COHERENCE

Understanding the Informal in Systems Requirements Engineering

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http://www.comp.lancs.ac.uk/computing/research/cseg/projects/coherence/

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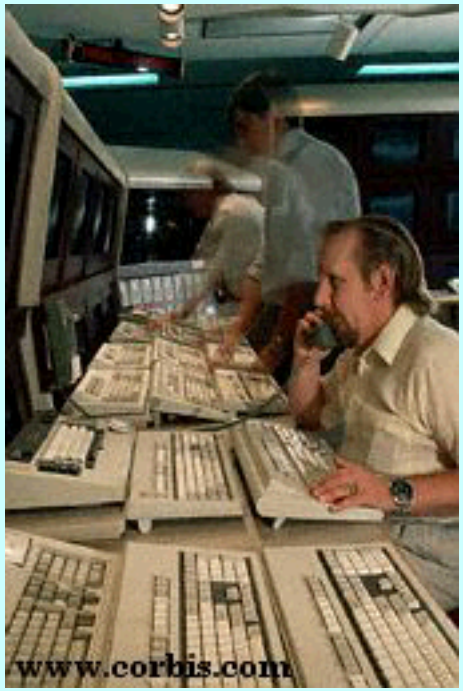
Socio-technical systems



- Computer-based systems are part of broader socio-technical systems that include the technical system, processes, people and organisational procedures
  - Air traffic control
  - Medical imaging
- Socio-technical systems are inherently cooperative systems involving both synchronous and asynchronous cooperation

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Working practices

- Responsive and reactive
  - People change their working practices in response to new information and they react rapidly to unusual circumstances
- Inherently flexible
  - If documented procedures and processes exist, they are often interpreted in different ways by different people and may be subverted in subtle but important ways
- Professional
  - Most people adopt a professional attitude to their work and design the work to take into account their professional skills
- Hard to articulate
  - It is difficult for practitioners to articulate the essential features of everyday tasks

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Cooperation

- Pre-defined cooperation
  - Some processes are explicitly cooperative and involve different people working on the same artefacts at different times.
  - These are the types of process that may be automated using workflow systems and specified using process models. There is a defined sequence of operations required and a division of work across these operations
- On-demand cooperation
  - Knowledge-based processes may have elements of pre-defined cooperation but more cooperation is ‘on-demand’ i.e. people cooperate when they need to do so. The patterns of cooperation and its synchronicity is impossible to specify in advance
  - The division of labour is flexible and is constantly renegotiated, often implicitly based on the current demands of the work

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On-demand cooperation

- On-demand cooperation is an informal process.
  - Documents are passed from A to B with scribbled notes in the margin giving information about what has been done and what is required
  - People leave notes for themselves and others about actions and artefacts
  - Informal meetings are recorded by annotating documents with the conclusions of these meetings
- On-demand cooperation is the principal mechanism for exception management in many processes
  - When things go wrong, the formal process models are often discarded and opportunistic, on-demand cooperation is used to handle the exceptions

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Awareness

- Work often depends on the awareness of what others people are available and what they are doing
- An informal notion - formalising awareness changes its nature and is practically impossible
- Workplaces are often arranged to support awareness
  - Public and private spaces
  - Co-location of related tasks
- Awareness may be a trigger for on-demand cooperation

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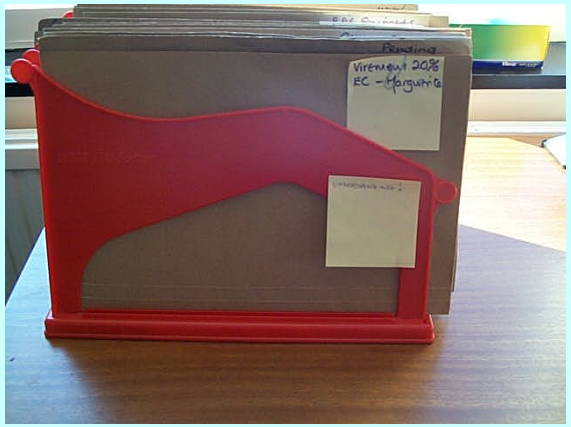
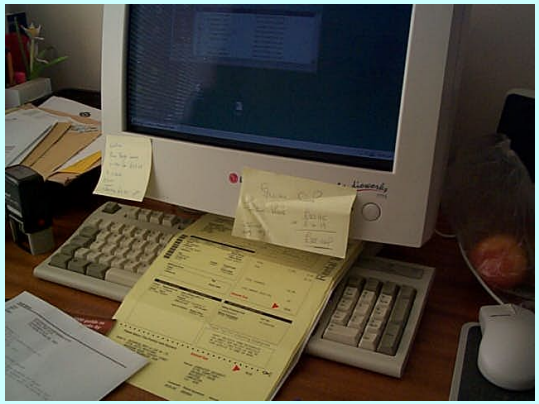
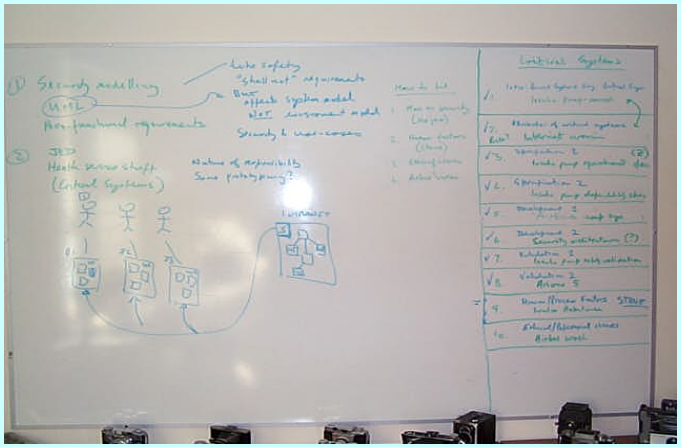
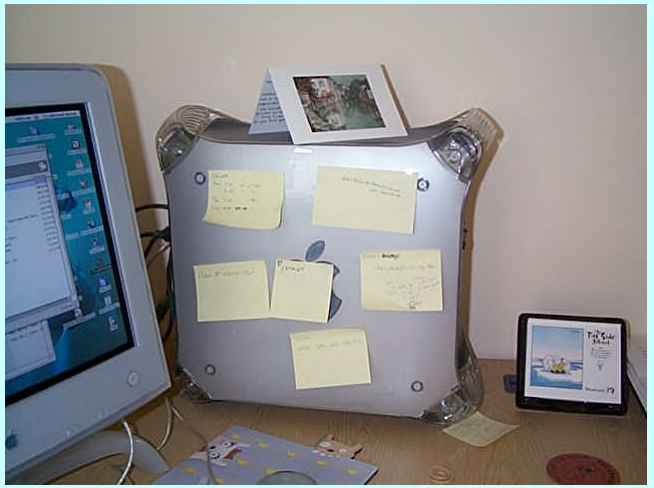
Office reality









Scribbles and stickies

- Informal mechanisms of communication
  - Universal - no previous knowledge is required to use them and they may be used anywhere
  - Visible - they are obvious on a document or in a workplace
  - Identifiable - different handwriting identifies the producer. In some cases, explicit actions (different colours of pen) may be used to identify the writer.
- Mechanisms for awareness
  - People use stickies for reminders of what to do
  - Others can look at these stickies to become aware of what is being done

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Supporting informality

- Technical, computer-based systems have to support and tolerate informality to be effective in socio-technical systems
  - The systems must not constrain necessary informality and flexibility
  - Wherever possible, the system may support this informality and flexible working practice
- Existing techniques of requirements elicitation and analysis need to be extended to help analysts recognise and understand informality
  - To derive the requirements for these systems, we need to have a better understanding of cooperation and awareness in socio-technical systems

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Ethnography

- The details of some tasks, particularly those which are context-sensitive are difficult to articulate. Observing people doing these tasks is a better way of understanding the work than asking them about them.
- Ethnography is an observational method of social analysis whereby a social scientist becomes absorbed into a culture and observes the details of the practices in that culture.
- Its fundamental assumption is that details are as important as abstractions and details can only be discerned by prolonged observation
- It can be used to study various types of work, particularly where this work has a social element

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Benefits of ethnography

- *Understanding the real process*
  - Whatever process is specified, practitioners rarely follow the formal process. Providing process support based on this formal process has been, in many cases, unsuccessful
- *Understanding cooperation*
  - Many tasks are explicitly or implicitly cooperative. As ethnography is a method of social analysis, it can help understand this cooperation. Structured analysis methods and task analysis tend to factor out cooperation from the process
- *Understanding awareness*
  - In some types of work, actions depend on awareness of other actions. Ethnography, with its focus on detail, can recognise this.

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Problems with ethnography

- *Non-judgmental*
  - The ethnographer presents information about the work without making an assessment of its importance
- *Prolonged*
  - Ethnography (typically) takes a long time
- *Personalised*
  - Ethnographers keep detailed notes of their observations but our experience is that these notes are not readily understood by anyone apart from the observer
- *Disassociated*
  - Up till now, ethnography has been a separate part of the analysis process. There has been little work on using ethnography with other forms of analysis

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Lancaster experience

- More than 10 years of cooperation between social scientists and computer-scientists in studying work practices and their influences on computer-based
  - Air traffic control
  - System design
  - Financial services
  - Engineering design
  - Student admissions
- Various techniques have been developed to bring results from social analysis into mainstream requirements analysis

Coherence

- A ‘lightweight’ method which allows requirements engineers to apply some of the lessons we have learnt from several years of ethnographic studies
- The method includes
  - Process guidance - how to look for and recognise social issues which may affect the requirements for a system
  - Representation guidance - how to represent the social analysis using graphical system models
- Notations in Coherence are based on UML
  - Emerging standard for OO analysis
  - Good quality tool support is available (with some extensibility)

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Viewpoints and concerns

- Viewpoints
  - Perspectives on a process or system which provide a partial description of the system. The descriptions may represent the existing process or system or the desired process or system. They are a means of *organising and structuring* the elicitation and presentation of system requirements
- Concerns
  - Issues which are of relevance to all viewpoints and which are orthogonal to them. In requirements analysis, these may represent business goals such as 'time to market' or overall system attributes such as efficiency, safety and functionality.

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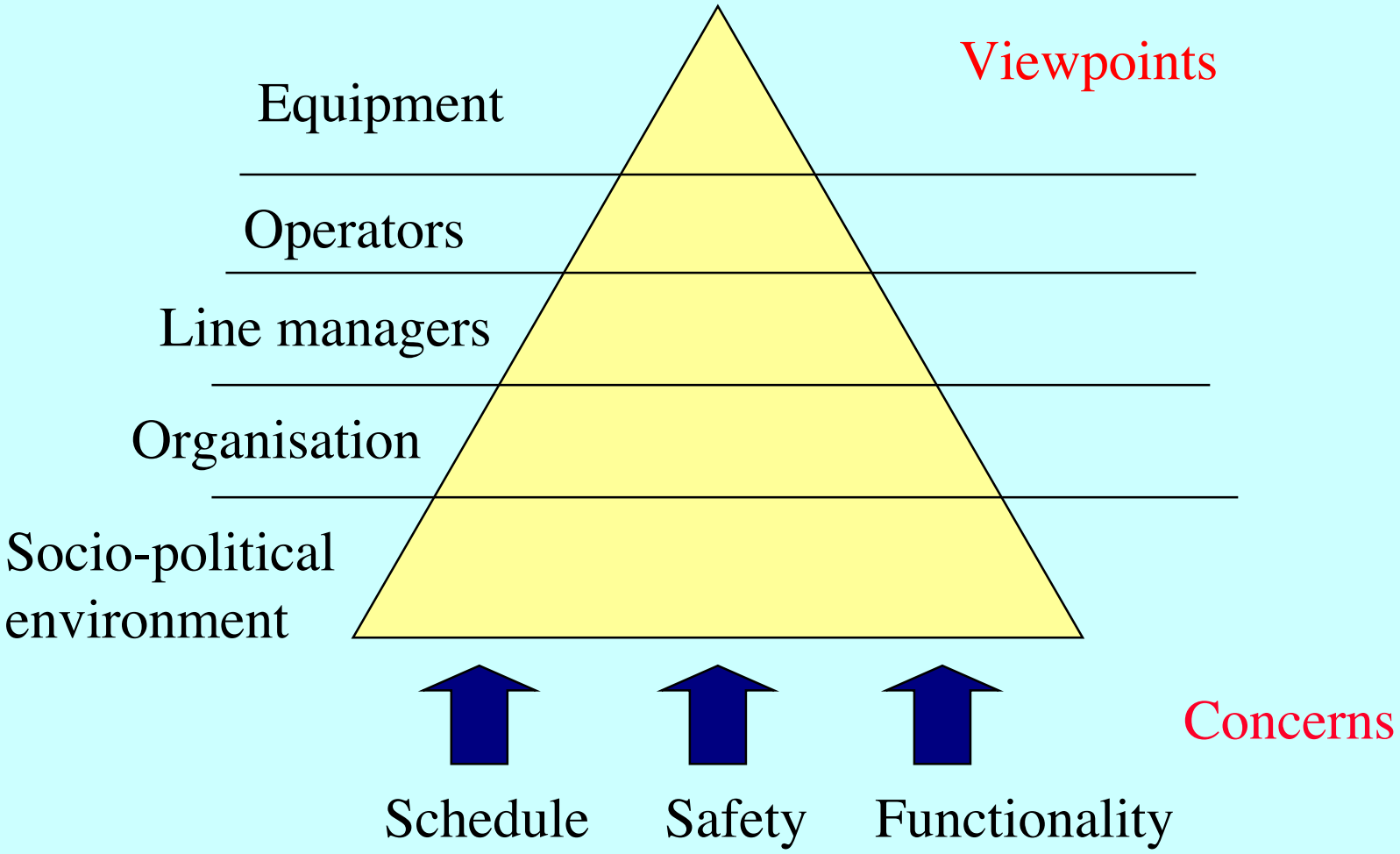
Viewpoints and concerns



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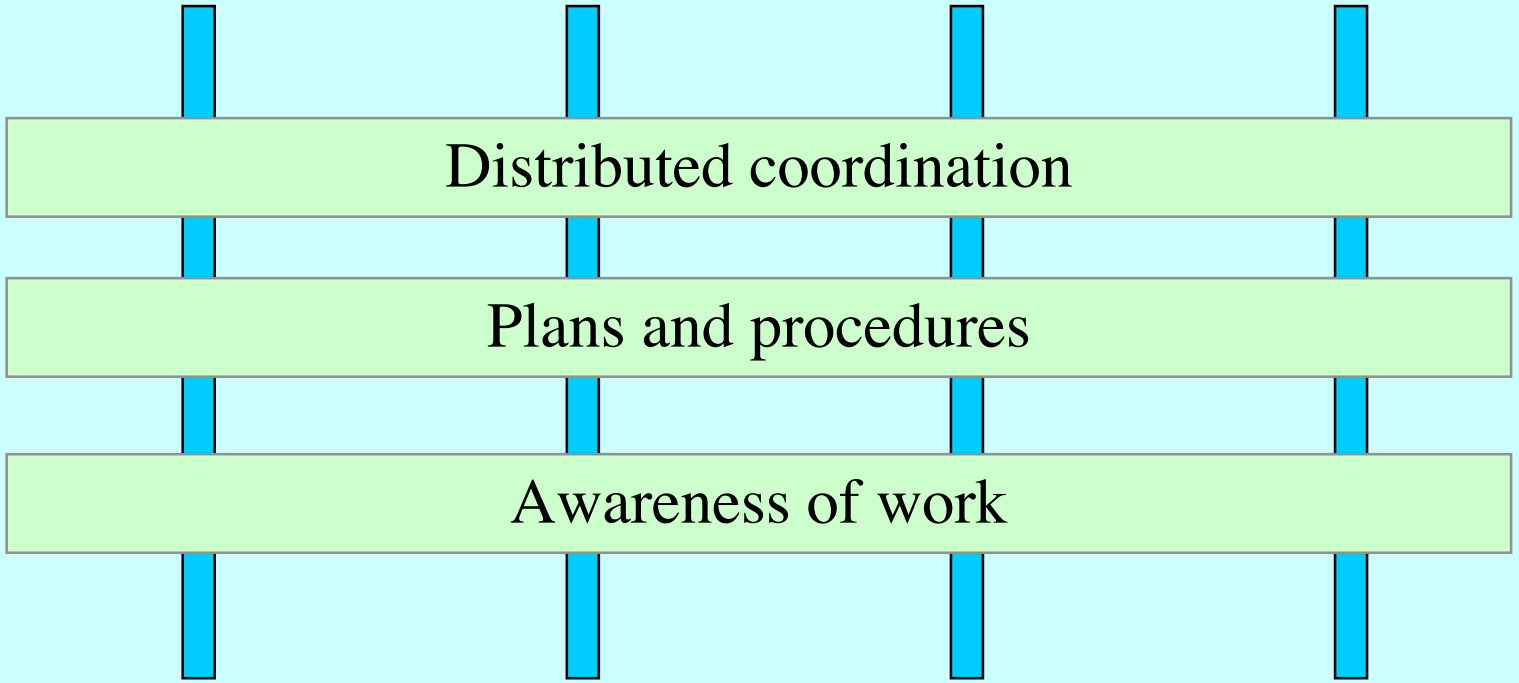
Social viewpoints and concerns



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Social viewpoints

- Social viewpoints give requirements engineers guidance on how to organise their social analysis
- We have identified three viewpoints that seem to be fairly universal
  - Distributed coordination
    - » The coordination of people and tasks as part of everyday work
  - Plans and procedures
    - » The role of organisational plans and procedures which both facilitate and inhibit processes
  - Awareness of work
    - » The organisation of activities to promote awareness of the work by the people involved in the process

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Viewpoint examples

- Distributed coordination
  - Air traffic control is a team activity involving 5 controllers in each sector. How do they share tasks, cope with heavy loads, coordinate their activities etc.
- Plans and procedures
  - In an ATC system, different teams have evolved different control strategies which follow to a greater or lesser extent the formal ATC procedures
- Awareness of work
  - Awareness of other controller activities is critical for safety in an ATC system. It is also important for workload planning

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Concerns

- Paperwork and computer work
  - How is paper and technology used in the workplace?
- Skill and the use of local knowledge
  - How are skills and local knowledge applied?
- Spatial and temporal organisation
  - How does the physical and temporal organisation affect the performance of the work?
- Organisational memory
  - How is implicit organisation knowledge usedto facilitate the performance of work?

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Paperwork and computer work

- Distributed coordination
  - How is work coordinated through the use of paper and computer-based forms?
  - How do forms embody the work and the people doing the work?
- Plans and procedures
  - To what extent do people trust descriptions of the system that they use?
  - If a procedure specifies the use of specific representations, is this use monitored by the organisation?
- Awareness of work
  - How does paper and the affordances it offers facilitate awareness

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Process steps

- Determine the appropriateness of concerns in the current content
- Elaborate concerns to more specific questions
- Identify additional viewpoints (not social viewpoints) in addition to the social viewpoints
- Interact with stakeholders to understand the system requirements
- Elaborate requirements as annotated use-cases and supporting UML models

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Concern choice

- Decide whether or not the identified social concerns are relevant in a particular context
  - For example, the spatial organisation concern is likely to be important where work is co-located and synchronous but less significant where work is distributed and asynchronous
- Identify other concerns which are relevant
  - Social analysis is part of the elicitation process but its coverage is incomplete. Other concerns e.g. based on business goals may also be relevant and these should be identified at this stage

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Concern elaboration

- Concerns are elaborated to more specific concerns and, finally, into a set of questions. The analyst looks for the answers to these questions during the elicitation process
- Spatial and temporal organisation
  - Sub-concerns might be use of shared space, use of private space, physical workspace layout, synchronous organisation, asynchronous organisation
  - Possible questions:
    - » How are shared workspaces organised?
    - » Does data have a ‘use-by’ date
    - » How does work move from shared to private workspaces
    - » How does the physical layout of the workspace facilitate information retrieval

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Viewpoint identification

- We have already identified 3 social viewpoints. This stage is concerned with identifying other viewpoints which may be relevant and understanding the relationships between these and the social viewpoints
  - End-user viewpoint - concerned with specific tasks
  - Management viewpoint - concerned with the results produced by end-user viewpoints
- Relationships with social viewpoints
  - End-user tasks may depend on distributed coordination
  - Plans and procedures may explicitly define end-user task processes
  - End-user tasks may be facilitated by awareness of other work

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Requirements discovery

- Investigation of a workplace to develop a better understanding of that workplace. Requirements emerge from this understanding
- Driven by concerns not viewpoints. Concerns provide the questions that should be answered for each viewpoint. Social concerns may also be relevant to other (non-social) viewpoints
- Essentially opportunistic but facilitated by the questions which are generated from the concerns.
- Questions may be answered through interviews, observation, existing documentation, etc. This is NOT structured ethnography.

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Awareness of work viewpoint

Name:	Awareness of work
Focus:	How the physical organization of the control suites affects how controllers can make sense of each other's activities. How controllers monitor the work of other controllers, and how controllers orient their work to facilitate others monitoring it.
Concerns:	Paperwork and computer work Skill & the use of local knowledge Spatial and temporal organization ~~Organizational memory~~ Safety Volume of traffic
Sources:	Controllers, and observation of controllers at work
Requirements:	AW1 (Making work available) AW2 (Availability of awareness information) AW3 (Relationship of suite layout to controlled airspace)

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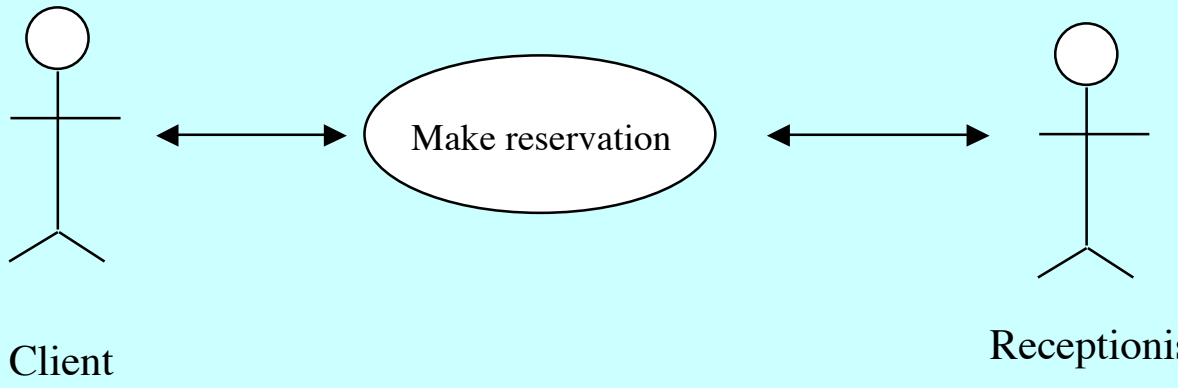
Object-oriented analysis

- Jacobsen's approach to OOA which is reflected in the UML is based on the notion of use-cases where a use-case represents some interaction with a system



- Applying the Coherence approach helps us to find and understand relevant use-cases and helps with the documentation of use-cases

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Coherence and use-case models

- **Actor** Interactor stakeholders are identified and then used to generate viewpoints
- **Use case** Use case descriptions are generated by plans & procedures viewpoint
- **Problem domain object model** Problem domain objects are identified by distributed coordination and awareness of work viewpoints
- **Object model** Fragments of model are generated by awareness of work viewpoint
- **Interface descriptions** Not directly addressed by Coherence, but can be recorded in UML models

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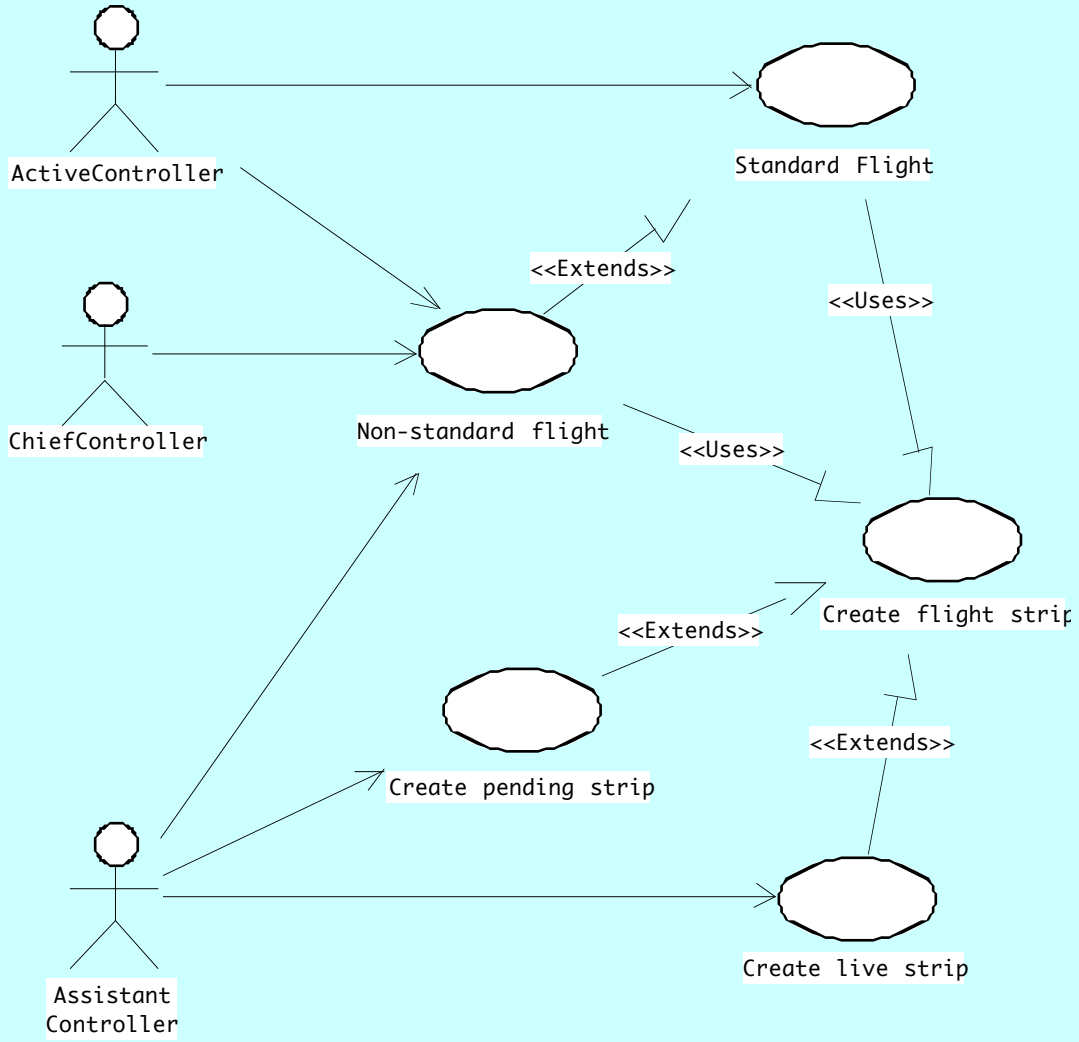
Use-case identification



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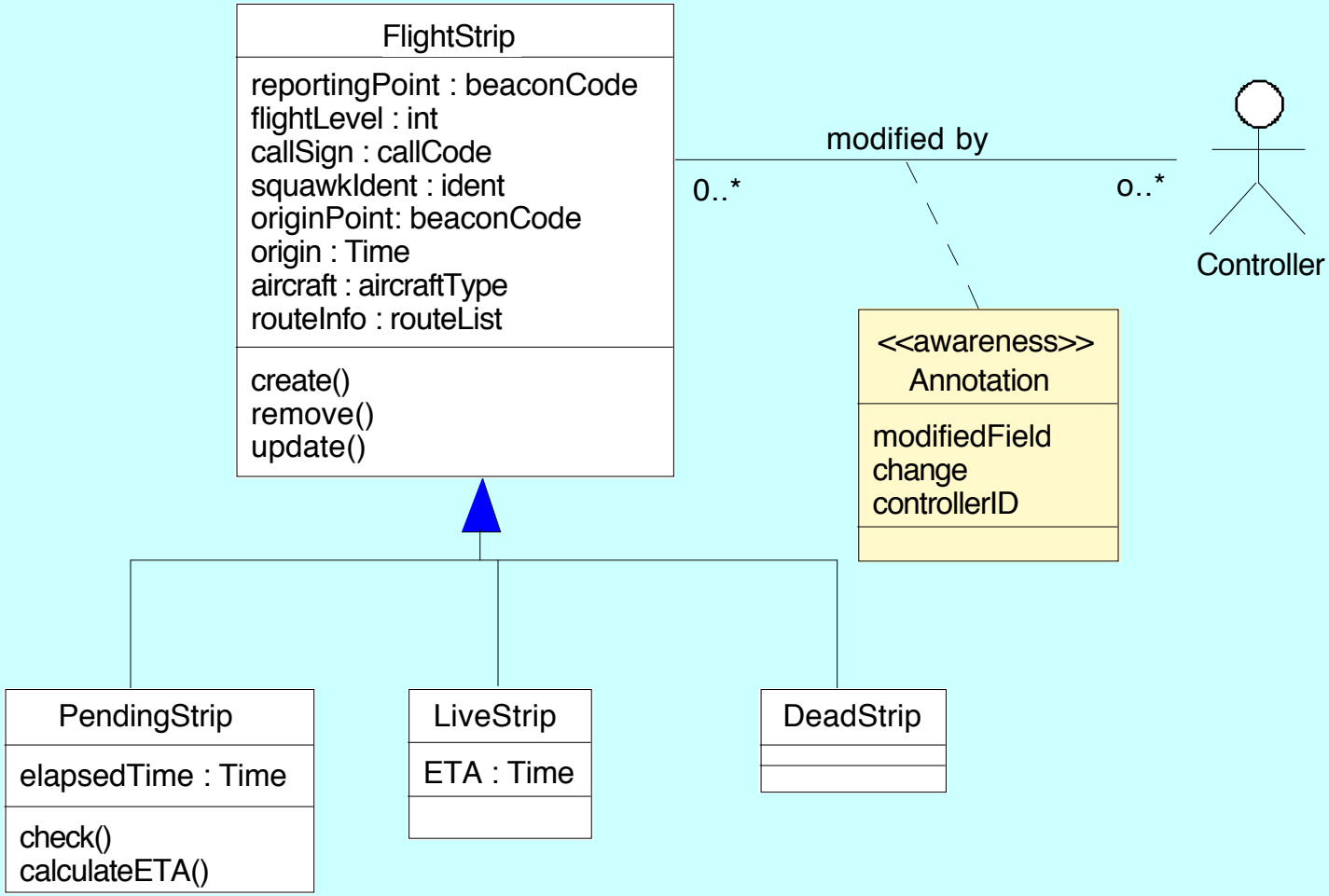
Awareness annotations



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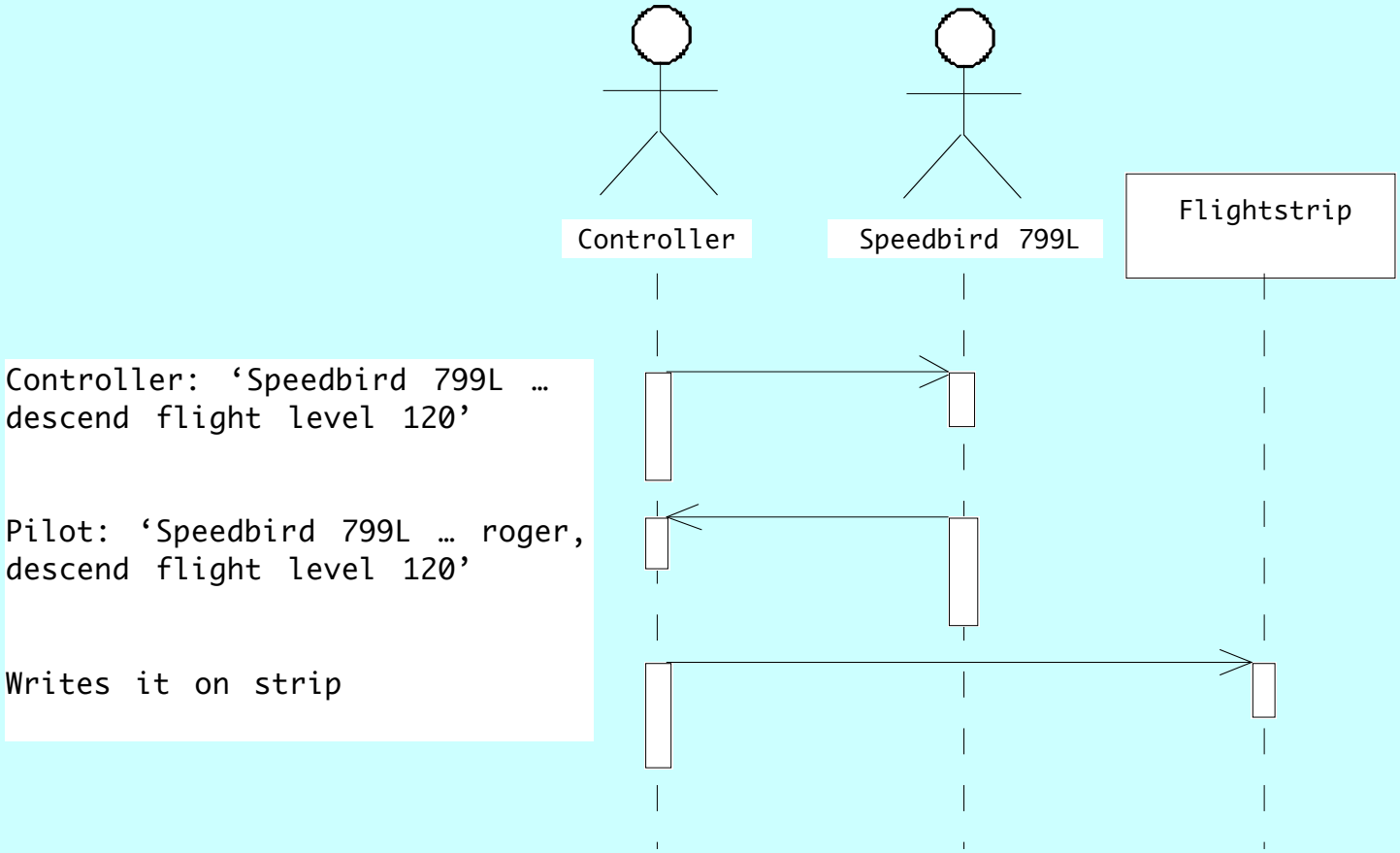
Modelling communication

- Providing system designers with models of communications between the participants in a process helps them develop an understanding of how to support that communication
- The distributed coordination viewpoint captures communications. These can be modelled using (extended) UML sequence diagrams that show interactions between people as well as interactions between a system end-user and the objects that are modified in that interaction

Flight coordination



Summary

- Informality is processes is normal and good and automated systems should tolerate and support this informality
- Informality is reflected in patterns of cooperation and awareness of the actions and presence of others
- The COHERENCE method is an approach to social analysis that is intended to help requirements engineers understand cooperation and awareness
- The method uses the UML notation to make it accessible to engineers
- Evaluation of the method has been carrried out in a major financial institution and is currently under further development using patterns of interaction

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