

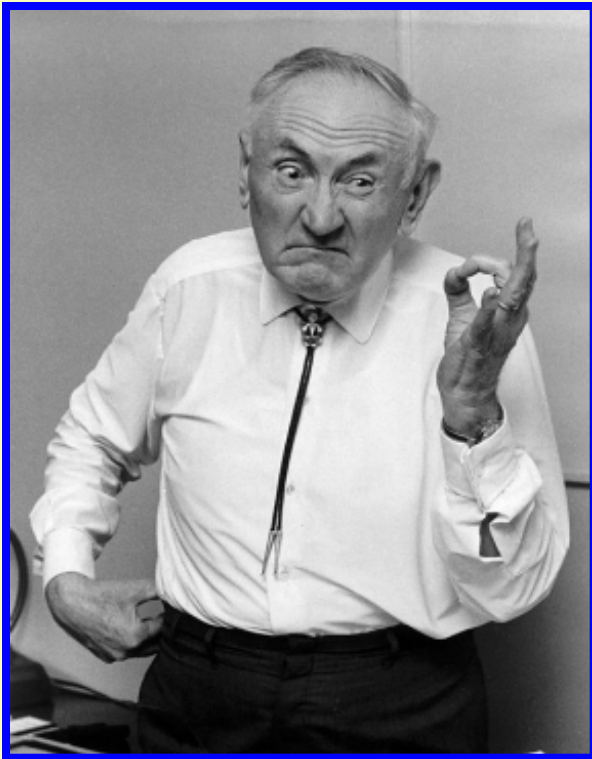
***Strategic
Decision Support Modelling
with
Morphological Analysis***

Report Documentation Page

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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*"

“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



Problem

Puzzle

= **Complex issue which is not well formulated or defined. (“Wicked problems”)**

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

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

“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**

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)**

Philosophy:

THE METHOD SHOULD BE:

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

Results:

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

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**

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**

Ground Target Model: scenarios vs. systems

Tactical scenarios	Purpose	Effect/ penetration: What required	Effect/ precision: What required	Guidance system: final phase	Attack 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/ identification capacity	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

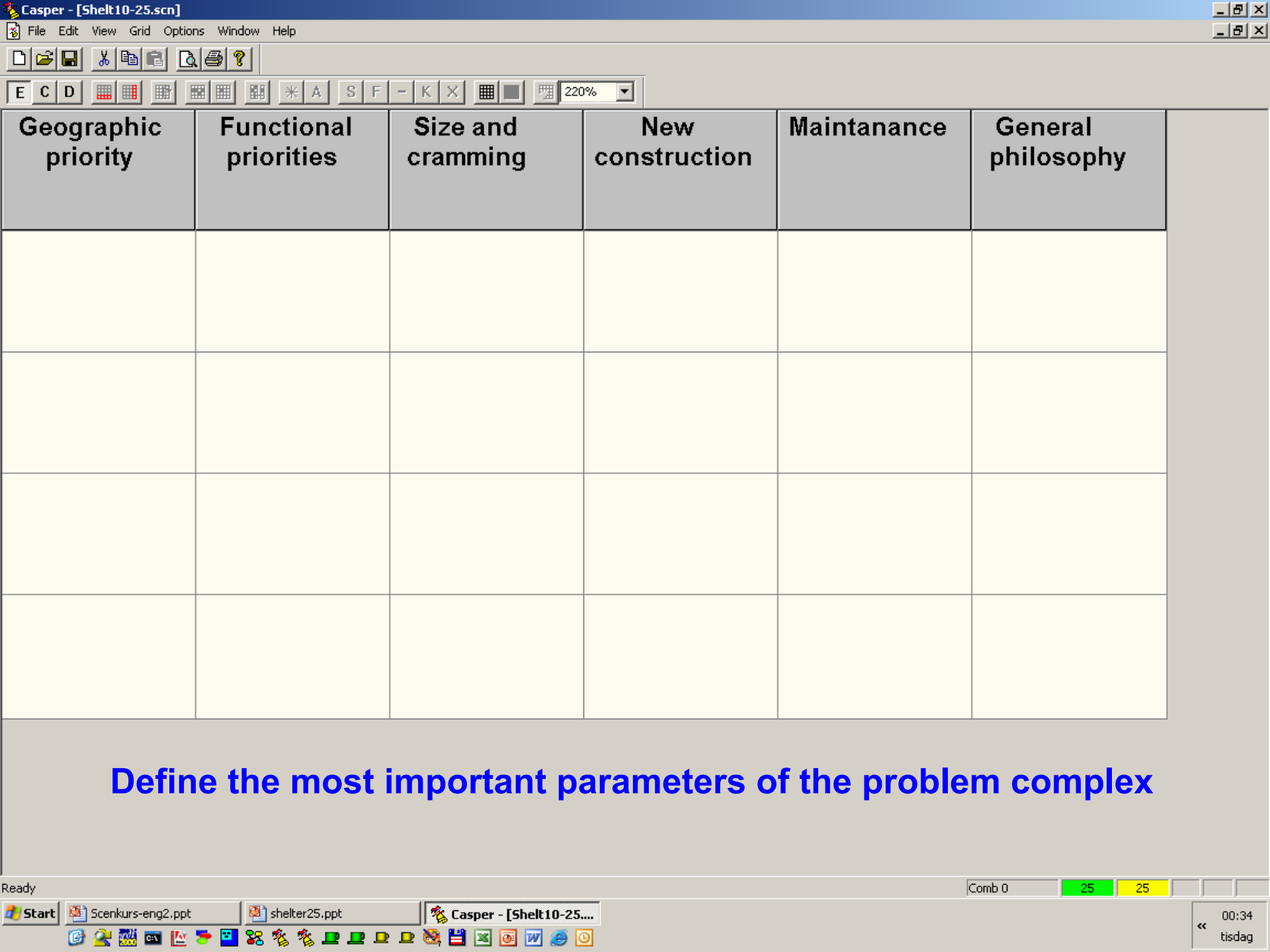
Morphological model containing 38,000 possible configurations



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Building a morphological model (Swedish Bomb Shelter Program)

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**Geographic
priority**

**Functional
priorities**

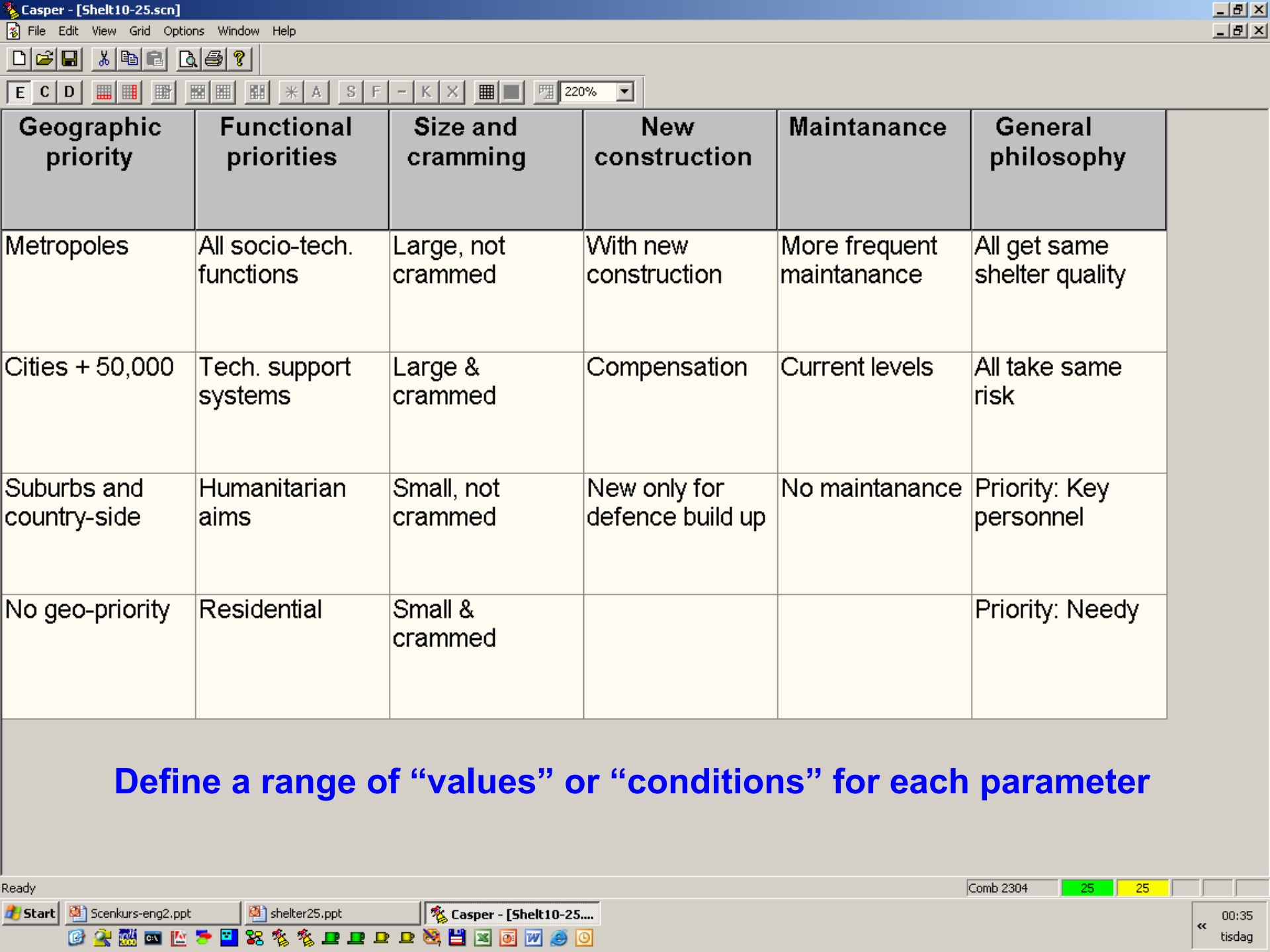
**Size and
cramming**

**New
construction**

Maintanance

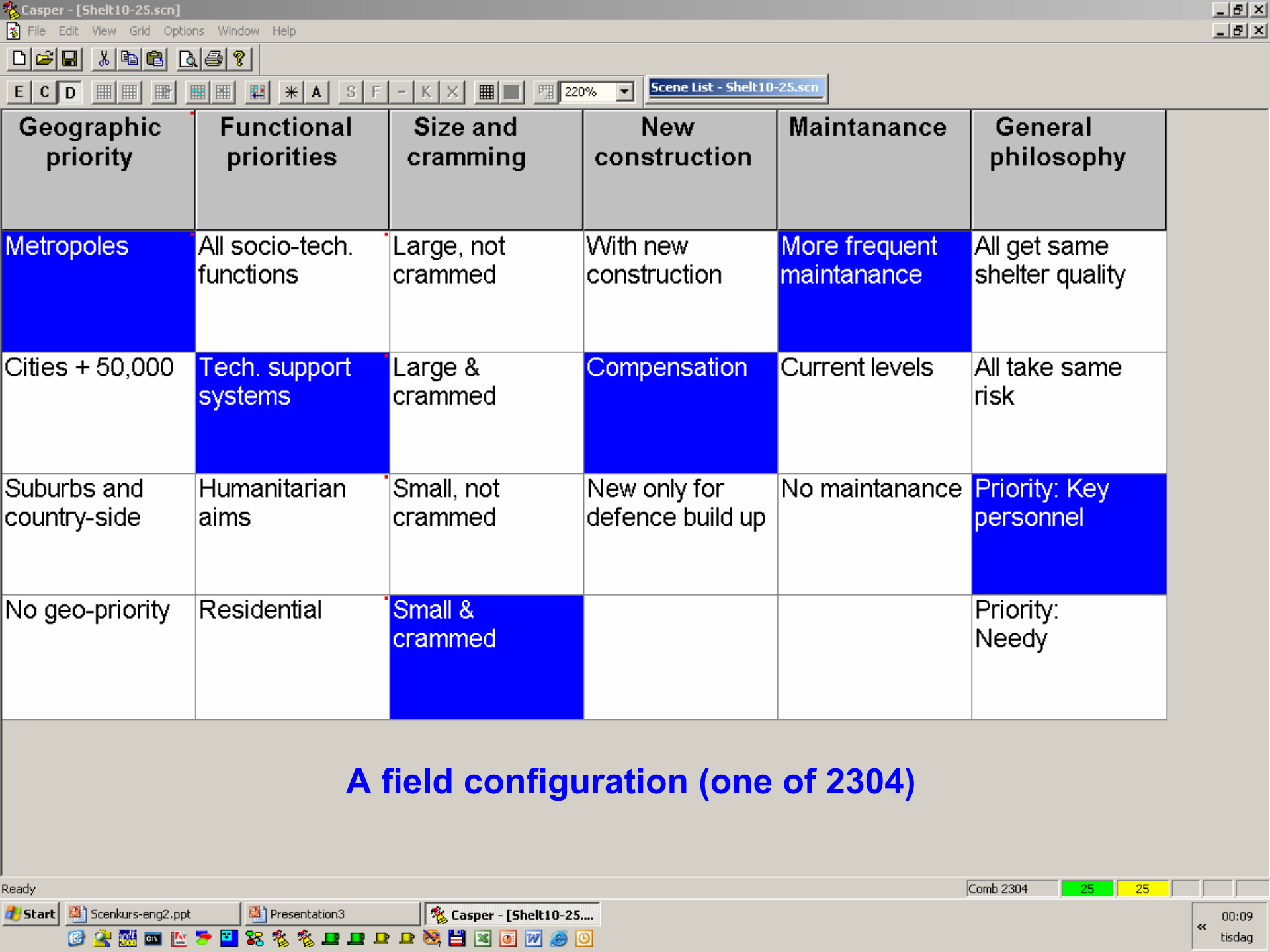
**General
philosophy**

Define the most important parameters of the problem complex



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

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

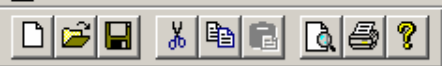


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A field configuration (one of 2304)

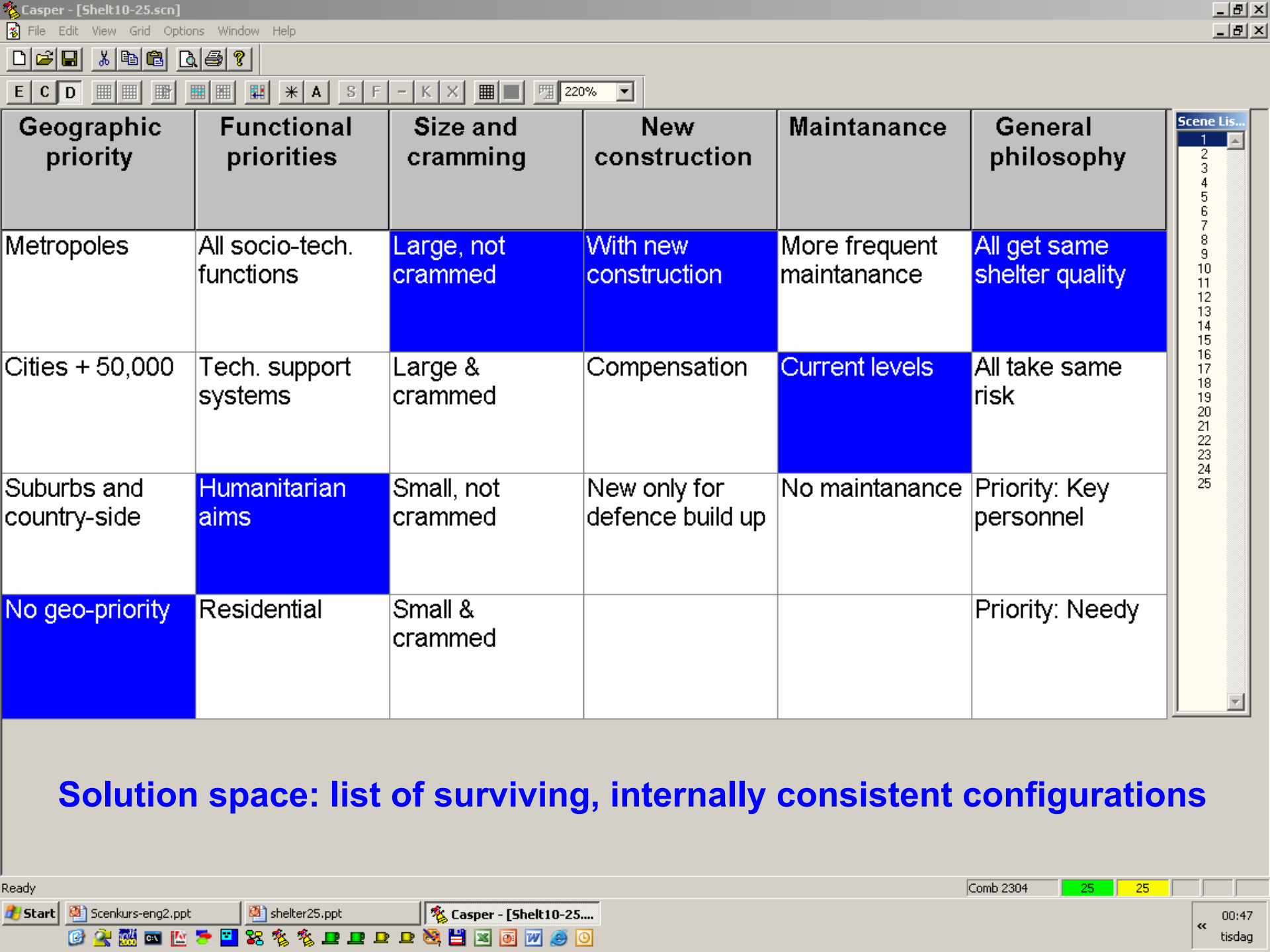
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Contradictory value pairs



Internal Consistency matrix

		Geographic				Functional				Size and				New		Maintana		
		Metropolises	Cities + 50,000	and countryside	No geo-priority	ocio-tech.	support	Humanitarian	Residential	Large, not crammed	Large & crammed	all, not crammed	Small & crammed	With new construction	Compensation	or defence build	frequent maintenance	Current levels
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																	



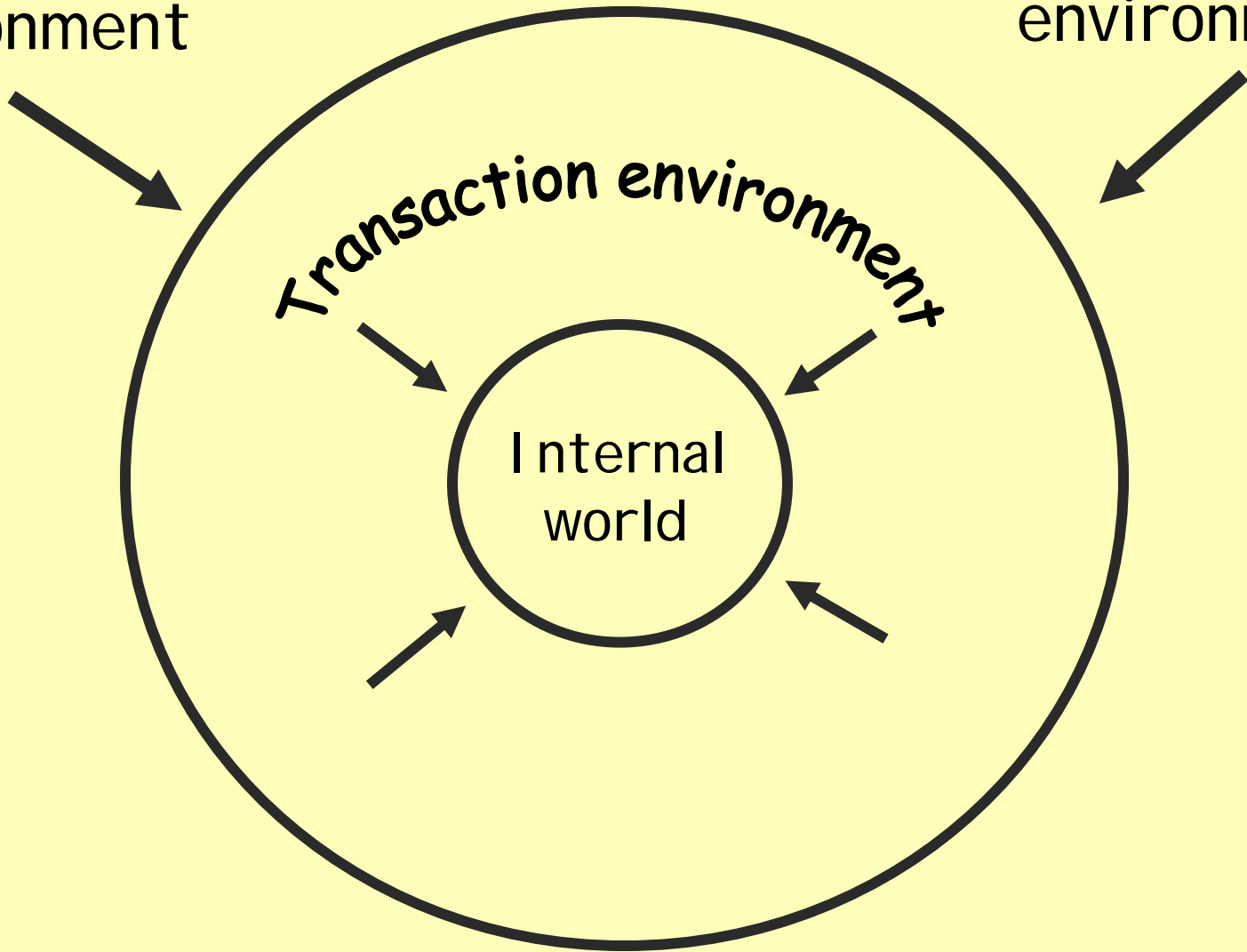
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Cities + 50,000	Tech. support systems	Large & cramped	Compensation	Current levels	All take same risk
Suburbs and country-side	Humanitarian aims	Small, not cramped	New only for defence build up	No maintenance	Priority: Key personnel
No geo-priority	Residential	Small & cramped			Priority: Needy

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Solution space: list of surviving, internally consistent configurations

Contextual environment

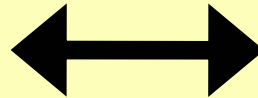
Contextual environment



Linked morphological fields:

Scenario field

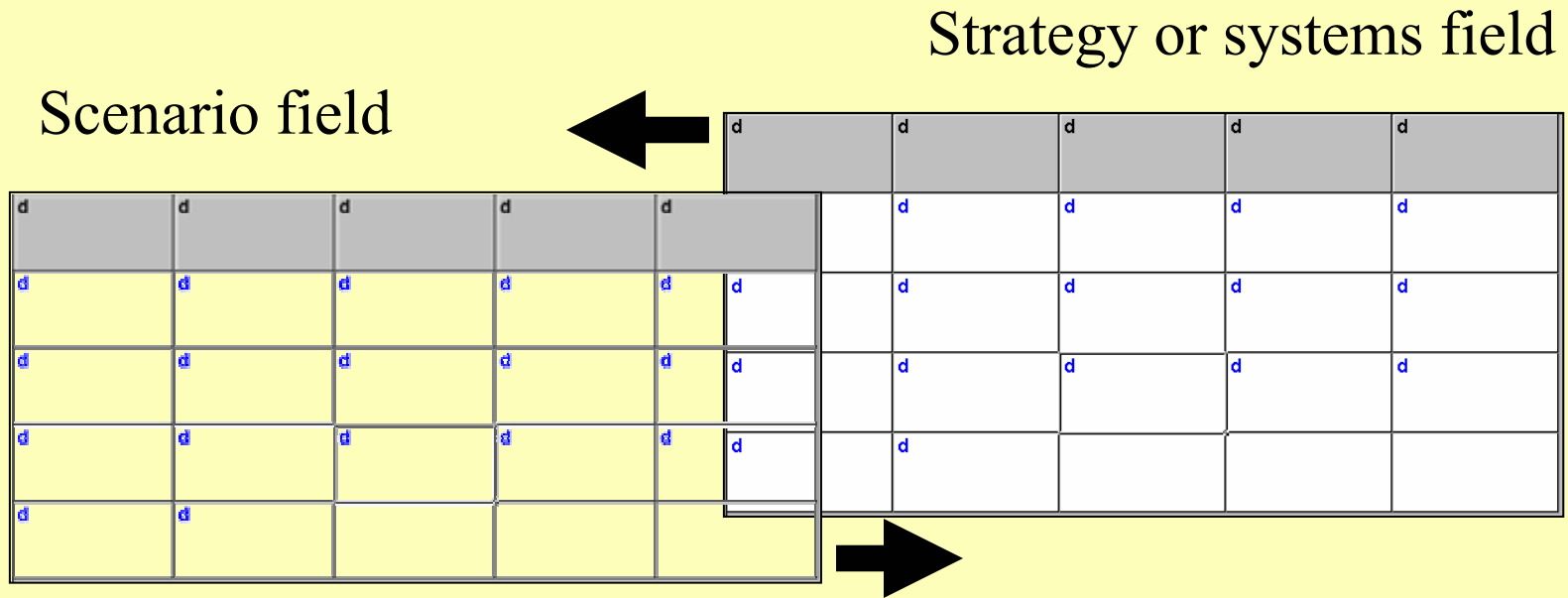
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Strategy or systems field

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Scenario-Strategy overlay:



Examples

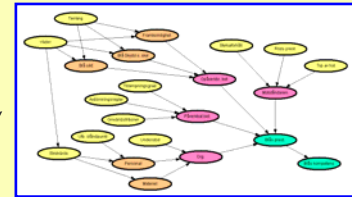
Three methods for strategic decision support modelling

MA

Geografisk prioritering	Funktionell prioritering	Storlek och trängsel	Nybyggings	Underhåll	Skyddsrum-Bevott
Endast stora lokaler	Alla socio- tekniska funktioner	Stora, två våningar	Med ny konstruktion	Mer bekvämt	Alla får samma skydd
Städer med mer än 50.000	Teleskop- skyddsystem	Stora, två våningar	Kompensation för konstruktionstid	Skvadsade stök	Alla får samma risk
Förorter och småstaden	Personer i redning	Små, två våningar	Endast under "beredning"	inget	Funktionella verktyg och utrustning
Ingen geografisk prioritering	Småskalig	Små, två våningar			De stora prioriterade

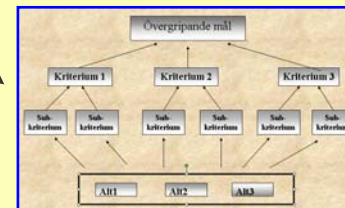
Structure (parameterise) a problem complex ("wicked problems")

BN



Causal network model

AHP



Evaluate alternatives given a hierarchy of goal criteria

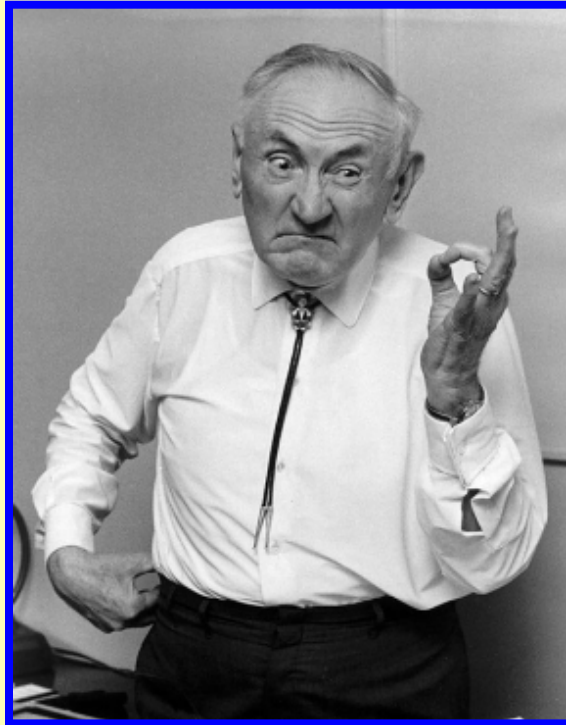
Information on General Morphology

www.foi.se/ma

www.swemorph.com

ritchey@foi.se

Thank you ...



and have a nice day...

