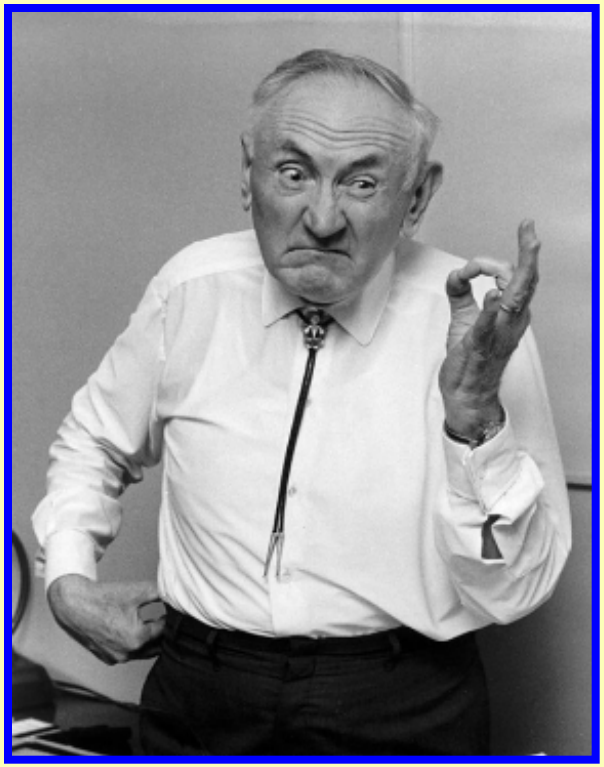
Developing Scenario Laboratories
with
Morphological Analysis

Tom Ritchey
Swedish Morphological Society
Presented at ICCRTS 14 - 2009



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 modeling using a ”***morphological field***”

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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**
  (Decision support modelling)
- **POSITION ANALYSIS (STAKEHOLDER ANALYSIS)**

Philosophy:

THE METHOD IS:

- **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) LABORITORY**
- **COMPLEX OVERLAY LABORATORY**
- **VALIDATED IO-MODEL/INSTRUMENT**

Project examples: Defence Sector

- National Strategic Threat Scenarios (updated yearly)
- Operational Environments for Peacekeeping Operations
- Tactical Scenarios for Future Ground Target Systems
- Scenarios and Strategies for Future Air Defence Systems
- Developing a Swedish Airborne Capability
- Developing an Amphibious Brigade
- IW: Operational Environments and Strategies
- Sensor Systems for Information Gathering Units (RSA)
- Scenarios for Future Russian Military Power Projection (FFI)
- Personnel Structures for new Combat Boat (Dutch Navy)
- UAV tactical study
- TAV – Total Asset Visibility (Logistics study)
- New Swedish Submersible Boat Concepts

Model to Evaluate Preparedness for Terrorist Actions Involving Chemical Releases

PLANNING/ PLANS	TRAINING AND EDUCATION	PERSONNEL AVAILABLE	EQUIPMENT AVAILABLE	LEADERSHIP LEVEL (pre-defined)	EVACUATION and cordoning of contaminated area	Indication of source and substance group	Information to public	Direct help for seriously injured	Final decontamination of affected persons
Full municipal preparedness plan/ object oriented planning	Broad co-op. training for C-agents	20 eller more	Special for specific C-agent substance group	Level 4	Effective evac. and info within 15 minutes	Indication of source and substance group within 15 minutes	Warning and information within 5 min	Help up to 20 people with first decon. within 15 min	Complete decon. of 10/hour begun within 30 min.
Response plan for C- agents	Internal traning for C- agents	13 - 19	Base for general C-agent	Level 3	Effective evac. and info within 30 minutes	Indication of substance group within 15 minutes	Warning and information within 30 min	Help 1-5 people with first decon. within 15 min	Complete decon. of 10/hour begun within 60 min.
Standard routine (check list) for command level	Base education + regular training C-accidents	8 - 12	Less than base for general C-agents	Level 2	No effective evac within 30 minutes	Indication of source and substance group within 30 minutes	No measures within 30 minutes	Help 10-20 out of area within 15 min	Partial decon. of 10/hour begun within 30 min.
Standard routine for general C-accident		5-7		Level 1		Indication of substance group within 30 minutes		No measures within 30 minutes	Organised airing and observation (after evac.)
						No measures within 30 minutes			No measuresbegun within 60 minutes

Morphological model containing 29,000 possible configurations

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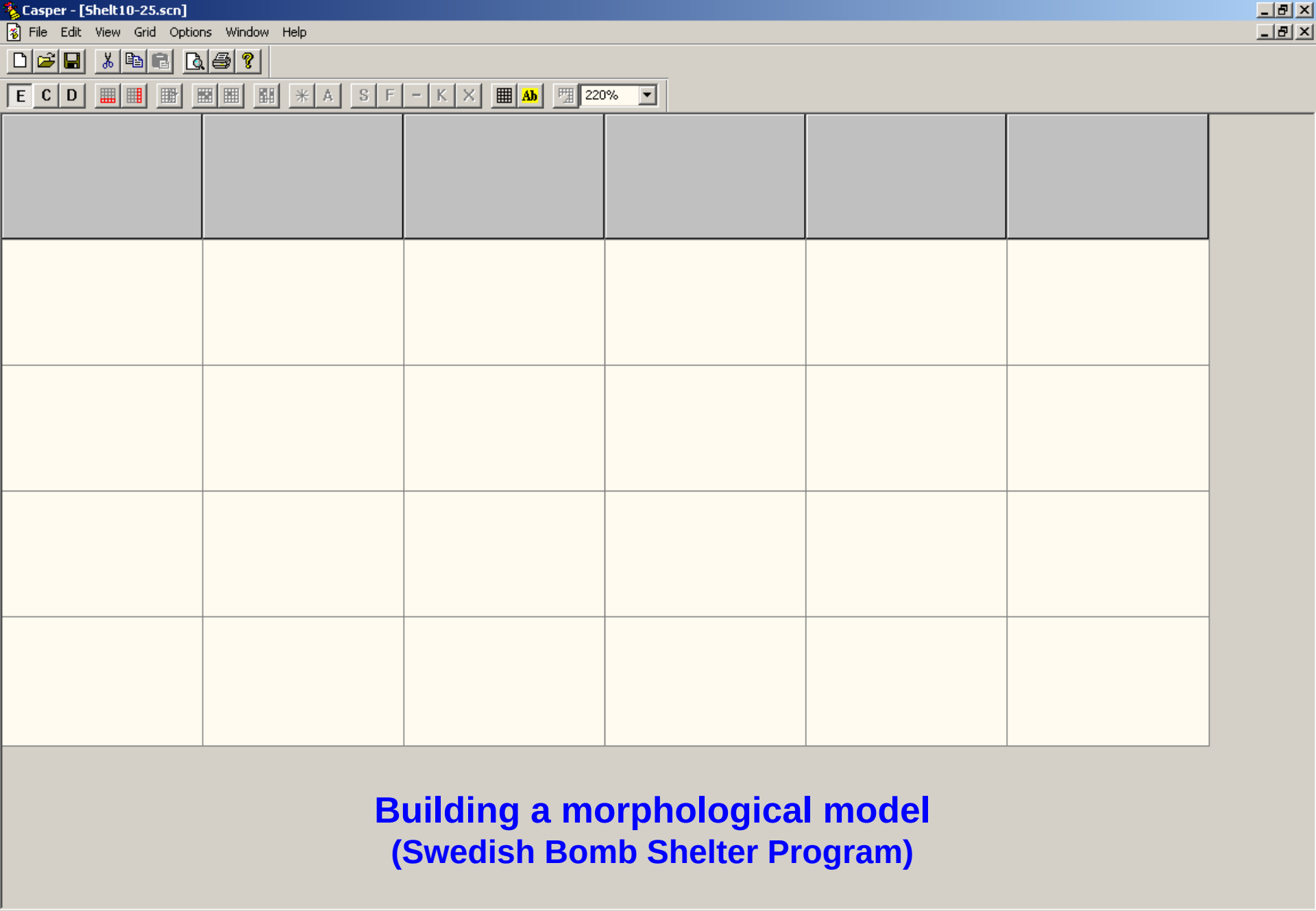
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(Swedish Bomb Shelter Program)
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Geographic priority	Functional priorities	Size and cramming	New construction	Maintanance	General philosophy

Define the most important parameters of the problem complex

Geographic priority	Functional priorities	Size and cramming	New construction	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

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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		
		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																		
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	Compensation																		
	New only for																		
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	No																		
General philosophy	All get same																		
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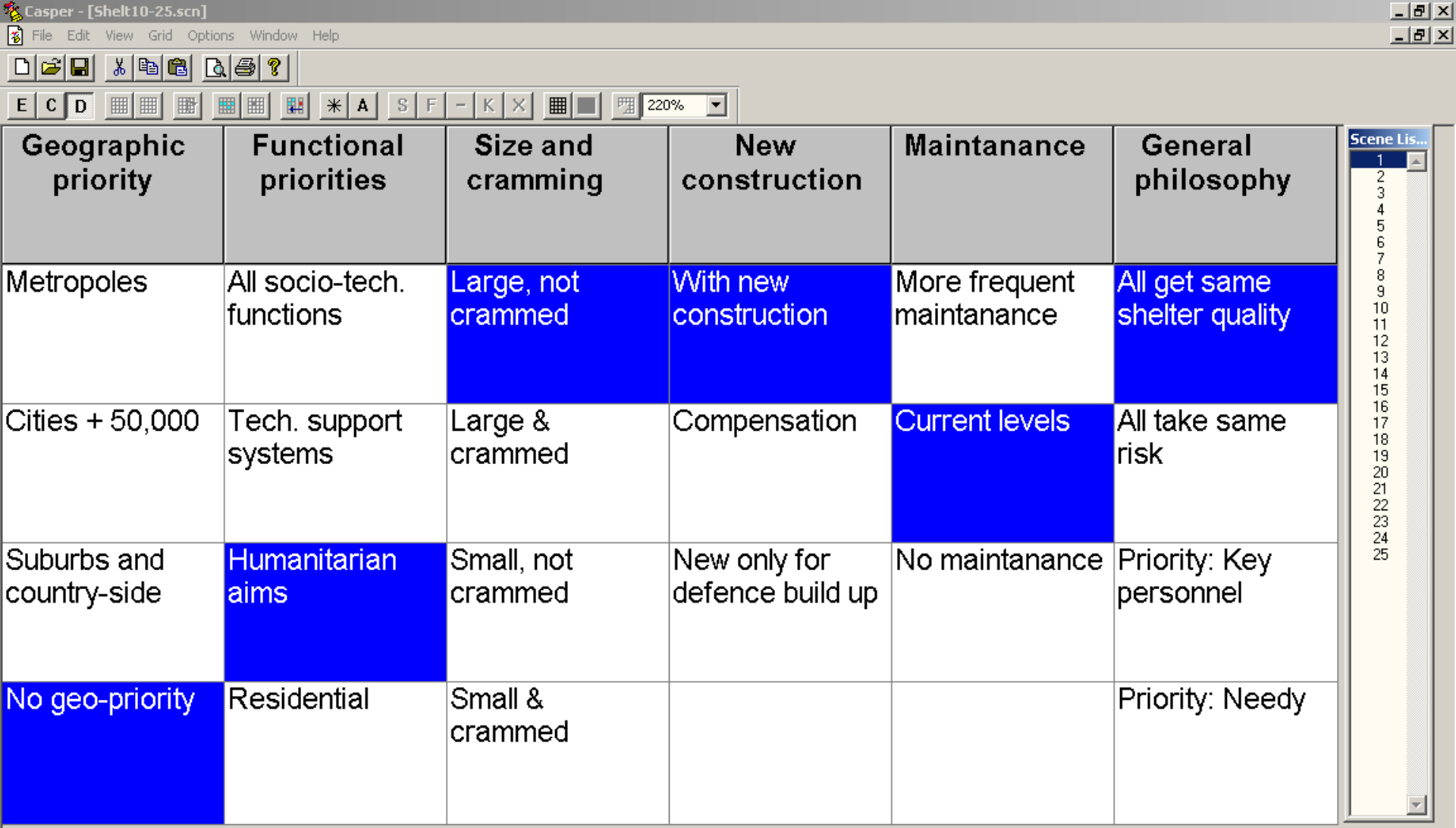

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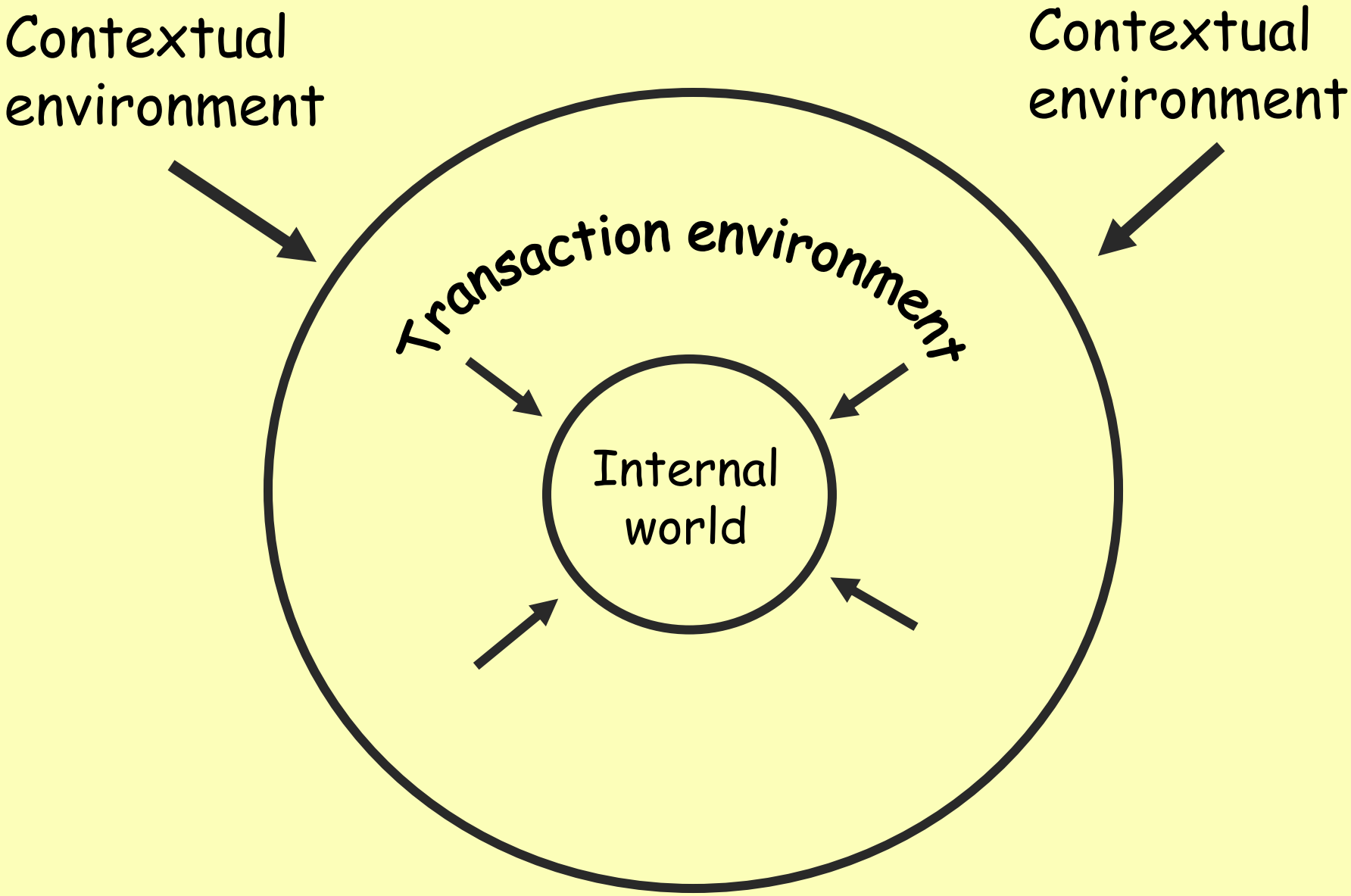
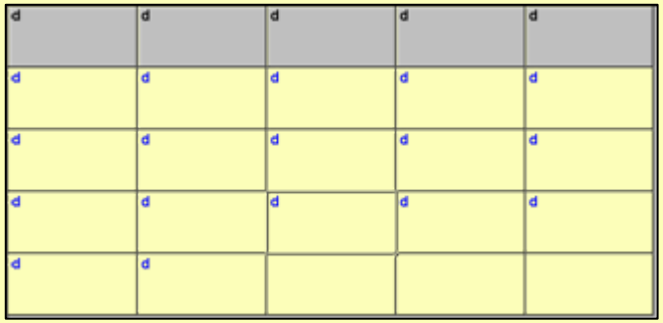
Solution space: list of surviving, internally consistent configurations


Contextual environment
Contextual environment
Transaction environment
Internal world

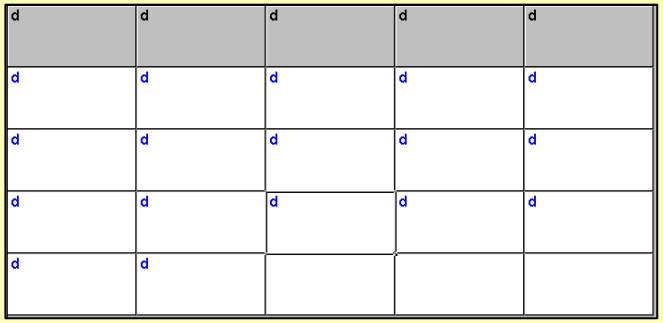
Linked morphological fields:

Scenario model



Contextual and transaction environment

Strategy/system model



Case Studies

TACTICAL SCENARIOS FOR FUTURE GROUND TARGET SYSTEMS

TACTICAL DEMANDS ON SYSTEM →

← SYSTEM PROPERTIES

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Tactical situations	Purpose	Effect/ penetration:	Effect/ precision:	Guidance system: final phase	Attack attitude:	Time to effect after decision to employ	Special weapon system demands/ properties	System
S 1	Destroy	Bunker buster	Great accuracy Little or no side effect	Visual	Vertical	Within 10 s	Recognition/ identification capacity	System 1
S 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
S 3	Disrupt	30 mm (medium)	Good accuracy Some side effects	Radar		Within 10 minute	Updateable target co-ords.	System 3
S 4	Warn	Small-bore + fragmentation (soft)	Area effect 200x300	Acustic		Within 30 minute	Sensor guided warhead	System 4
S 5			Area effect 500x400	Co-ordinate based		Within 1 hour	Pre-programmed target co-ords.	System 5
S 6						Within 5 hours	Basic capacity	System 6
S 7						Within 24 hours		System 7
						More than 24 hours		System 8
								System 9
								System 10
								System 11

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PEACE KEEPING PLANNING MODEL

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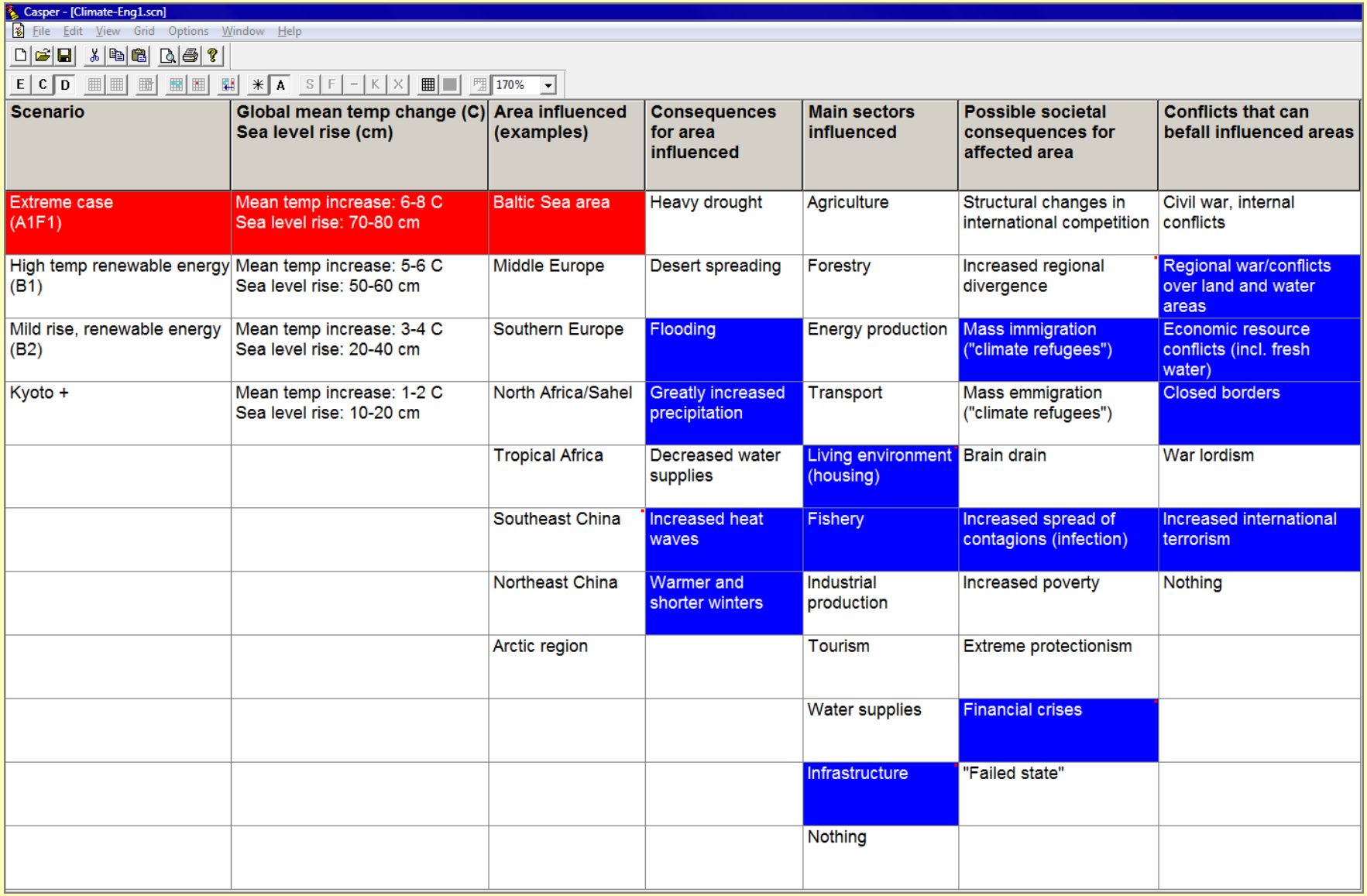
Use of force against military belligerent	Security tasks toward cil. pop.	Humanitarian tasks toward civ. pop.	Structure and capacity of military belligerent	Operational environment/ Infrastructure	Level of consent	Distance from Sweden	Acceptable casualties	Preparation time	Endurance time	Minimum resources required
Use of force to carry out military tasks	Protection and policing of total operational area	Carry out reconstruct. with own resources	Advanced level irregular forces (Afghanistan)	Full urban infrastruct & local support (SFOR)	No parties available for consent (Somalia)	Immediate national surroundings	None or vary few	<= 30 days	Max 6 months	Resource 1
Use of force to defend mandate	Protection of total operational area	Support other orgs' humanitar. tasks	Middle level mil. capacity (Yugoslavia)	Ditto and some local support (KFOR)	No consent (Serbia)	Europa and its surrondings	Some (Bosnia)	30 - 60 days	6-12 months	Resource 2
Use of force only in self defence	Protection in parts of operational area	Support pop. (according int. law)	Low level regular forces (Bosnien)	Accessible road network (Somalia)	Only strategic consent (UNPROFOR)	Rest of world	Relatively high (Congo)	60- 90 days	> 12 months	Resource 3
No defined military tasks	Some policing assignments	No defined tasks	Lower level irregular forces (Somilia)	No working infrastructure (Angola)	Full consent (IFOR)			> 90 days		Resource 4
	No defined tasks									Resource 5
										Resource 6
										Resource 7
										Resource 8

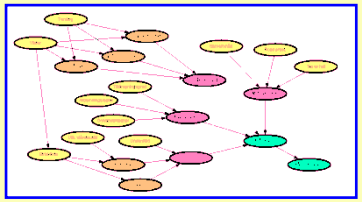
SEGMENT OF CLIMATE CHANGE – CONFLICT MODEL



Scenario	Global mean temp change (C) Sea level rise (cm)	Area influenced (examples)	Consequences for area influenced	Main sectors influenced	Possible societal consequences for affected area	Conflicts that can befall influenced areas
Extreme case (A1F1)	Mean temp increase: 6-8 C Sea level rise: 70-80 cm	Baltic Sea area	Heavy drought	Agriculture	Structural changes in international competition	Civil war, internal conflicts
High temp renewable energy (B1)	Mean temp increase: 5-6 C Sea level rise: 50-60 cm	Middle Europe	Desert spreading	Forestry	Increased regional divergence	Regional war/conflicts over land and water areas
Mild rise, renewable energy (B2)	Mean temp increase: 3-4 C Sea level rise: 20-40 cm	Southern Europe	Flooding	Energy production	Mass immigration ("climate refugees")	Economic resource conflicts (incl. fresh water)
Kyoto +	Mean temp increase: 1-2 C Sea level rise: 10-20 cm	North Africa/Sahel	Greatly increased precipitation	Transport	Mass emmigration ("climate refugees")	Closed borders
		Tropical Africa	Decreased water supplies	Living environment (housing)	Brain drain	War lordism
		Southeast China	Increased heat waves	Fishery	Increased spread of contagions (infection)	Increased international terrorism
		Northeast China	Warmer and shorter winters	Industrial production	Increased poverty	Nothing
		Arctic region		Tourism	Extreme protectionism	
				Water supplies	Financial crises	
				Infrastructure	"Failed state"	
				Nothing		

MA is a starting point for other strategic decision support methods

BN



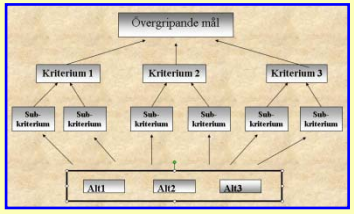
Causal network model

MA

Geografisk prioritering	Funktionell prioritering	Storlek och trängsel	Nybyggande	Underhåll	Skyddrums-filosofi
Endast största städerna	Alla socio-tekniska funktioner	Stora, ej trånga	Med ny konstruction	Mer frekvent	Alla får samma skydd
Städer med minst 50,000	Tekniska stödsystem	Stora, trånga	Kompensation för nuvarande brister	Nuvarnade nivå	Alla tar samma risk
Förorter och landsbygden	Humanitär inriktning	Små, ej trånga	Endast under "återtagning"	Inget	Funktionella tyckelpers. prioriterade
Ingen geografisk prioritering	Bostäder	Små, trånga			De svaga prioriterade

Structure (parameterise) a messy problem complex (“wicked problems”)

AHP



Evaluate alternatives given a hierarchy of goal criteria

Information on General Morphology

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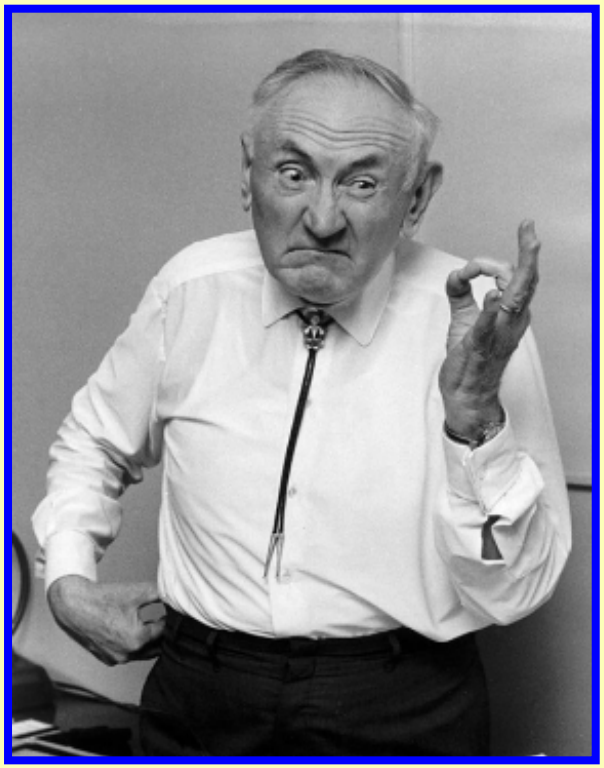
The End



Have a nice day ….

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