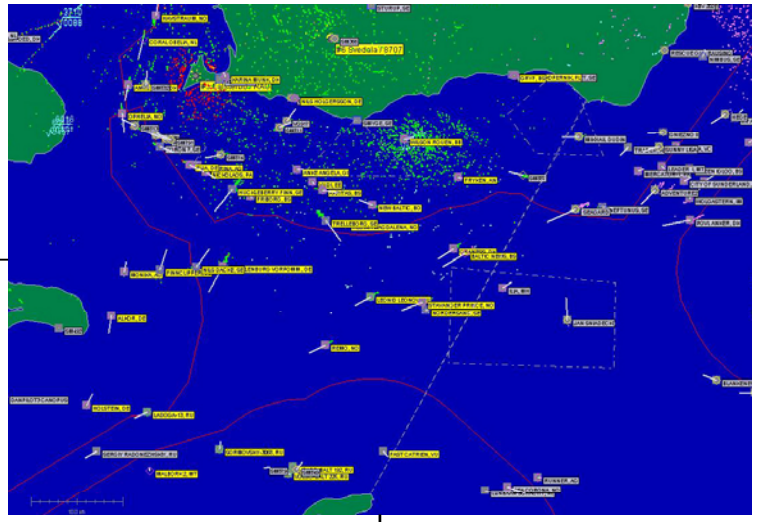


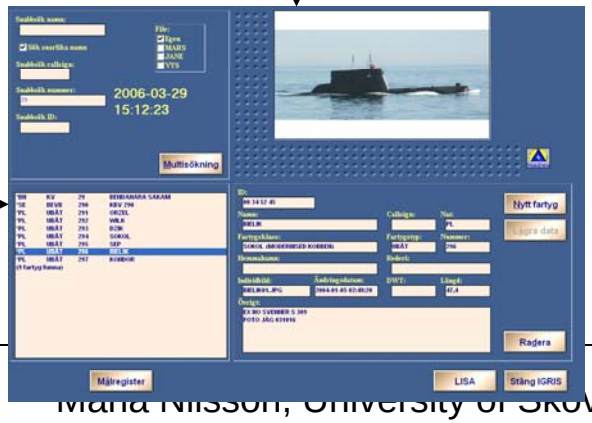
- *Method*: participatory observations, 5 experts

IF as Distributed Process : Empirical Investigation

1) A vessel enters the area of surveillance

2) AIS and Radar locate/identify



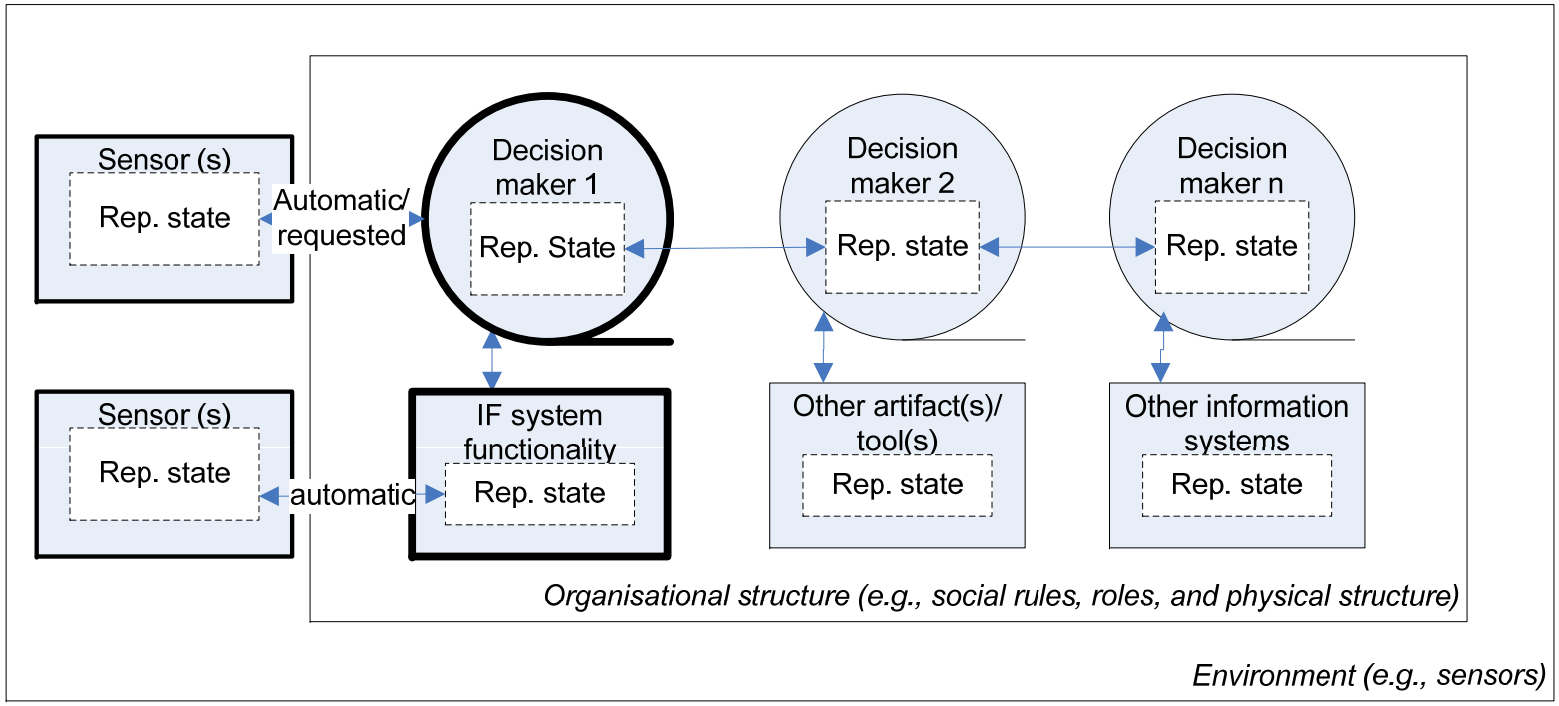


3) Users study radar readings to distinguish interesting vessels from noise and add additional information for identification purposes

cf. page 45

Results: Models

- An IF process can be characterised as consisting of transformations of representational states
  - ➢ mediated by technology and humans



cf. page 52

Conclusion

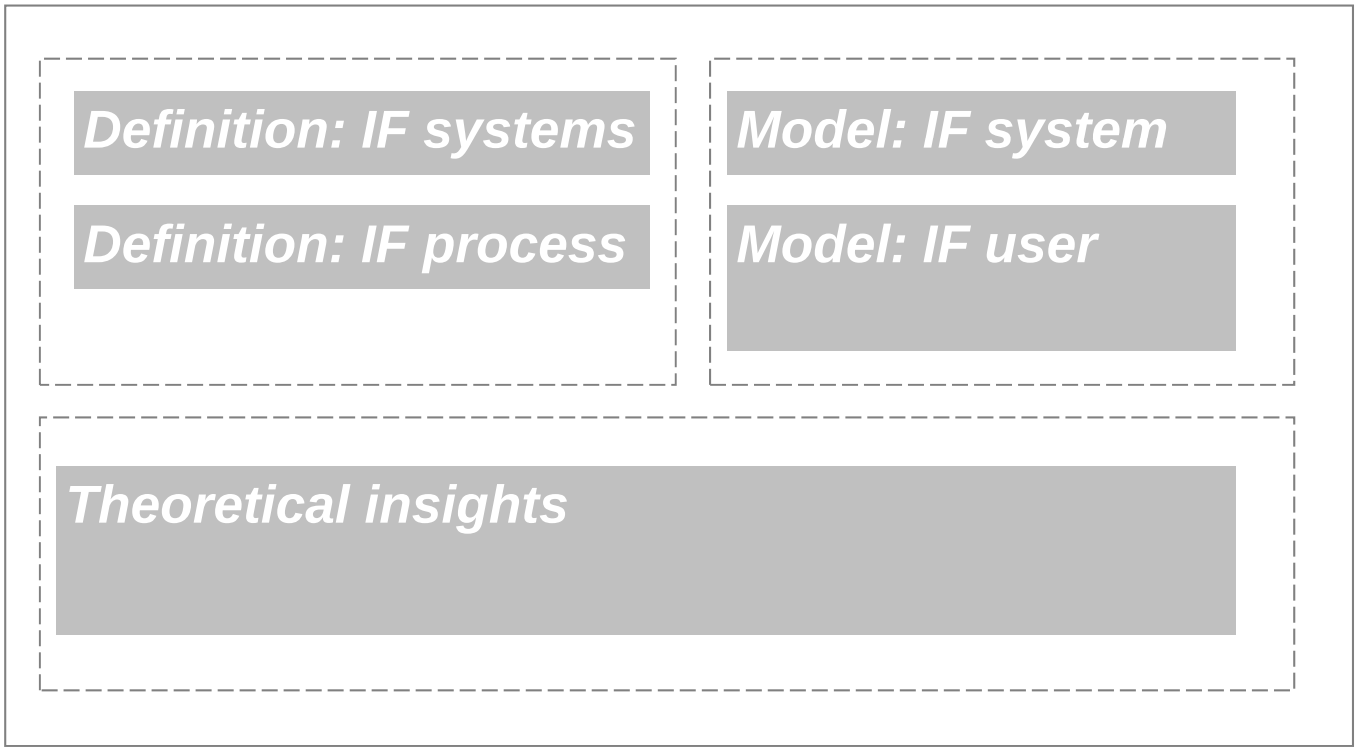
- There are interdependencies between human decision making and information fusion
  - Situation vs. impact assessment (cf. JDL model and DM findings)
  - Supporting one decision vs. supporting the activities in the decision making process (cf. JDL model and DM findings)

- These interdependencies needs to be accounted when developing effective decision support

cf. page 54

Conclusions

- Identified building blocks for future framework



cf. page 49

Summary of Contributions

1) Introducing and promoting cognitive science research (e.g., a decision making perspective) as natural part of IF research, i.e.,
   a. Detailed characterisation of an IF process as it includes both humans and technology (cf. Papers I and IV)
   b. A new decision support class highlighting IF as decision support, i.e., IF driven decision support (cf. Paper II)
   c. A characterisation of the decision situation as embedded in an IF context (cf. Paper III)
   d. Empirical investigations of IF systems as decision support (cf. Papers V and VI)

cf. page 54

Summary of Contributions

2) An analysis of human decision making and IF systems/processes and their interdependencies, i.e.,

   e. Identification of interdependencies between human impact and situation assessment vs. machine impact and situation assessment (cf. Paper V and VI)

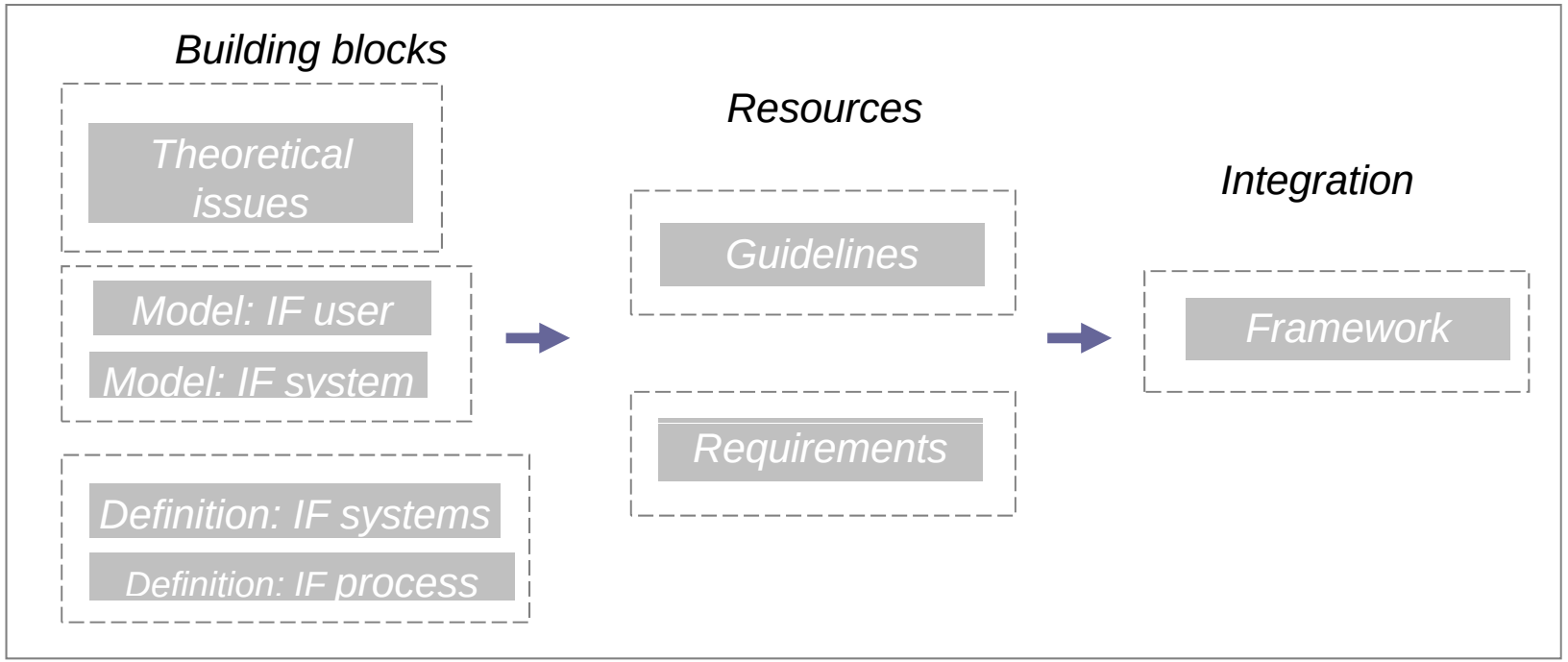
   f. Identifications of interdependencies between human decision making and the interface of IF technology (cf. Paper III and Paper V)

   g. Identifications of interdependencies between users' activities and IF processes (cf. Paper IV)

cf. page 54

Future Work

- Informing the development of future IF systems
  - Cooperation between human and technology within information fusion processes/systems



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Thank you for your attention