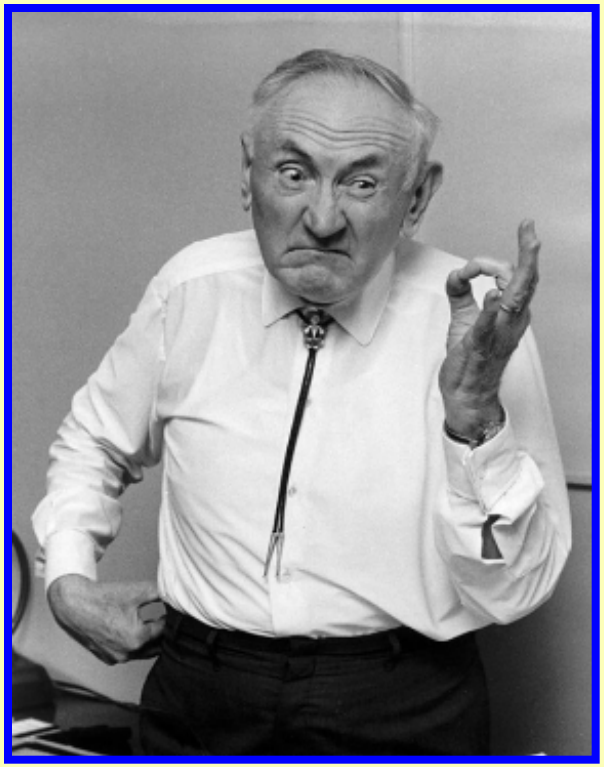
FOI
SWEDISH DEFENCE
RESEARCH AGENCY

Strategic Decision Support Modelling with Morphological Analysis

FOI



Fritz Zwicky

1898-1974

Professor of Astronomy (1942-1968)
California Institute of Technology

Co-founder of Aerojet Engineering

President of ”International Academy of Astronautics”

- Discovered evidence for ”dark matter” in galaxies (1933)
- Triple-hypothesis: ***supernova***, ***neutron stars*** & ***cosmic rays***(1934)
- Galaxies and galaxy clusters act as gravitational lens (1937)
- Developed **morphological analysis** as a general method for non-quantified modelling using a ”***morphological field***”

FOI

“Wicked problems”

H. Rittel & W. Melvin (1973). "Dilemmas in a General Theory of Planning“, *Policy Sciences* **4**, Elsevier Scientific Publishing, Amsterdam, pp. 155-169.

“Social messes”

Russel Ackoff: (1974). *Redesigning the Future*, Wiley.

What's the problem ?

Mess = Complex issue which is not well formulated or defined. ("Wicked problems")

Problem = Well formulated/defined issue, but with no single, clear-cut solution (various solutions depending on…)

Puzzle = Well defined problem with a specific solution which can be worked out.

Russel Ackoff: Re-designing the Future, 1974

FOI

"One of the greatest mistakes that can be made when dealing with a mess is to carve off part of the mess, treat it as a problem and then solve it as a puzzle -- ignoring its links with other aspects of the mess."

(Pidd, M: *Tools for Thinking,* 1996)

Morphological Analysis:

A GENERALISED METHOD FOR STRUCTURING AND ANALYSING COMPLEX PROBLEM FIELDS WHICH:

- **ARE INHERENTLY NON-QUANTIFIABLE**
- **CONTAIN NON-RESOLVABLE UNCERTAINTIES**
- **CANNOT BE CAUSALLY MODELLED OR SIMULATED**
- **REQUIRE A JUDGMENTAL APPROACH**

FOI

For What ?

LONG-TERM PLANNING and STRATEGY EVALUATION

- **DEVELOPING SCENARIO MODELLING LABORATORIES**
- **STRUCTURING AND ANALYSING COMPLEX POLICY SPACES**
- **RELATING ENDS & MEANS IN STRATEGIC PLANNING (Process support for decision-making)**
- **“POSITION ANALYSIS” (STAKEHOLDER ANALYSIS)**

FOI

Philosophy:

THE METHOD SHOULD BE:

- Group & process oriented
- Generic (general method for NQM)
- Transparent (No black boxes)
- Traceable (”Audit trail”)
- Easy to update results

FOI

Results:

- A structured (dimensioned) problem
- Simple (scenario) laboratory
- Complex overlay laboratory
- Validated IO-model/instrument

FOI

For whom ?

Swedish Total-Defence Structure

- Scenarios and Strategies for Long-term Planning
- Airborne Capacity*
- Amphibious Brigade
- Future ground target systems*
- UAV Tactical Systems
- Markus: The Future Ground Soldier
- New Education and Training Systems for the Army
- Swedish SEAD Capacity
- Information Warfare Systems and Contexts (CSIR)
- Instrument for Evaluating Military Exercises
- Risk Analysis for UXO

FOI

For whom ?

Civilian Agencies, NGOs and Companies

- National Rescue Services (SRV)
- Environmental Protection Agency (EPA)
- Foreign Aid and Development Agency (SIDA)
- Swedish Energy Agency (Stem)
- Nuclear Waste Disposal Agency (SKB)
- Nuclear Power Inspectorate (SKI)
- Swedish Postal Services
- CSIR – Republic of South Africa (IW)
- Center for Science, Policy, Outcomes – Washington DC

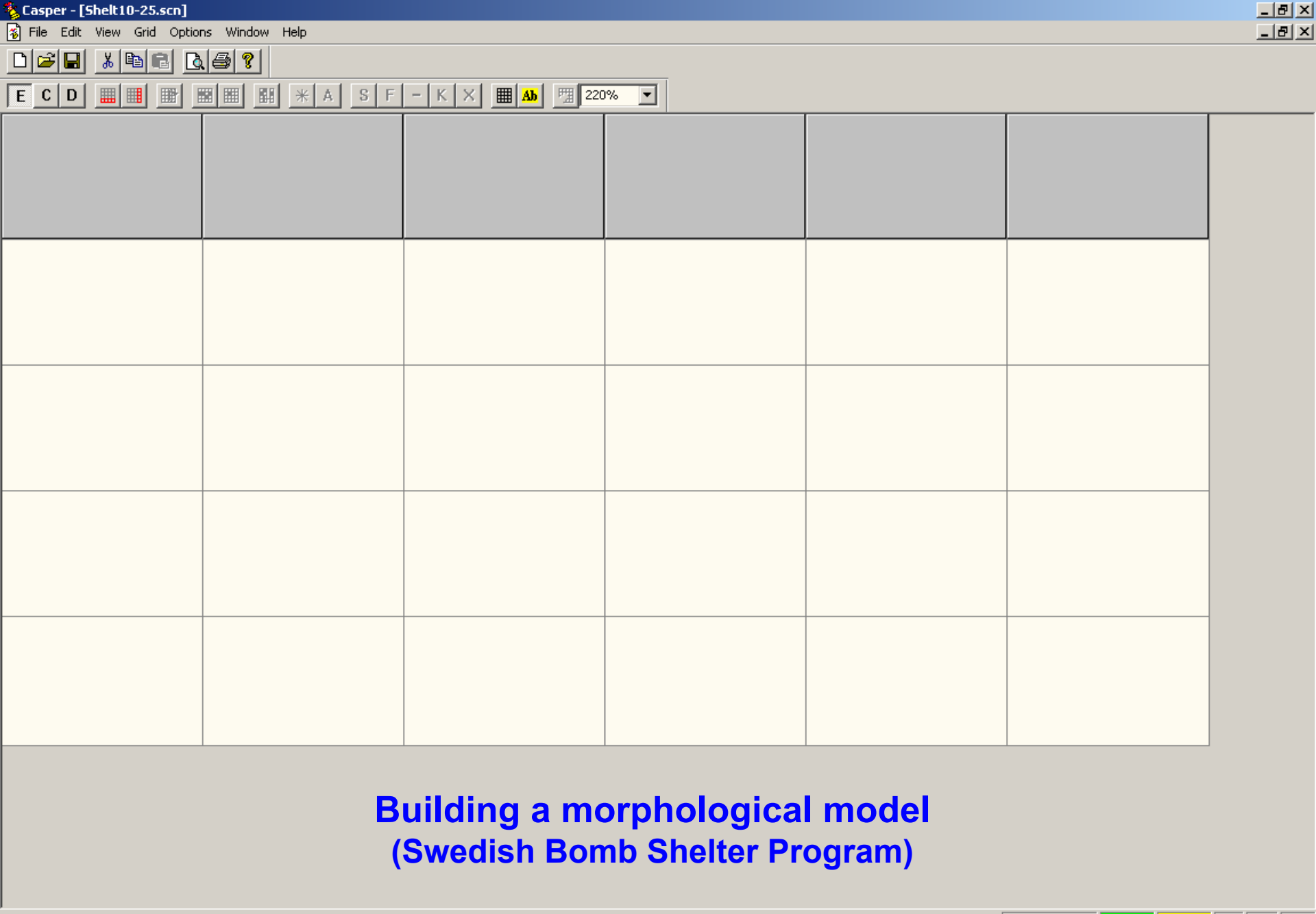
FOI

Ground Target Model: scenarios vs. systems

Tactical scenarios	Purpose	Effect/ penetration: What required	Effect/ precision: What required	Guidance system: final phase	Attaqck attitude: What required	Time to effect after decision to employ	Special weapon system demands/properties	System
Scenario 1	Destroy	Bunker buster	Great accuracy Little or no side effect	Visuellt	Vertical	Within 10 s	Recognition/ identificationcapacity	System 1
Scenario 2	Pin down, stop	Kinetic energy + RSV (Hard)	Great accuracy Limited side effect	IR	Horizontal	Within 1 minute	Command self-destruction (Abort mission)	System 2
Scenario 3	Disrupt	30 mm (medium)	Good accuracy Some side effect	Radar		Within 10 minute	Updateable target co-ords.	System 3
Scenario 4	Warn	Small-bore + fragmentation (soft)	Area effect 200x300 m	Akustisk		Within 30 minute	Sensor guided warhead	System 4
Scenario 5			Area effect 500x400 m	Koordinatbestäm,		Within 1 hour	Pre-programmed target co-ords.	System 5
Scenario 6						Within 5 hours	Basic capacity	System 6
Scenario 7						Within 24 hours		System 7
						More than 24 hours		System 8
								System 9
								System 10
								System 11

Morphological model containing 38,000 possible configurations

FOI


Casper - [Shelt10-25.scn]
File Edit View Grid Options Window Help
E C D
220%
Building a morphological model
(Swedish Bomb Shelter Program)
Ready
Comb 0
25
25
Start
Scenkurs-eng2.ppt
Presentation3
PowerPoint-bildspel - [Pr...
Casper - [Shelt10-25....
00:07
tisdag

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy

Define the most important parameters of the problem complex

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
Metropoles	All socio-tech. functions	Large, not crammed	With new construction	More frequent maintanance	All get same shelter quality
Cities + 50,000	Tech. support systems	Large & crammed	Compensation	Current levels	All take same risk
Suburbs and country-side	Humanitarian aims	Small, not crammed	New only for defence build up	No maintanance	Priority: Key personnel
No geo-priority	Residential	Small & crammed			Priority: Needy

Define a range of “values” or “conditions” for each parameter

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
Metropoles	All socio-tech. functions	Large, not crammed	With new construction	More frequent maintanance	All get same shelter quality
Cities + 50,000	Tech. support systems	Large & crammed	Compensation	Current levels	All take same risk
Suburbs and country-side	Humanitarian aims	Small, not crammed	New only for defence build up	No maintanance	Priority: Key personnel
No geo-priority	Residential	Small & crammed			Priority: Needy

A field configuration (one of 2304)

Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
Metropoles	All socio-tech. functions	Large, not crammed	With new construction	More frequent maintanance	All get same shelter quality
Cities + 50,000	Tech. support systems	Large & crammed	Compensation	Current levels	All take same risk
Suburbs and country-side	Humanitarian aims	Small, not crammed	New only for defence build up	No maintanance	Priority: Key personnel
No geo-priority	Residential	Small & crammed			Priority: Needy

Contradictory value pairs

Casper - [Shelt10-25a.scn]

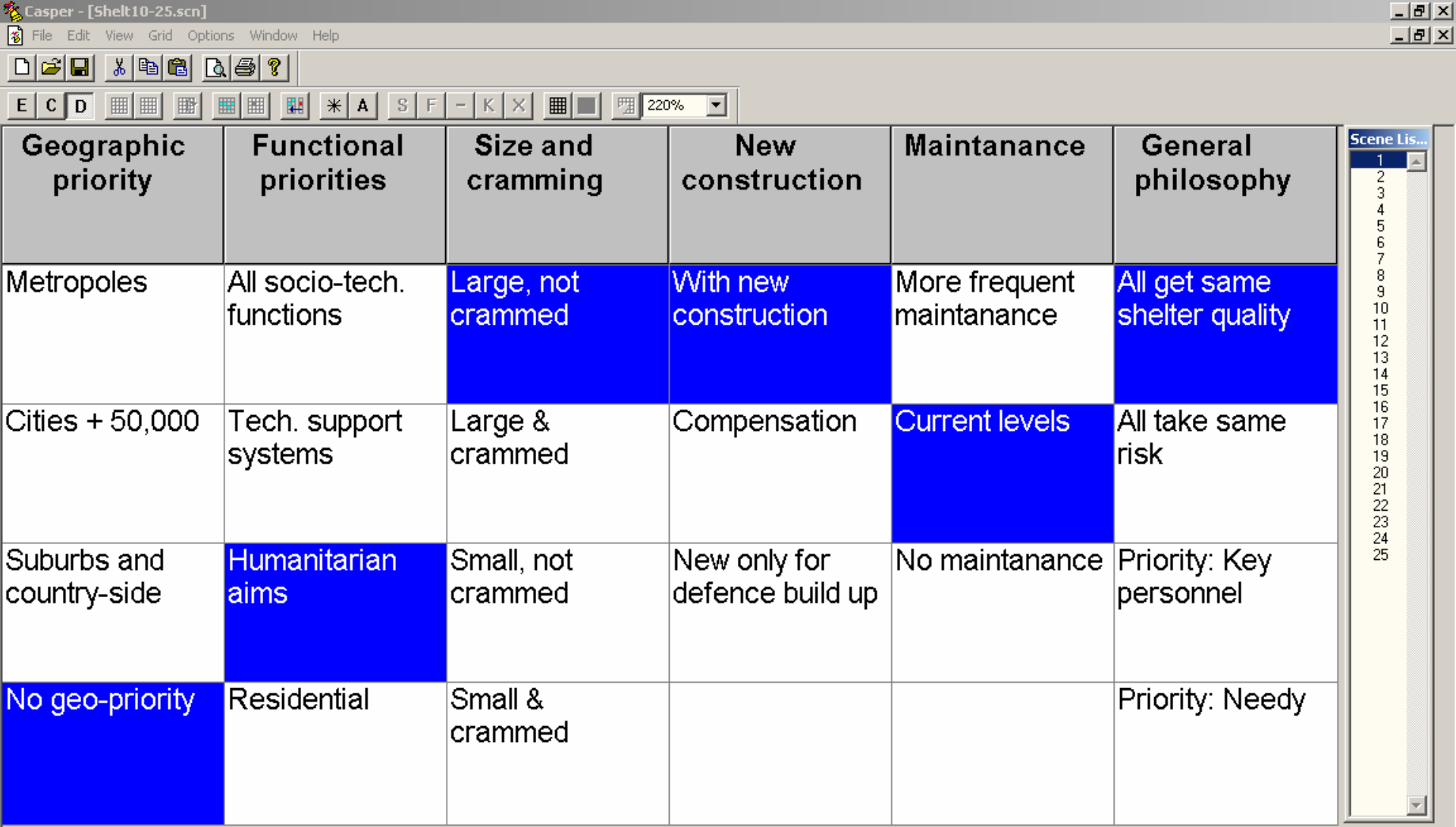
File Edit View Grid Options Window Help

Internal Consistency matrix

		Geographic				Functional				Size and				New			Maintana		
		Metropoles	Cities + 50,000	s and countryside	No geo-priority	cio-tech. functions	n support systems	Humanitarian aims	Residential	rge, not crammed	Large & crammed	all, not crammed	Small & crammed	With new construction	Compensation	or defence build up	frequent maintanance	Current levels	maintanance
Functional priorities	All socio-tech.																		
	Tech support																		
	Humanitarian																		
	Residential																		
Size and cramming	Large, not																		
	Large &																		
	Small, not																		
	Small &																		
New construction	With new																		
	Compensation																		
	New only for																		
Maintanance	More frequent																		
	Current levels																		
	No																		
General philosophy	All get same																		
	All take same																		
	Priority: Key																		
	Priority: Needy																		

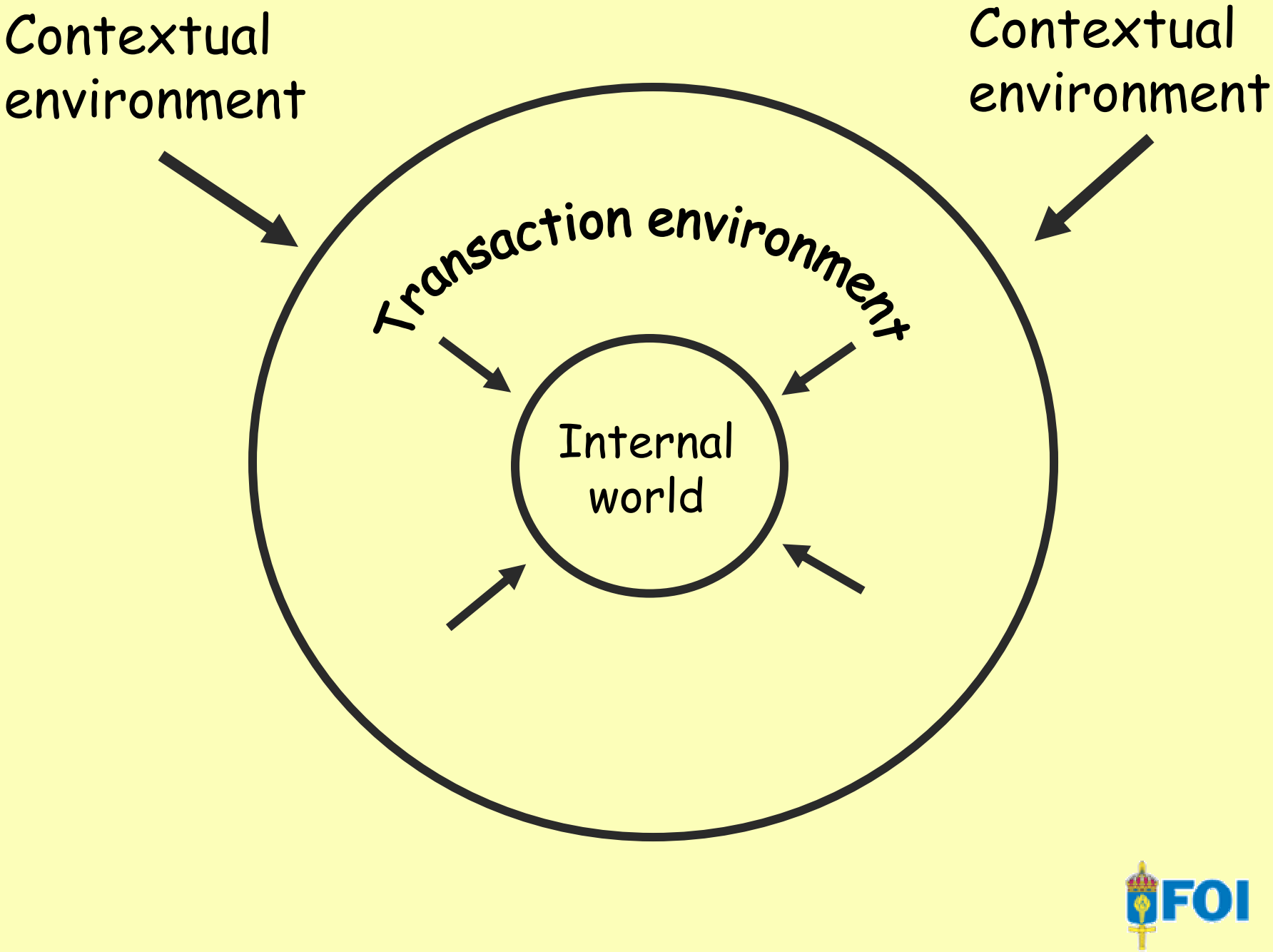
Ready

Comb 2304 | 25 | 25



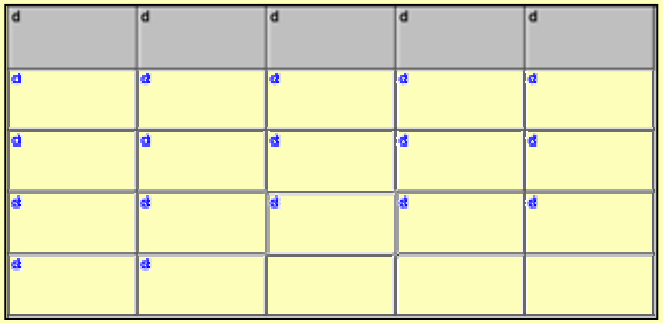
Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy
Metropoles	All socio-tech. functions	Large, not crammed	With new construction	More frequent maintanance	All get same shelter quality
Cities + 50,000	Tech. support systems	Large & crammed	Compensation	Current levels	All take same risk
Suburbs and country-side	Humanitarian aims	Small, not crammed	New only for defence build up	No maintanance	Priority: Key personnel
No geo-priority	Residential	Small & crammed			Priority: Needy

Solution space: list of surviving, internally consistent configurations

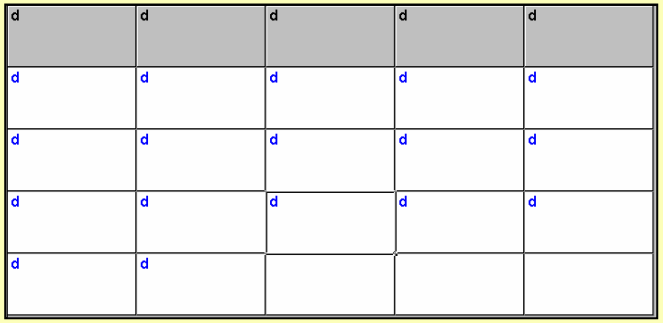

Contextual environment
Contextual environment
Transaction environment
Internal world

Linked morphological fields:

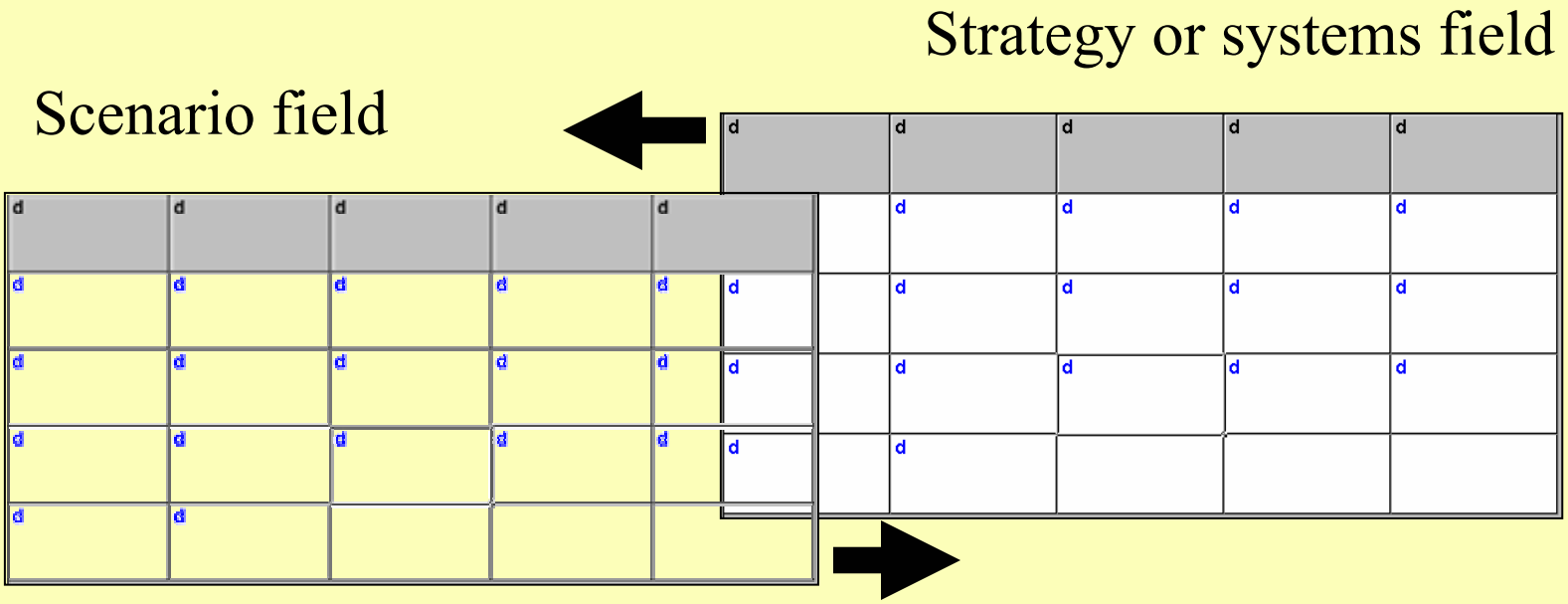
Scenario field



Strategy or systems field



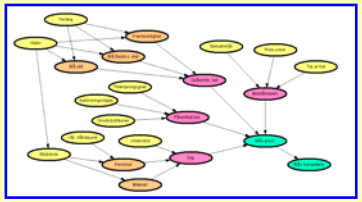
Scenario-Strategy overlay:



Examples

Three methods for strategic decision support modelling

BN



Causal network model

MA

Structure (parameterise) a problem complex ("wicked problems")

AHP

Evaluate alternatives given a hierarchy of goal criteria

FOI

Information on General Morphology

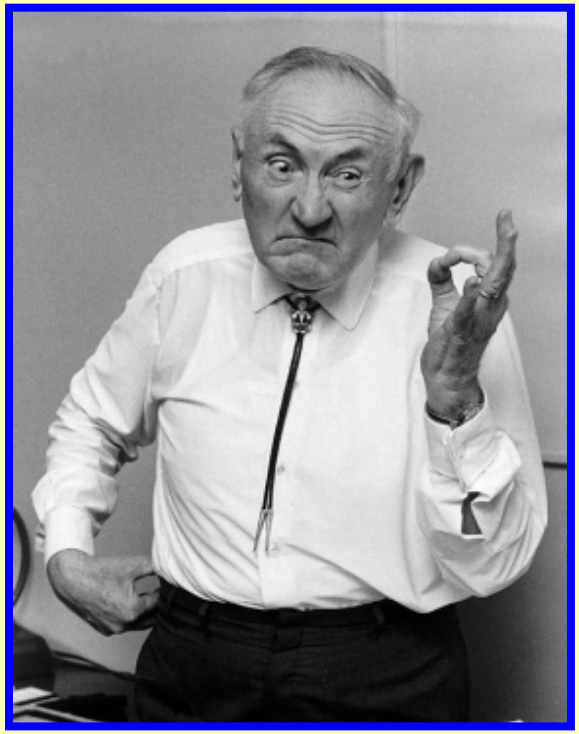
---

www.foi.se/ma

www.swemorph.com

ritchey@foi.se

Thank you …



and have a nice day…