OUTLINE

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Essential principle behind our approach

- Construct computer-based artefacts for interactive use by stakeholders
  - knowledge = knowledge about interaction with the artefact
  - communication = interaction from different viewpoints
- Use a new computer-based modelling technique ("Empirical Modelling")
- Key concepts: observables, dependencies, agents, agency
- Principal tool: the dtkeden interpreter
- distributed system for dependency maintenance
  (cf communicating spreadsheets with visualisation)

Empirical Modelling:
A New Approach for Understanding Requirements

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ICSEA'11 CNAM Paris

December 1998

1. Background to our research

Requirements Elicitation is concerned with

- the transmission of knowledge from some source to the analyst
- conceptualization for requirements specification
- identifying and specifying the domain boundary

Our approach

is not primarily concerned with Requirements Elicitation

BUT

is concerned with issues relevant to Requirements Elicitation:

- communication between stakeholders
- common understanding between stakeholders
- the rigidity of the domain boundary
- principles of knowledge representation

Requirements for Understanding Requirements

- interactive communication between stakeholders
- 'constructing' knowledge - to include building artefacts
  - to reflect experiential knowledge
  - to transform experiential to propositional knowledge (where appropriate)
- collaborative working and negotiation for requirements
- openness in both the problem domain and the solution domain

Major themes

----> Constructing shared understanding
----> Interaction amongst stakeholders, and between stakeholders and their environment

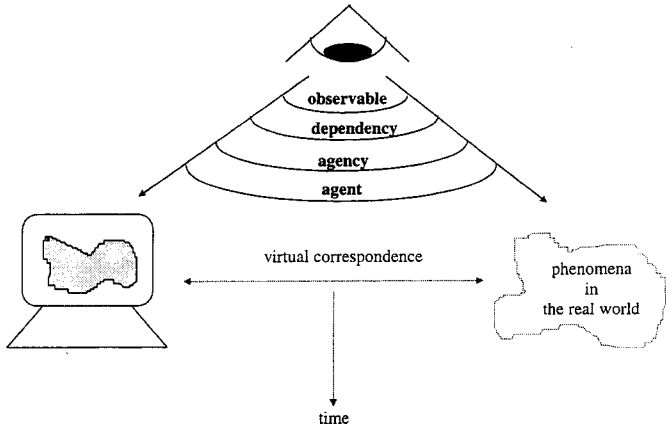
Why **understanding** rather than **eliciting** requirements?

... address problematic issues for conventional requirements elicitation:

- what is known is more than what is said - e.g. the problem of tacit knowledge
- requirements is often the result of negotiation between stakeholders, i.e. it involves a social process
- the rigid domain boundary makes it difficult to adapt to the changing environment
- orthodox knowledge capture and representation can inhibit innovation and re-engineering

Our perspective:

NOT requirements elicitation as the initial phase of the software development
BUT requirements understanding as a life-cycle concern



2. Empirical Modelling (EM)

Basic concepts

- An **observable** is a characteristic of the modelled environment to which an identity and current value can be attributed.
- A **dependency** is an empirically established relationship between observables, in which a change to the value of one observable indivisibly effects changes to values of other observables.
- An **agent** is an instigator of change to observables and dependencies.
- An **agency** expresses the scope for an agent to register or change the value an observable.

3. EM for Understanding Requirements

Three kinds of relationship in interaction between stakeholders (P-H Sun):

- subordinative
  communicating hierarchically without active feedback
  cf. a lecture as a way of **imparting** knowledge
- coordinative
  interacting to exchange information with a preconceived mode and plan
  cf. tutorial or working subgroup as a way of **sharing** knowledge
- collaborative
  interacting freely in an open exploratory manner
  cf. seminar as a way of **constructing** knowledge

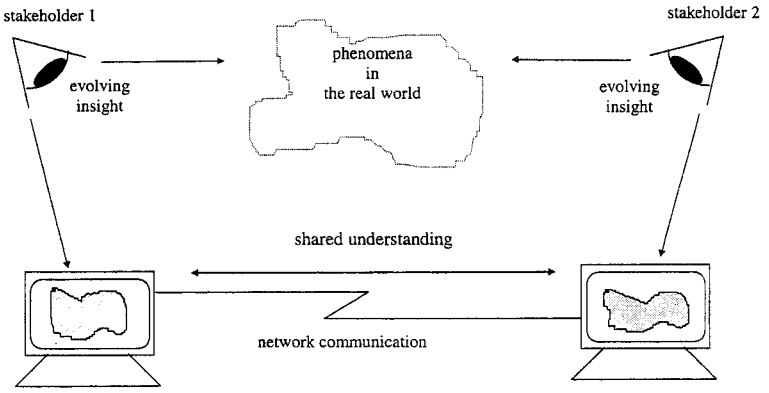
All three kinds arise in requirements understanding

e.g. subordinative
expert > analyst, programmer > analyst, computer specialist > client

e.g. coordinative / collaborative
subgroup for cooperative decision-making with / without strategy

Knowledge representation best suited to subordinative and coordinative activities

Collaborative working emphasises knowledge construction not representation



Shared understanding between stakeholders

Empirical Modelling is a technique that

- emphasises interactive, metaphorical and experiential aspects of computer-based modelling (cf the computer as a physical artefact / the computer as an instrument)
- gives primary emphasis to modelling **state-as-perceived-by-agent** rather than modelling **system behaviour**

The modeller, acting in the role of external observer and super-agent, derives system behaviour by

- representing the state of the system in terms of the basic EM concepts
- exploiting automatic maintenance of dependency
- animating agent interaction by invoking agency directly or automatically

How EM is used for understanding requirements

- supports communication between stakeholders by means of computer-based models in a distributed environment that features
  - visualization / perceptualization
  - concurrent interaction on a network of workstations
  - potential for very rich and open interaction
- supports the construction of common knowledge
- supports collaborative working for requirements
- does not preclude private cognitive processes
- softens the domain boundary for openness

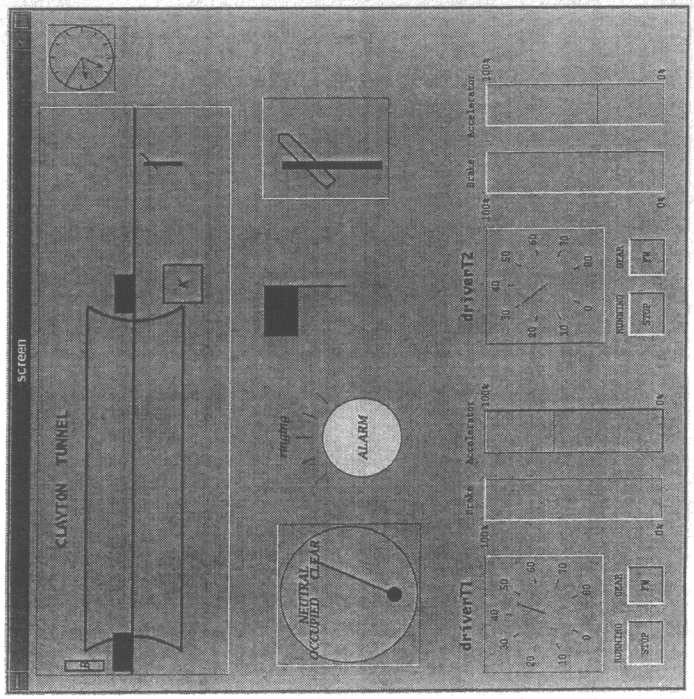
The Collaborative Working Environment for EM

Combines **agent-oriented modelling** and **definitive (definition-based) scripts**

- agent-oriented analysis classifies observables with respect to agents and agency
- scripts metaphorically represent state-as-perceived-by-agents

Characteristic features:

- visualization supplied by definitive notations for graphics and window layout
- definitive scripts represent distributed state
- dtkeden provides a client/server architecture
- agency (e.g. oracles / handles) is specified by using a special-purpose notation LSD
- communication is mediated by the server (as if in "God's view")



4. Case study: a historic railway accident

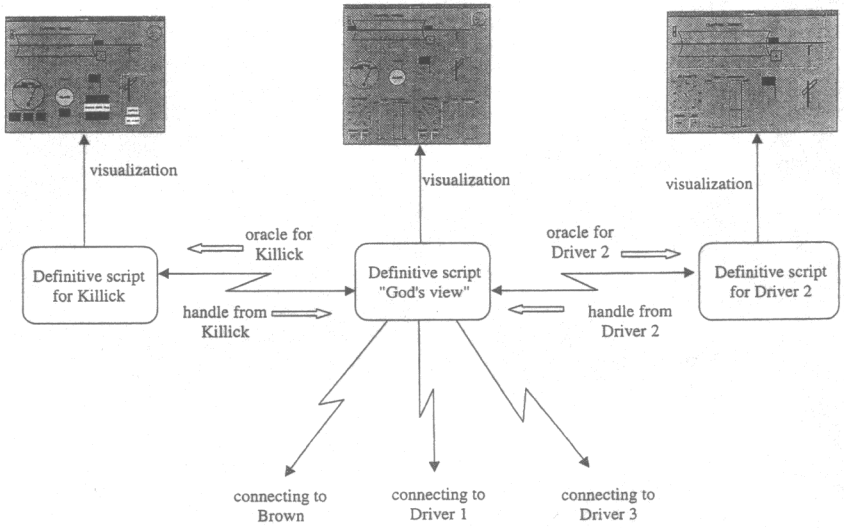
Background:

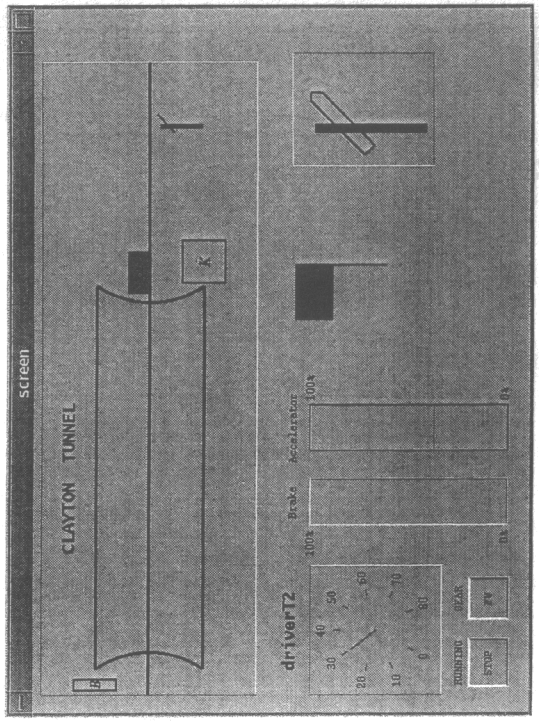
Have used EM to model railway operations at the Clayton Tunnel in 1861
… the scene of the first serious accident to involve telegraph technology

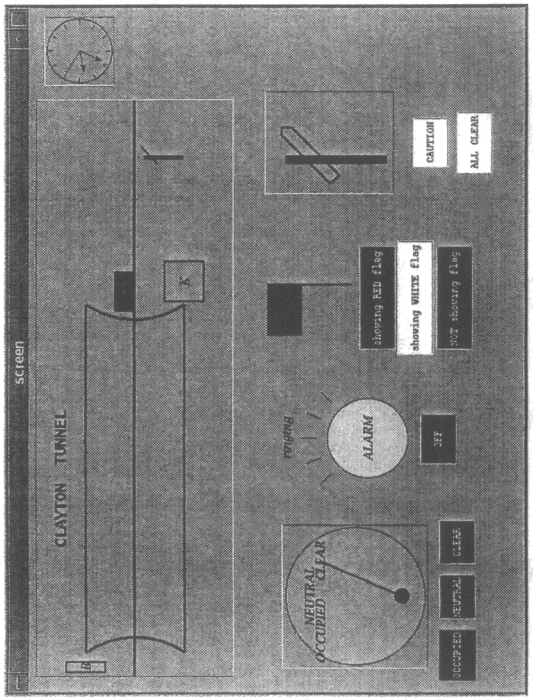
Motivation:

- to gain insight into the individual understanding of the work practices of signalman and drivers at the time, and into how these may have contributed to the accident
- to illustrate the potential of EM in modelling for shared understanding amongst stakeholders
- to show how EM supports knowledge construction in an open-ended experiential fashion

Collaborative Working Environment







5. Conclusion

- Requirements are situated and distributed
  - they cannot be comprehensively captured in a closed specification
  - they need to be cultivated and constructed as understanding is acquired
  - their identification entails more than subordinative and/or coordinative interaction
- Understanding requirements is a cognitive and social process for constructing common knowledge that is most effectively addressed
  - through collaborative interaction
  - with the support of computer-based modelling
- Empirical Modelling provides a promising framework for such modelling
  - model construction is intimately linked to knowledge acquisition
  - model-building is most naturally conceived as an open-ended distributed activity
  - it deals with knowledge in an experiential rather than propositional manner, as is essential in supporting collaborative interaction