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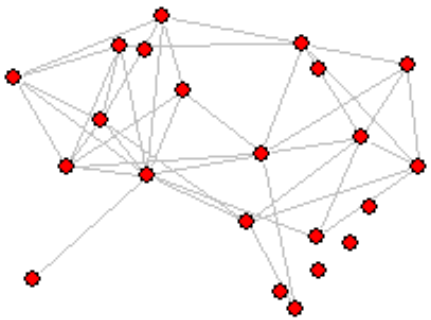
A network perspective on organisations: Mapping enterprise C2 networks with MINERVA



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Defence Science and Technology Organisation (DSTO)
Australian Government, Department of Defence.

11th ICCRTS
Coalition Command and Control in the Networked Era

September 2006

Outline

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- The networked organisational form
- Why all the fuss about networks suddenly?
- The social side of networks
- Social/organisational network analysis
- MINERVA: new tool for network data collection.
  - Functions and features
  - Future Developments

Introduction

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- Groups and organisations
  - Organisations are goal directed activity systems; may have superordinate identity and goals
- Network view of organisations
  - Focus on structure and nature of relationships (rather than just attributes of component parts)
  - Network structure, and node embeddedness influences outcomes
- Is it really new?
  - Hierarchies, process maps still networks
  - Newness in:
    - Electronic communication networks potential
    - Scientific perspectives on networks
    - Growing recognition and acceptance of importance of informal social structures and processes.

Drivers behind network interest

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- Practical advances
  - Computing power now sufficient for required calculations for network analysis
  - Cheap communications infrastructure and the recognition of potentials for fast knowledge/information/data sharing in the military context. (e.g. NCW concepts)
- ‘Network’ science
  - Complexity/emergence
    - Tipping points, ‘scale free’ distributions, ‘small worlds’ with high clustering and short path lengths
  - New statistical approaches
    - Can deal with multiple interdependencies among variables (e.g. Snijders, Pattison, Robins etc.)
  - Developing theoretical and empirical base for human/social aspects of networks, “rise of the network society”, networked organisational form etc.

Social networks are *social*

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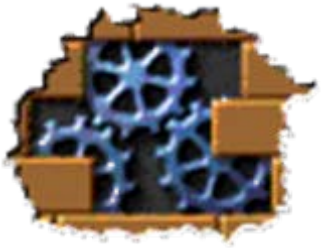
- More cables does not equal ‘better’
  - People have agency – not just data routers
- Significance of *social* networks recognised in organisational contexts:
- “Who you know” (and how you feel about each other) is important
    - Social capital concept
    - Importance of *trust* – affective component to links.
- Formal versus informal distinction
  - Salience is influenced by the ‘image’ we have of organisations (Morgan, 1997)
    - ‘Mechanistic’ vs ‘living’ images



Mechanistic Image

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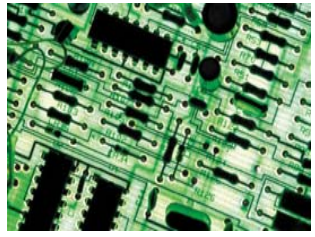
- Focus on Formal structures imposed by management goals
- Top down design
- Examples include reporting networks, formal or prescribed processes and collaborations, formal organisational groupings
- *Affects performance*:
  - Efficiency, control, accountability.
- Can be modelled, predicted engineered (e.g. BPR)



Living images

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- Focus on *informal social networks* between individuals
  - Social networks not just *sociable* – actually often instrumental
- Bottom up emergent structure
- Examples include advice, trust, grapevine
- Stacey's (2001) *shadow organisation*
- *Affects performance*
  - Adaptability, information sharing, innovation, learning
- Can align or conflict with formal structures
- Can be influenced or shaped. But not controlled engineered or predicted

Which perspective is right?

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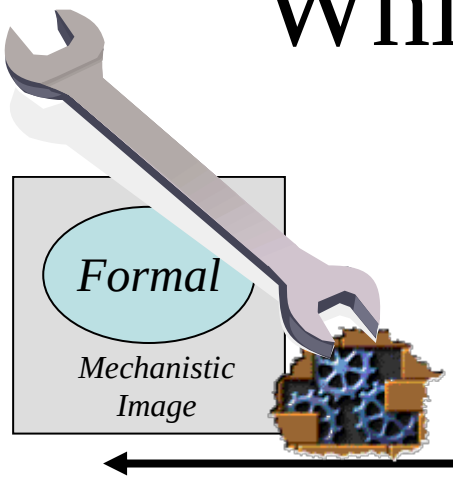

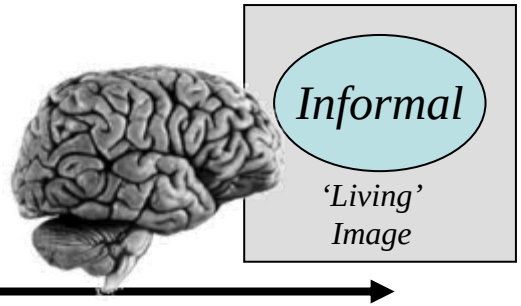

- stable environments
- repetitive problems
- clear persistent organisational functions
- 'tactical' levels of organisations
- 'production' focused outputs
- 'reactive' activities

- Complex dynamic environments,
- Novel problems
- ambiguous and changing organisational goals/functions
- 'strategic' levels of organisations
- decision/knowledge focused outputs
- 'anticipative' activities

- Organisations contain aspects of both ends of the spectrum
- The goals is to find the an appropriate *balance*, not to make the right choice of focus

SNA/ONA

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- Ok we can map it but so what?
- Insights:
  - Structure and embeddedness provides opportunities and constraints
  - Systems are multi-level
    - Individual, group, whole network
    - Interdependence between levels
  - Complex adaptive systems
    - Emergent structure
- Interventions
  - Map and feedback (useful)
  - Formal analysis (more useful)

SNA/ONA metrics

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- Range of quantitative metrics. E.g.:
  - Centrality
  - Structural holes
  - Structural equivalence
  - Cut-points
  - Emergent groups
- Can only be detected from a network perspective
- Provides insights invisible to traditional approaches

Multiplex, Multimodal networks

- Much graph theory based network science focuses on network structure (topology).
- Useful insights, but we must recognise that all nodes/links were *not* created equal
  - Many types of ties
    - Formal, informal…and ambiguous
  - Many types of nodes
    - People, tasks, resources…and many more
- Cant just apply standard network metrics to system of mixed data types
- The right blend depends on phenomena of interest and context.

Example SNA interventions

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- Overcome limitations of out-of-date and incomplete C2 representations
- Identify *enterprise* level organisational structures (e.g. coalition structures)
- Rapid Role Profiling
- Testing formal processes
- Identification of network based organisational vulnerabilities (e.g. cutpoints, bottlenecks, liaisons)
- Optimising physical layout of personnel
- Pure research on military social/organisational networks

Rapid Role Profiling

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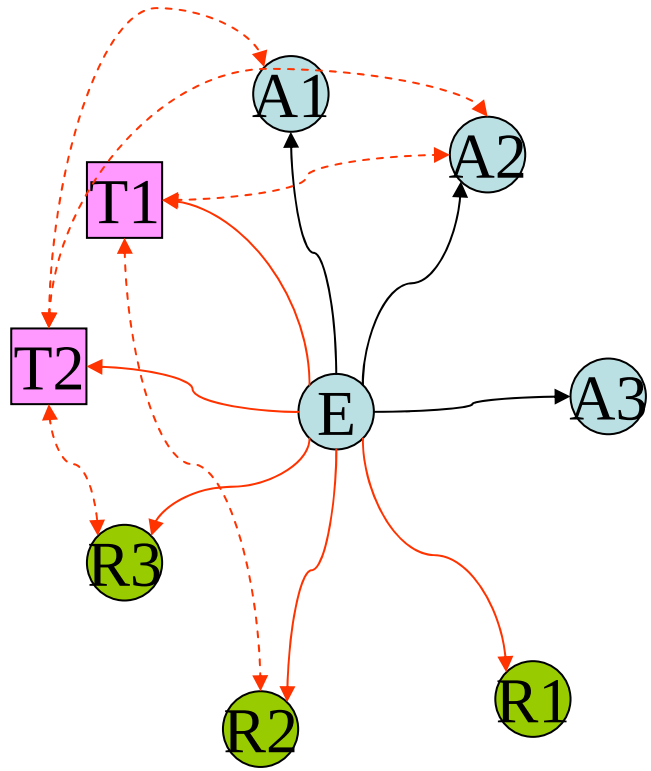
- 1st Gen:
  - Ask Ego "Who do you interact with and why?"
  - Social communication context reflects core aspects of role
  - Interaction with alters tells incoming billet what they need to do.
- **2nd Gen**
  - Expand 'modes' to consider other node types (e.g. tasks, resources etc)
- **3rd Gen**
  - Expand to consider links between different types of nodes
  - "I work with *people* Bill (A1) and Ben (A2) on the *task* of flower pot manufacturing (T2), using the *resource* clay (R3).



Example 2: Testing Processes

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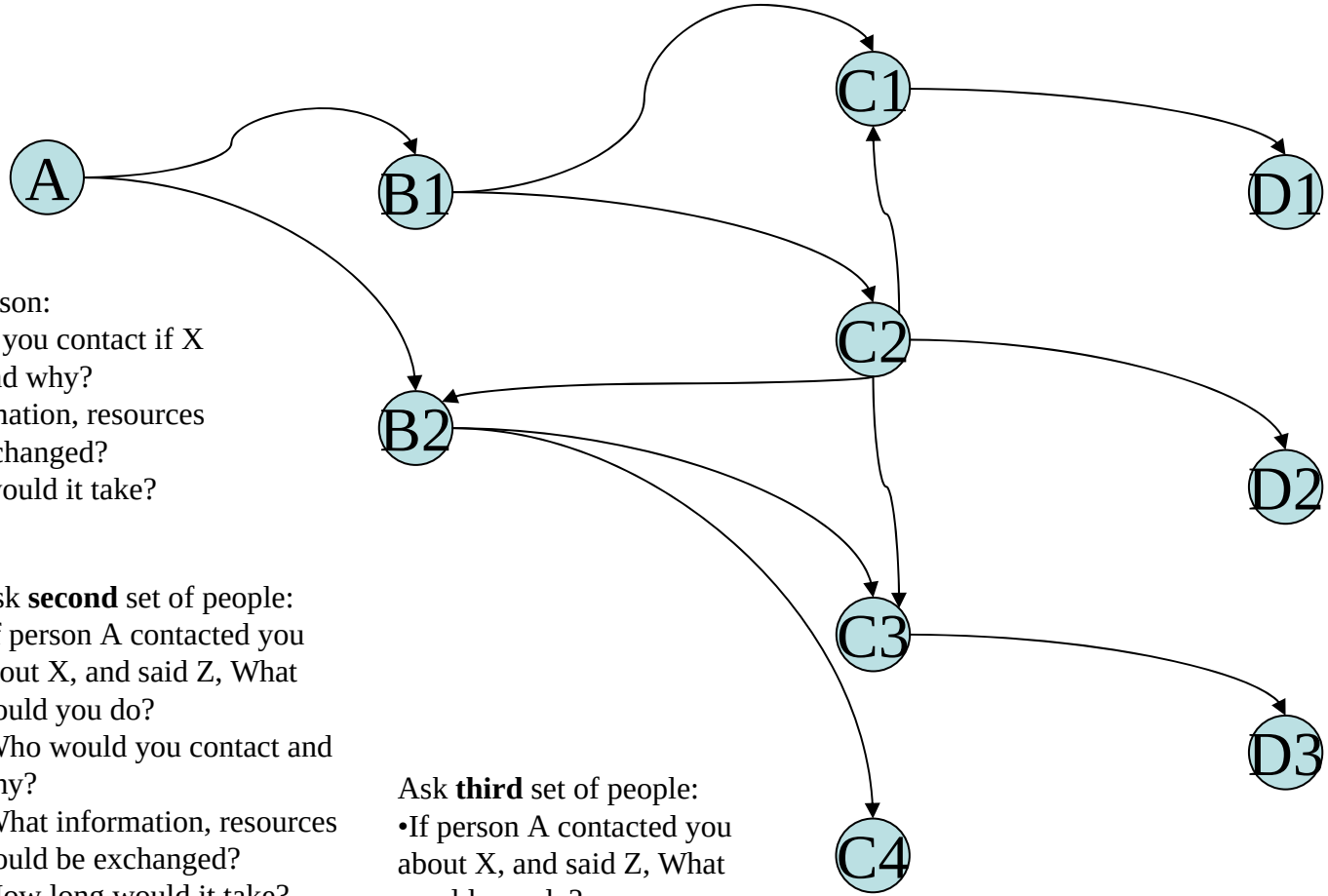

Ask **first** person:
•Who would you contact if X happened, and why?
•What information, resources would be exchanged?
•How long would it take?

Ask **second** set of people:
•If person A contacted you about X, and said Z, What would you do?
•Who would you contact and why?
•What information, resources would be exchanged?
•How long would it take?

Ask **third** set of people:
•If person A contacted you about X, and said Z, What would you do?
•Who would you contact and why?
•What information, resources would be exchanged?
•How long would it take?

Example2: Testing Processes

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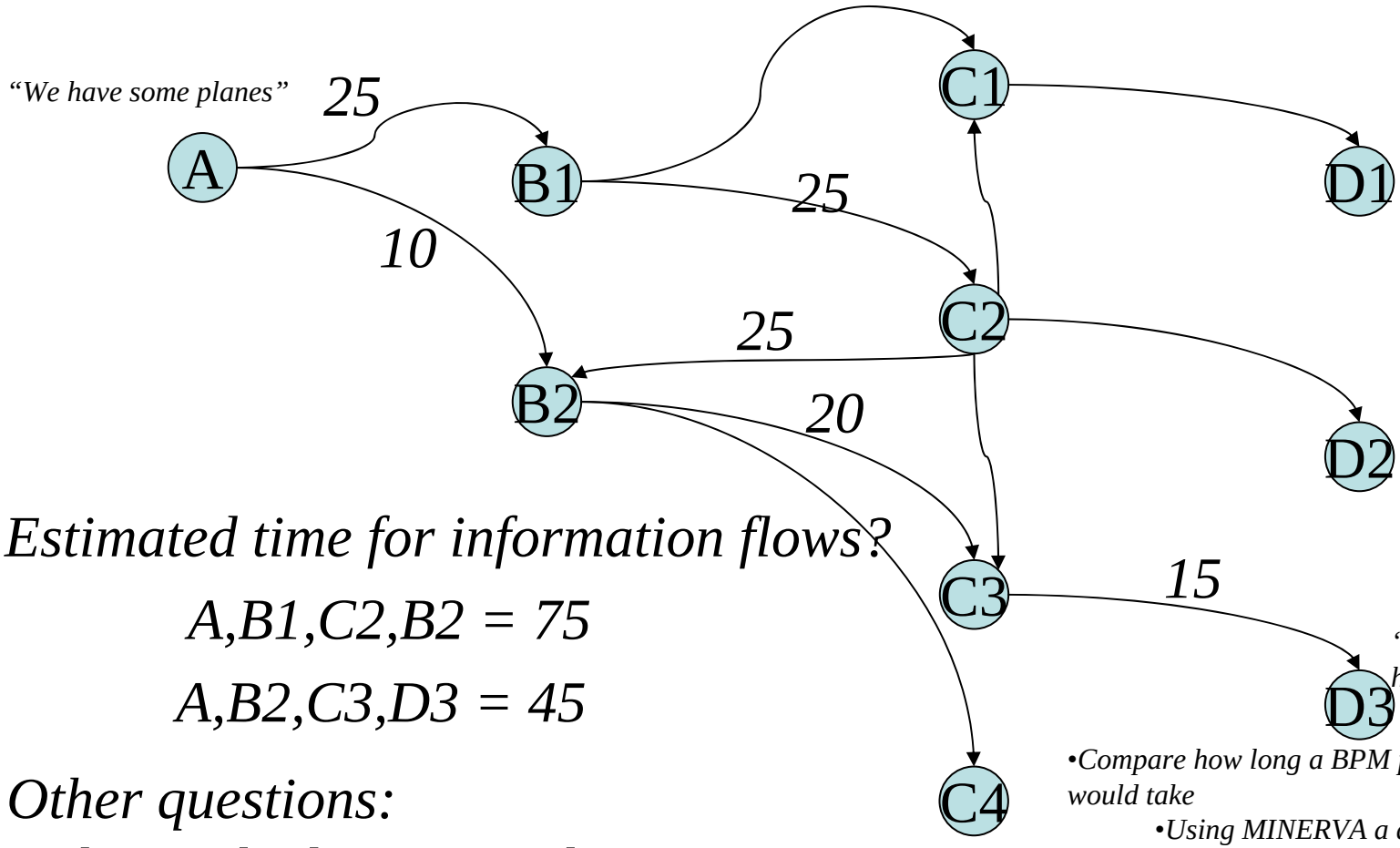

Estimated time for information flows?

A,B1,C2,B2 = 75

A,B2,C3,D3 = 45

Other questions:

- *What is the longest path?*
- *Which nodes are most central?*
- *Which nodes are bottlenecks?*

"Scramble aircraft, and here are ROEs"

- *Compare how long a BPM project with interviews would take*
  - *Using MINERVA a query trail could all be done in a few days*
  - *Takes maybe an hour per node in contact time, and maybe a day between waves of respondents..*
- *Data collection actually becomes a training and role playing exercise:*

E.g. 3: Structural Analysis

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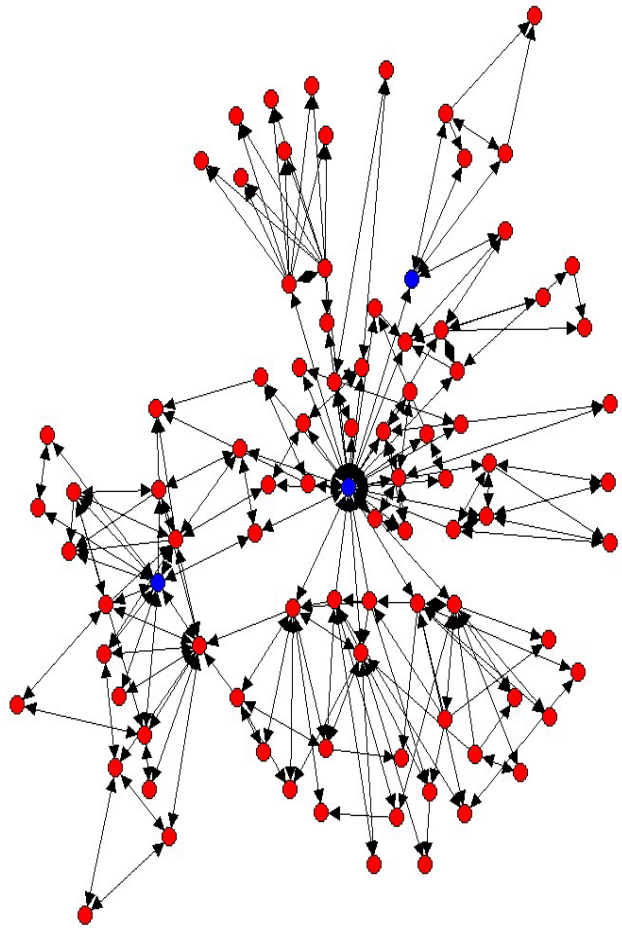
- E.g. blue nodes are cutpoints
  - Loss fragments the network
    - Systematic vulnerability
  - Also bottlenecks
    - Are they overworked?
- E.g. clear evidence of hierarchy and clustering
  - Does this mirror formal structure?
  - Is this what we want?
  - Who is in the clusters and should people be talking more across organisational boundaries?



The problem….

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- Ok so SNA can be useful:
- But data collection is problematic
  - Archival data may lack richness (or be too rich), and has legal/ethical issues.
  - Traditional pen/paper, observation, interview methods are resource intensive and plagued by other logistical problems.
  - Some existing online survey tools, but limited in function

New SNA survey tool: MINERVA

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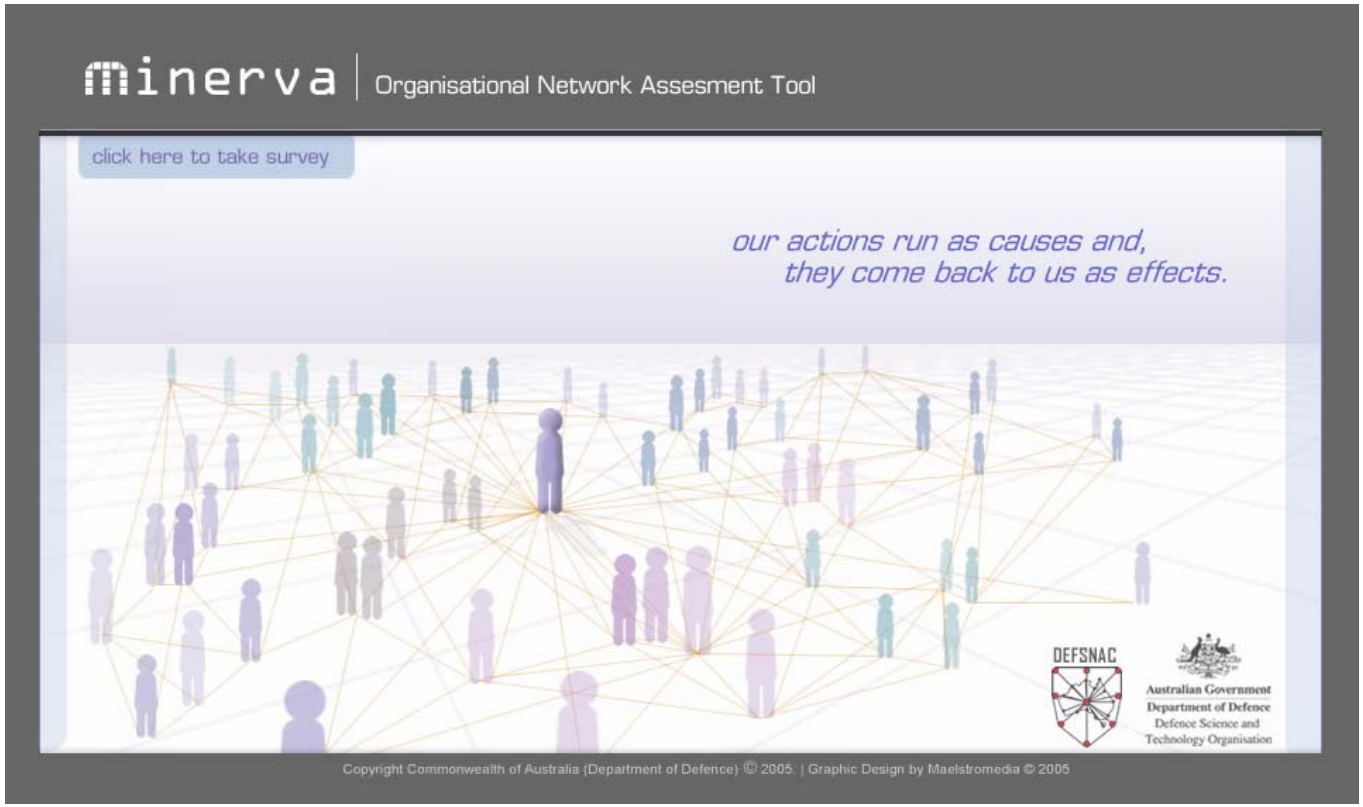

MINERVA created to be a
flexible, efficient, reusable tool
for creation and administration of network surveys.

MINERVA features I

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- WWW/Intranet administration through standard web browser
- Intuitive design for survey creation and response.
- Balances benefits of structure of general survey template with flexibility in structure, content, and question types

MINERVA Client: Survey creation

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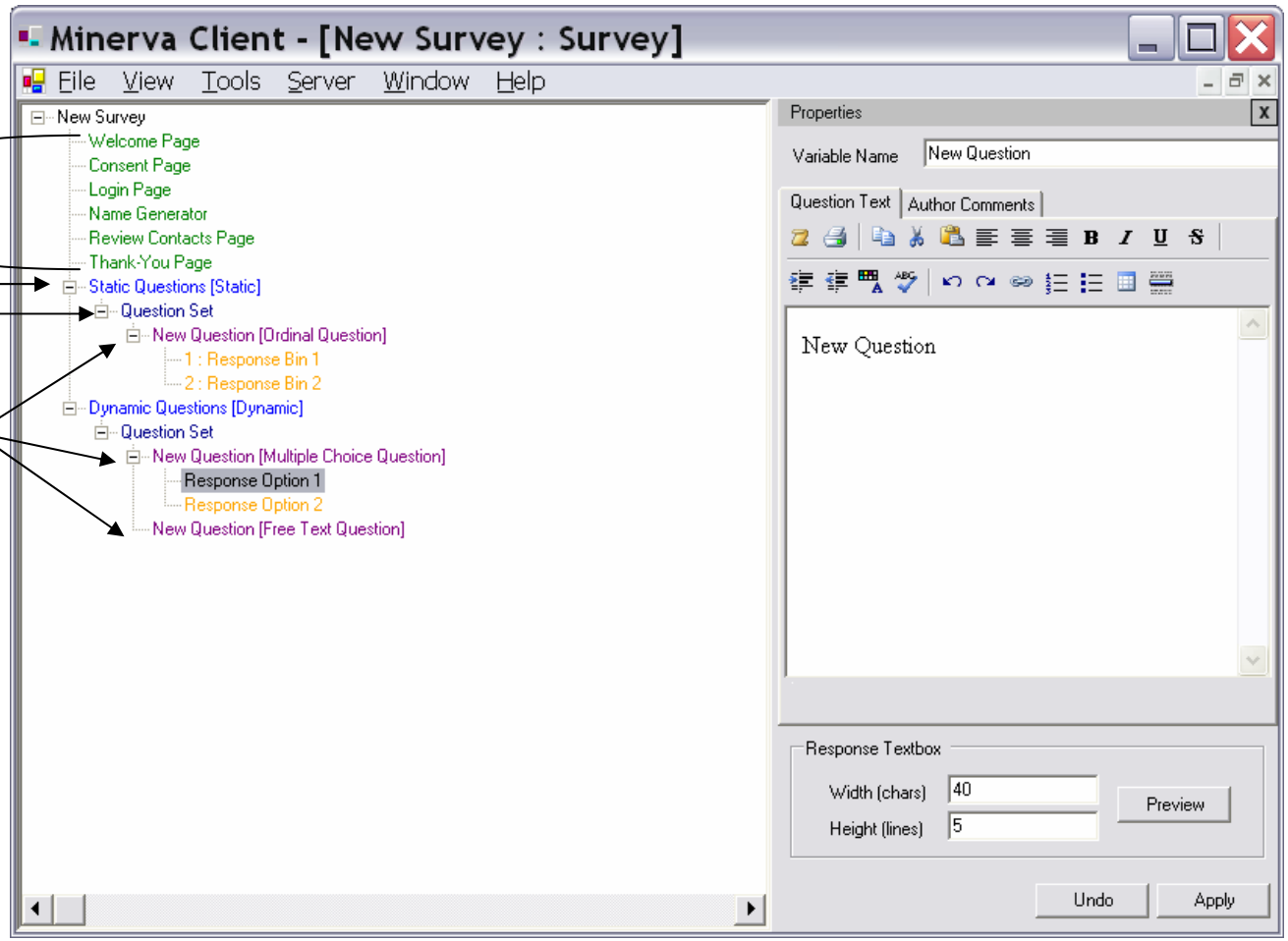
Standard screens

Sets and Sequences

Multiple question types



MINERVA features II

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- Organisational architecture concept
  - Draws on existing knowledge of organisational structure to guide identification and selection of contacts
    - Reduced cognitive load and encourages validity of response data
  - Allows dynamic validation and updating of organisational architecture
  - Automatic import of contact lists
    - Intelligent recognition of inherent structure

MINERVA Client: Org Architecture

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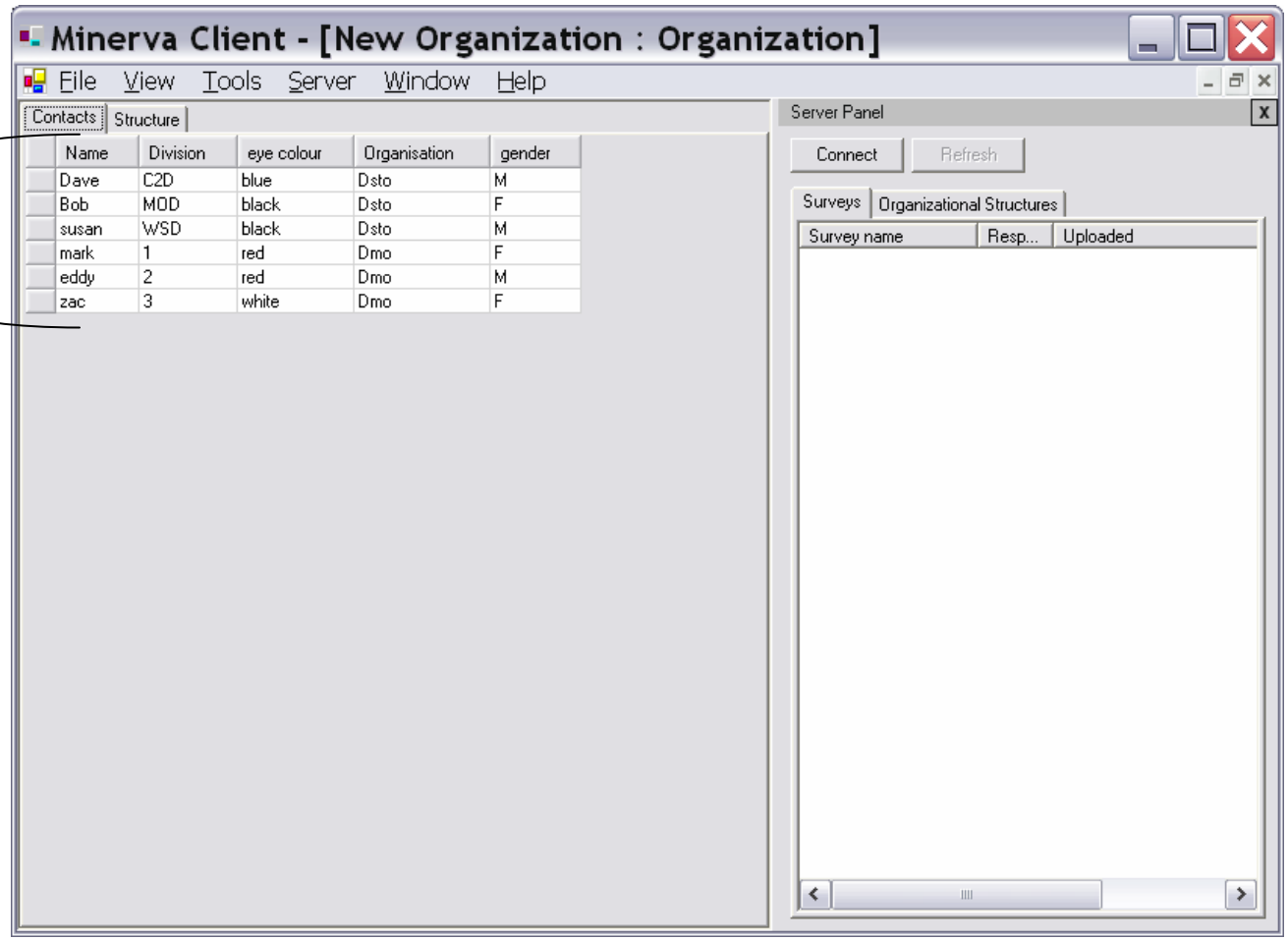
Org. Architecture



MINERVA features III

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- Support for dynamic snowball sampling
  - Who has been nominated but not responded?
- Accordance with ethics considerations
  - facility for obtaining informed consent
  - Public versus private data types
    - Balances need for rich information for org intervention with privacy requirements and truthful responses for more sensitive data

MINERVA features IV

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- Touchgraph network visualisation
  - Lets people see their own network at the end of responding – how they fit in to a wider picture
- Data export to formats for analysis in standard third party applications (e.g. CSV, pajek formats)
  - Facility for selective exports of subsets of network data
    - i.e. only certain types of links, certain types of nodes

Warnings

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- MINERVA helps with data *collection*
  - But doesn't tell what data to collect
    - Requires a good understanding of the problem space and theories and methods of Social Network Analysis.
  - And doesn't do the analysis
    - Requires other third party tools, and skill to use them.

Conclusions

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- Network perspective valuable
  - Knowing the characteristic of a network can provide useful insights that ‘traditional’ approaches to OR/OA/OE cannot.
- The network form of organisation is more than just electronic linkages and transfer of explicit information/data
  - Both formal and informal networks are important
  - Requires rich information about relationships that only people can provide
- Data collection is hard, expensive and time consuming.
  - MINERVA can collect formal and informal social network data quickly and cheaply
  - **MINERVA current status is advanced beta**
    - 1st gen: next step is to automate process mapping function

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