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Agent-Based Process Modelling for Virtual Enterprises

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MRes Innovative Manufacturing

(Management & Information Systems)

Presentation Outline

- Introduction to Virtual Enterprises & Multi-Agent Systems
- Research Aim
- Research Objectives
- Methodology
- Multi-Agent Systems for VE Modelling: Overview of the ZEUS Toolkit
- Key Findings
- Conclusions
- Recommendations
- Future Research
- Summary

Introduction to Virtual Enterprises

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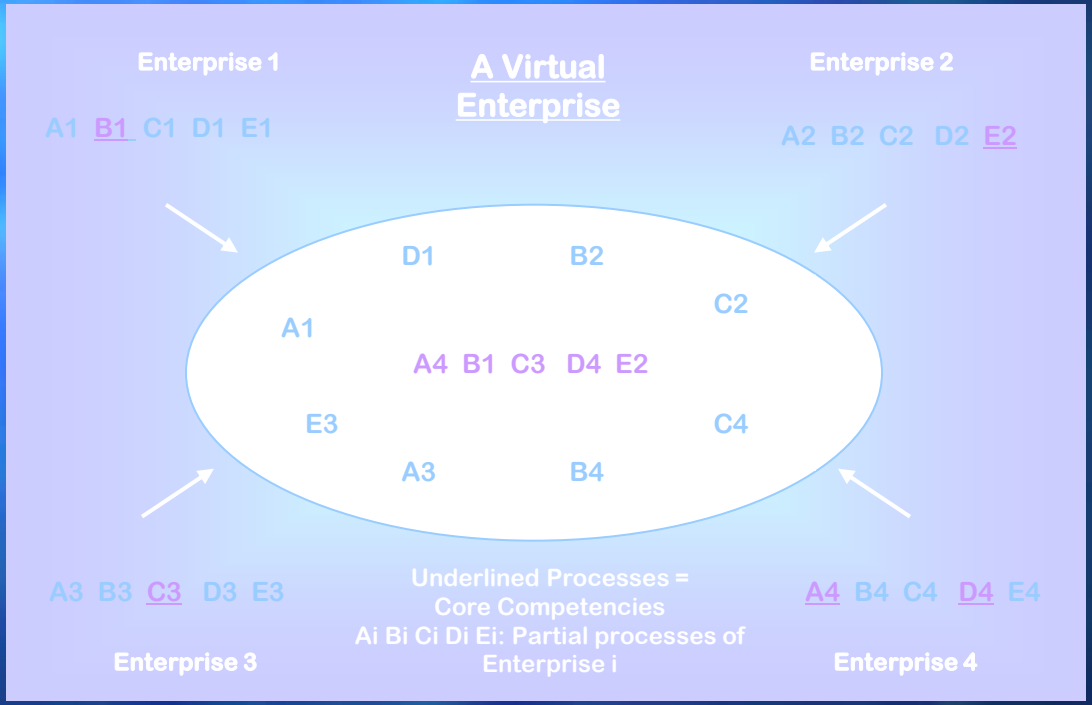
- Definition of Virtual Enterprises:

  - Davidow & Malone (1992)

  - Arnold et al (1995):

> '…a Virtual Enterprise is a cooperation of legally independent enterprises, institutions or individuals, which provide a service on the basis of a common understanding of business…the cooperation is maintained by using feasible information and communication technologies.'

Introduction to Virtual Enterprises



Source: Fischer et al (1996)

Introduction to Virtual Enterprises

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- **Examples of Virtual Enterprises:**
  - F International: home-working
  - Dell Computer Corporation: mass-customisation
  - Amazon.com: competitive prices
  - British Airways (Waterside): virtual work
  - Levy Gee: virtual business consultancy

Introduction to Multi-Agent Systems

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- DAI emerged 20 years ago:

  - Weiss (1999):

    '..the study, construction and application of Multi-Agent Systems..in which several interacting intelligent agents pursue some set of goals..'

- What is an Agent?:

  - Ferber (1999):

    '..a physical or virtual entity that can act, perceive its environment and communicate with others…is autonomous and has skills to achieve its goals & tendencies.'

Introduction to Multi-Agent Systems

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Agent Properties:

- Reactive
- Proactive
- Social Ability

Agent Types:

- Competitive
- Cooperative

Agent Standards:

- FIPA
- OMG MASIF

Agent Toolkits:

- 'sets of components'
- 'sets of tools'

Examples of Multi-Agent System Applications:

- Analysis of business processes in enterprises
- Optimisation of industrial manufacturing processes
- Virtual Reality based computer games

Research Aim

'Investigate the possibility of improving *communication* between enterprises, to enhance their *competitive position*. This will be done through exploring methods and software based on a Multi-Agent framework for the modelling of Virtual Enterprises.'

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Research Objectives

- To conduct a literature review on Virtual Enterprises and Multi-Agent Systems.
- To assess the compatibility of Multi-Agent System applications for Virtual Enterprise modelling.
- Technical proficiency with the ZEUS toolkit.
- To develop a Virtual Enterprise Modelling System using a MAS methodology integrated within the ZEUS toolkit.
- To analyse and evaluate the feasibility of the ZEUS toolkit for Virtual Enterprise modelling
- To evaluate the suitability of Multi-Agent Systems for Virtual Enterprise modelling

Methodology

- Literature Review
- Industrial survey on Virtual Enterprises
- Technical Proficiency in using ZEUS
- Analysis & evaluation of ZEUS

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MAS for VE Modelling

Benefits:

- VEs are composed of distributed, autonomous and heterogeneous components
- Distributed problem solving can be tackled
- Conflict management in VEs can be modelled using MASs

Drawbacks:

- Lack of infrastructure and definitive standards
- Security & virus mechanisms

Research Gap:

- Use of the ZEUS toolkit in modelling Virtual Enterprises

The Components of the ZEUS Tool-Kit

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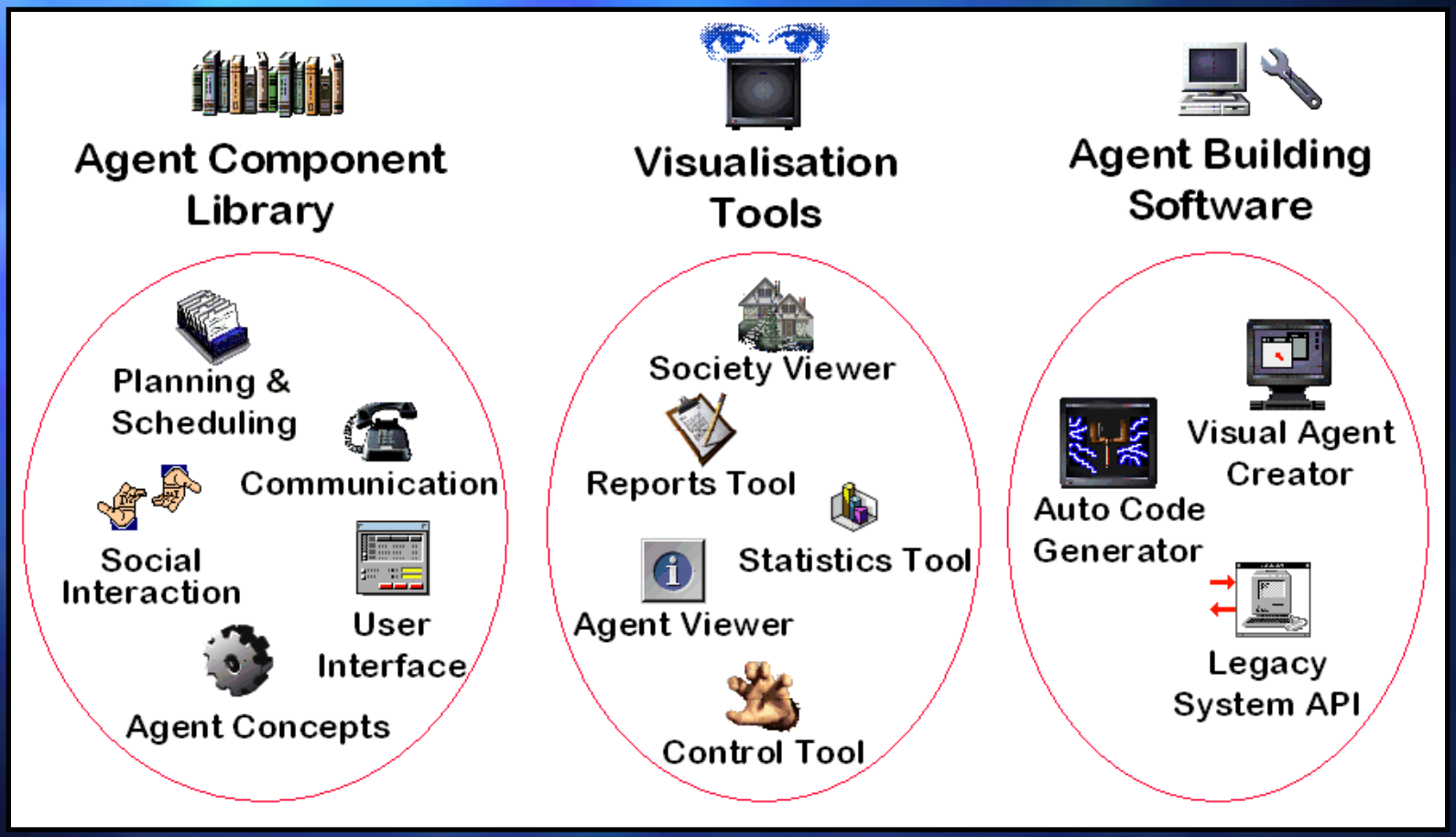

The Zeus Agent Design Methodology

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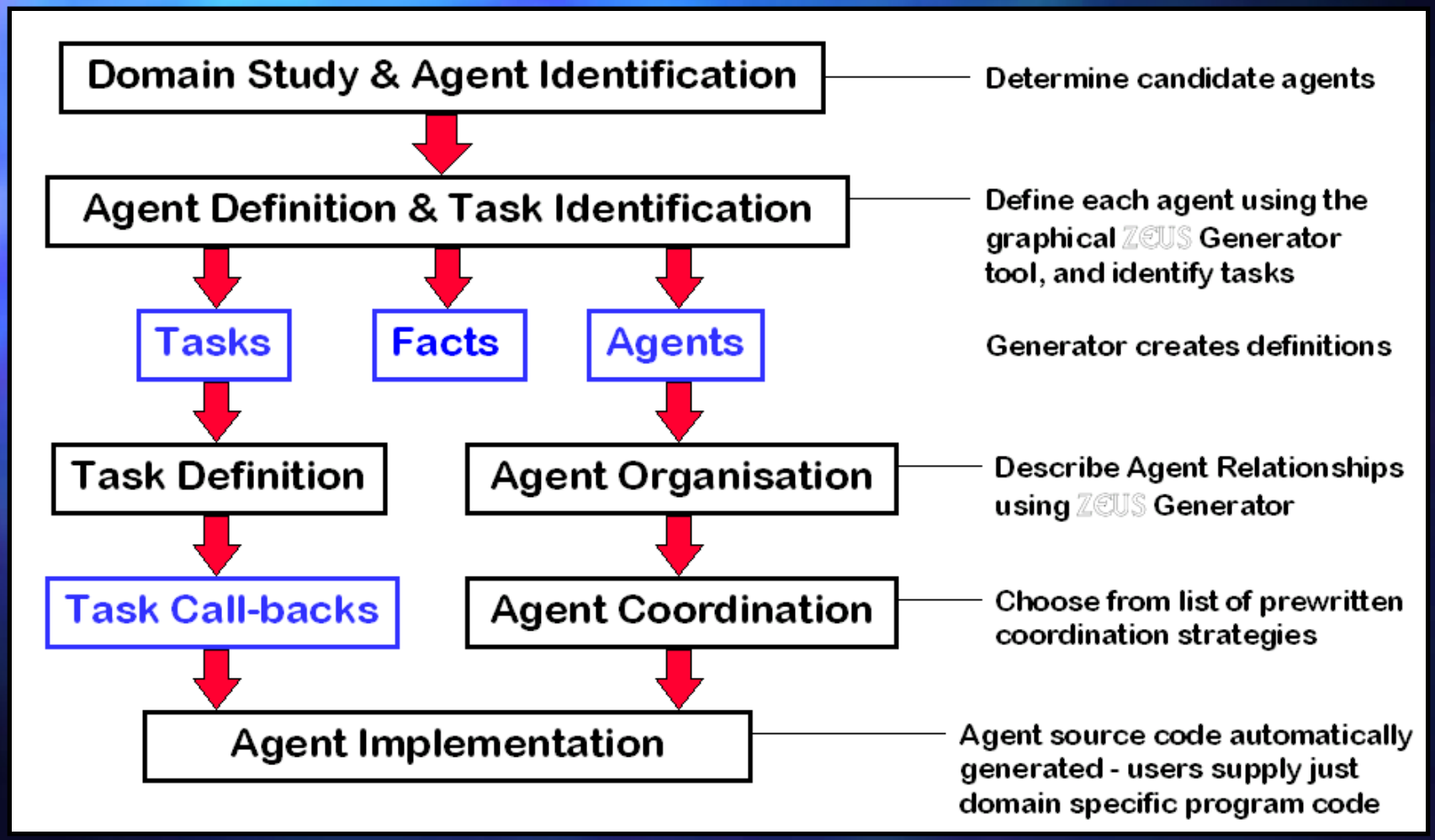
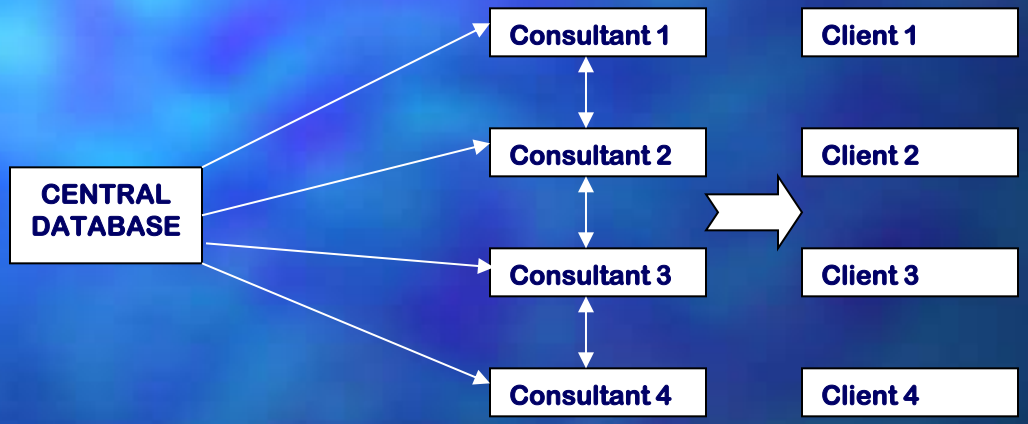


CMBC Case Study

Participants & Interactions of Cranfield Manufacturing Business Consultancy



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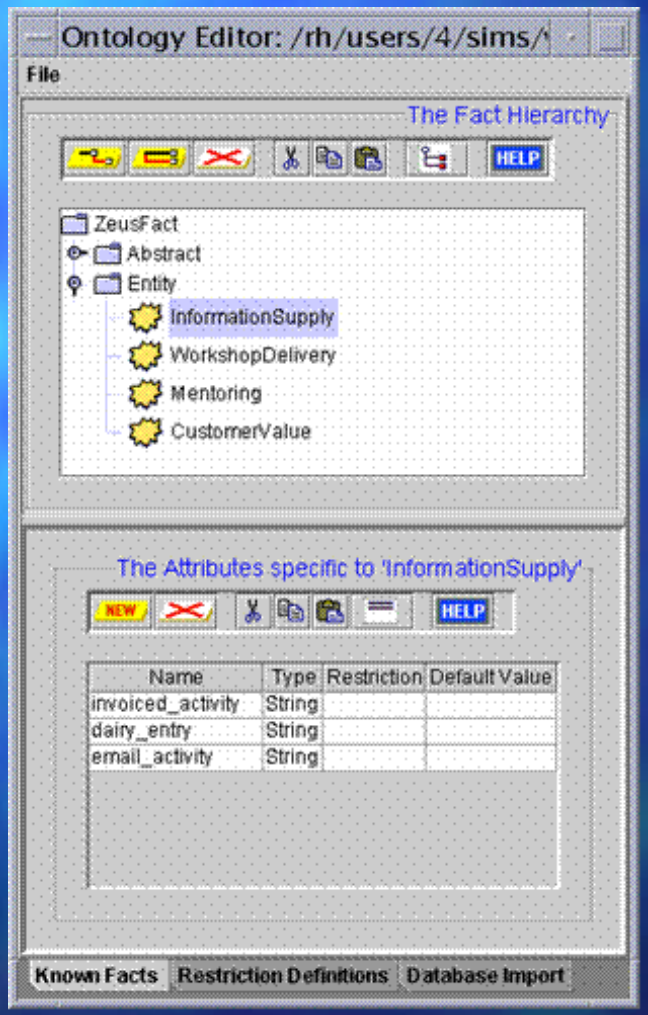
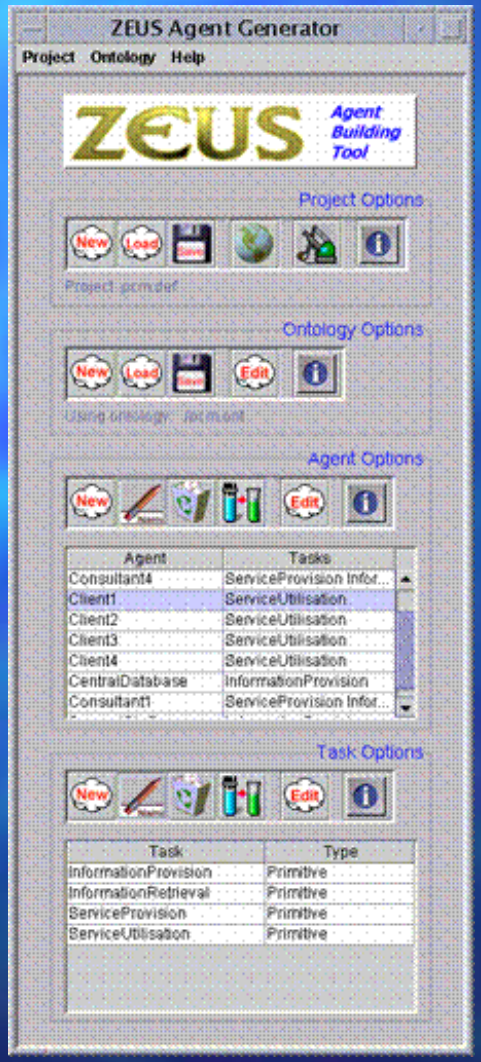
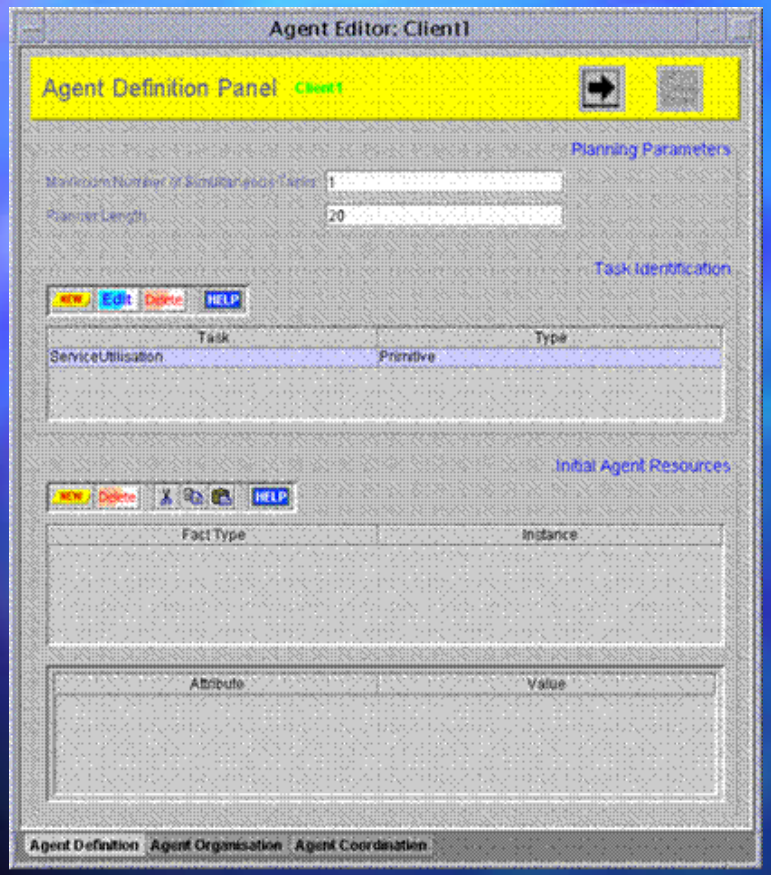
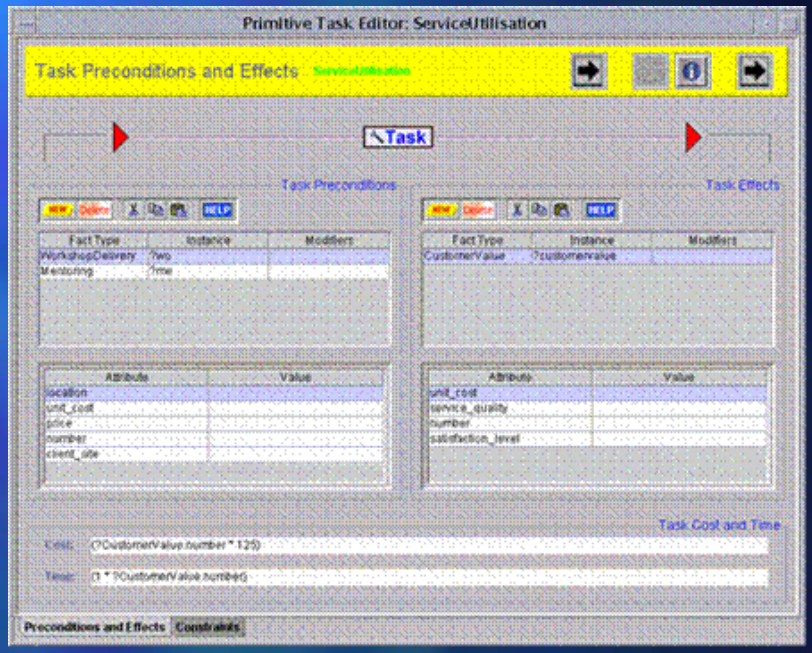


ZEUS Agent Generator

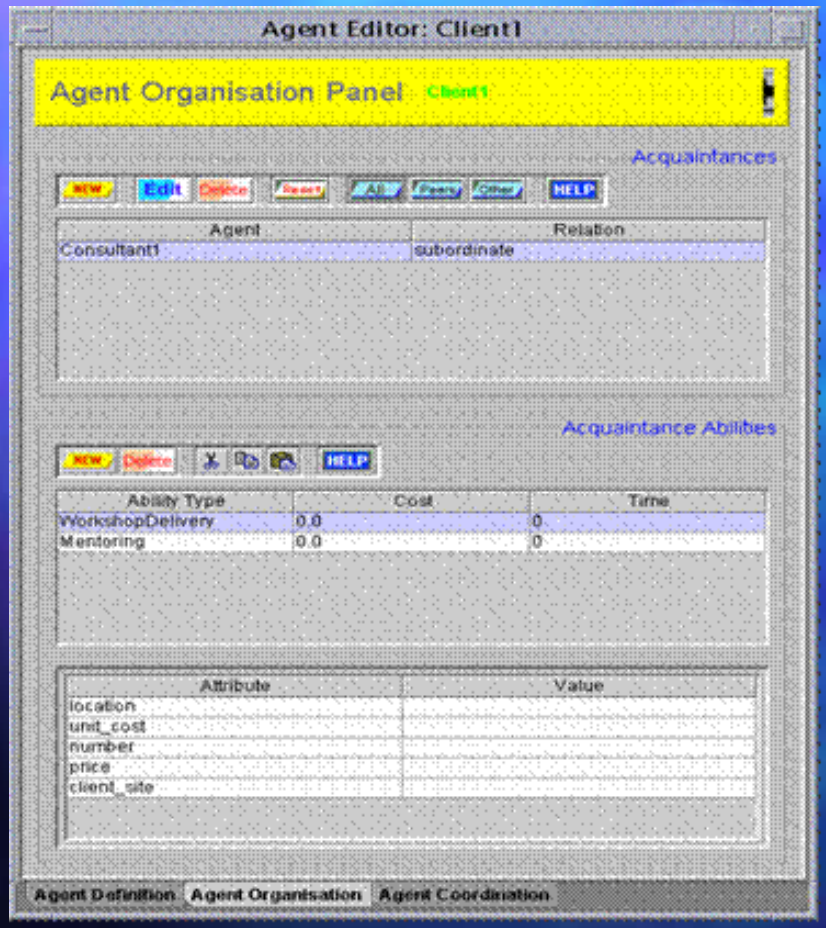


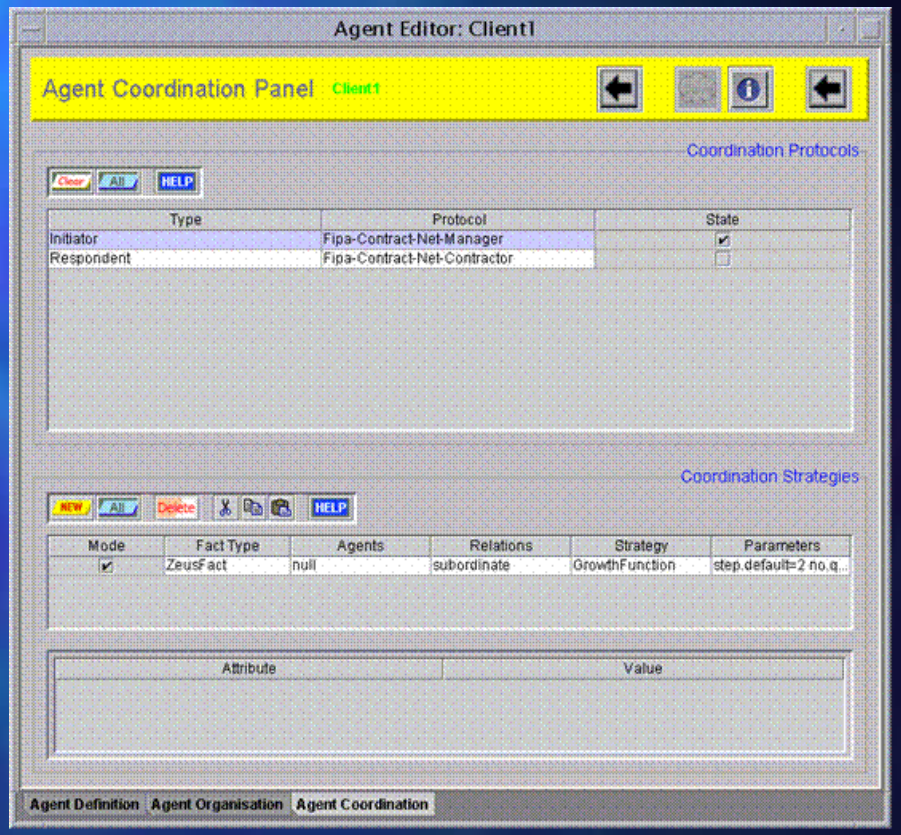
Task Definition



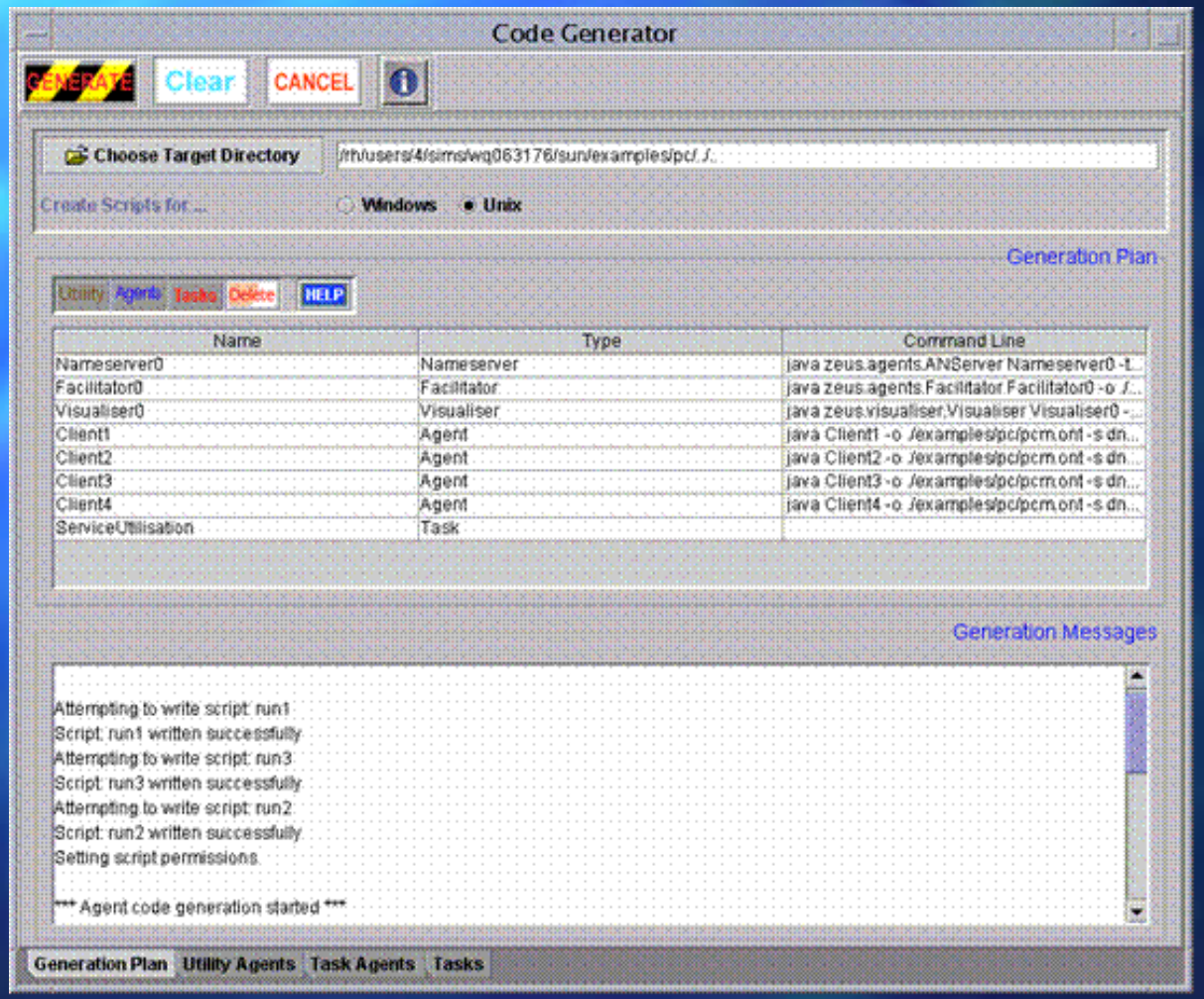


Agent Organisation & Coordination

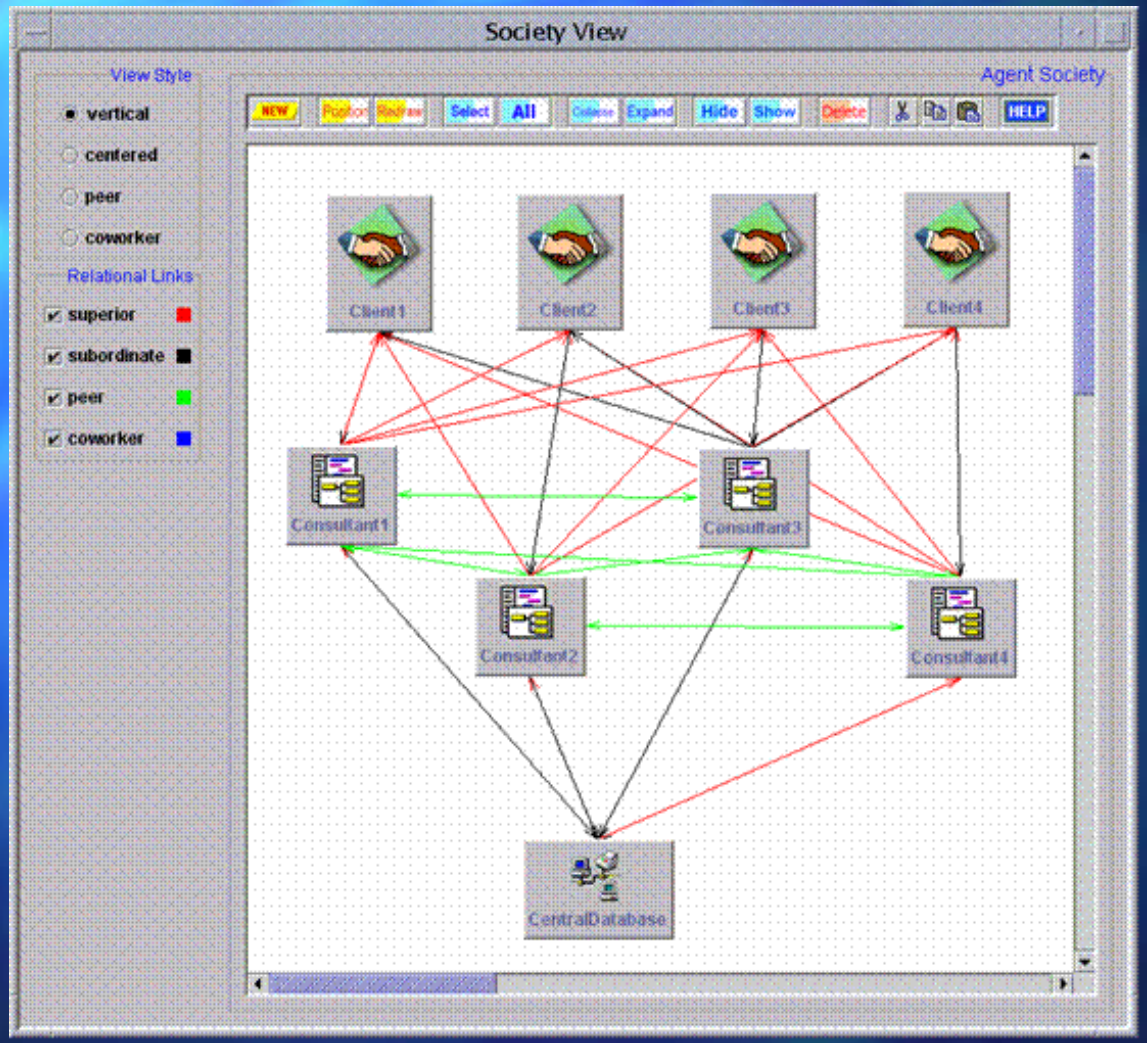




Code Generation



Society View



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Key Findings – MASs for VEs

- VEs are composed of distributed, autonomous and heterogeneous components, which can easily be decomposed and mapped into MAS applications
- The similarity in characteristics of VEs and MASs allows them to be used in combination
- If fundamental standards and ontologies cannot be established, this will lead to diverse applications for diverse purposes lacking congruency

Key Findings - ZEUS

- Installing ZEUS was a time-consuming process
- The domain analysis stage of the application development process required a wider variety of role models
- In the agent realisation process, the ZEUS interface was very easy to use
- The agent creation, definition and organisation processes were simple.
- The agent coordination process resulted in using the PC Manufacture case-study as a guide
- Technical difficulties when the application was implemented using UNIX

Conclusions

- VEs are currently significant organisational paradigms which will continue to gain significance in the future in a versatile range of industries
- Cultural and technological infrastructures must support VEs in order for them to be successful

Conclusions

- The ZEUS toolkit has the potential to be an effective application methodology for VE modelling, however, the discrepancies within it must be addressed

- If ZEUS software support could be improved, the CMBC case-study would not merely be used for illustrative purposes, but recommendations could have been made to the CMBC on how to improve their business processes: this is where the real value of ZEUS could have been tested

Recommendations

- Installation process could be made easier, with exact detailed instructions
- Online ‘live’ demonstrations of case studies would also be useful and more effective as a preview of the ZEUS suite of tools

Recommendations

- Improved software support through the following:
  - Online instant messaging boxes to provide immediate assistance
  - BTExact Technologies could create a discussion database on their web-site to discuss ZEUS problems
  - E-mail response times could be improved

Future Research

- Investigations into using different open-source toolkits for VE modelling purposes
- Research into combining different systems methodologies for VE modelling, for instance, UML, system dynamics and ZEUS, to create a multi-methodology
- Comparisons into the OO and agent-based paradigms and how they can be used in complementary ways

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Summary

- Introduction to VES & MASs
- Research Aim, Objectives & Methodology
- Feasibility of MAS for VE modelling: Overview of ZEUS Toolkit
- Key findings of VEs & MASs
- Conclusions
- Recommendations
- Future Research

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QUESTIONS

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