

Decision support in emergency operations

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Decision support

- Decision support includes technologies and methods to aid humans make **difficult** decisions
 - multiple sources of information
 - uncertain outcome

- Machines can keep track of a large amount of information

Human judgment versus formulas

- Rule-based statistical predictions are better than human reasoning in probabilistic settings
- Experience does not improve decision making when
 - the same type of decision gives different result each time
- Example
 - Doctors requested to consider likelihood of breast cancer in 40 year old women who tests positive on mammography, given some base data
 - 95 percent of the doctors answered wrongly with a factor of ten

Characteristics of emergency operations

- Need for fast and reliable action
- Decisions based on information from multiple sources
- Multiple agents involved in decision making
 - Strategic
 - Operational
 - Tactical
 - Ambulance personnel
 - Police
 - Fire dept
 - Relieve organisations ...
- Outcome of decisions may be uncertain
 - Several possible outcomes with different probabilities

Outline

- Risk analysis in emergency operations
 - Examples
- Decision support systems
- Use of decision support systems in emergency operations
- Needs and challenges in emergency operations
- Building a decision support system for emergency operations

Example: explosion at a chemical plant

- Risk of further damage?
- Population registry
 - Is this a densely populated area?
 - Should the inhabitants be evacuated?
 - Who lives nearby?
- Meteorological data, such as wind direction and speed
 - If toxic chemicals have been released into the atmosphere => how are they dispersed?
- Public transport
 - Are there railway/subway tunnels nearby?
- Local authorities
 - Where are the sewers?
 - Is there any chance chemicals may leak into the water supply?



Example: avalanche

- Limited time
 - Chance of survival decreases drastically after 18 minutes in an avalanche
- Many uncertainties
- Risk analysis
 - Is it safe to send rescue personnel into the avalanche area?
 - What is the chance of a new avalanche?
 - Slope degree, snow quality, experience
- Multiple roles involved
 - Police (overall responsibility)
 - Operational leader in the field
 - Local command

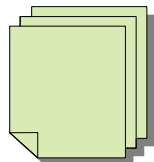


Risk analysis in emergency operations

- Concrete risks depends on data obtained from on site
 - Avalanche rescue operation
 - Industrial accident
 - Car crash
- But all risk assessment depends on
 - Information gathering
 - Experience
 - Probabilistic reasoning

Categories of decision support systems

- Based on...



Documents



Knowledge



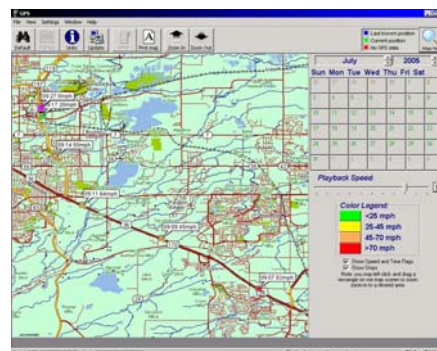
Communication



Human-machine cooperation

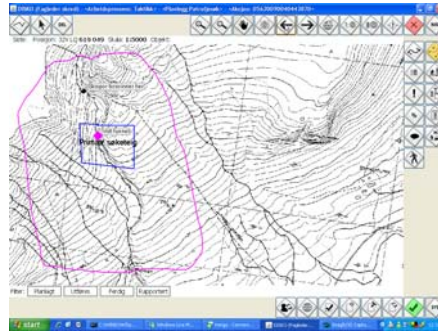
Geographical information support in emergency situations

- Geopol – police operation central
- TransFirePC – fire and rescue services
- SARA – the joint rescue coordination centres
- NARRE – facilitate decision support in crisis management



End-user initiatives

- DISKO-SAR (Distributed command control for search and rescue)
- Live tracking of rescue personnel in Google earth or equivalent map tool utilising GPS
- Use of satellite pictures in forest wild fire management



Needs in emergency situations

- Common understanding of situation among local command
 - Rescue personnel, police, etc
 - Requires *reliable* communication
- Fast and reliable retrieval of relevant information
 - Pre-emergency knowledge base to predict information needs
 - Automated generation of information
- Visualisation
 - Provided information must be simple to understand
- Adaptive and multi modal user interfaces

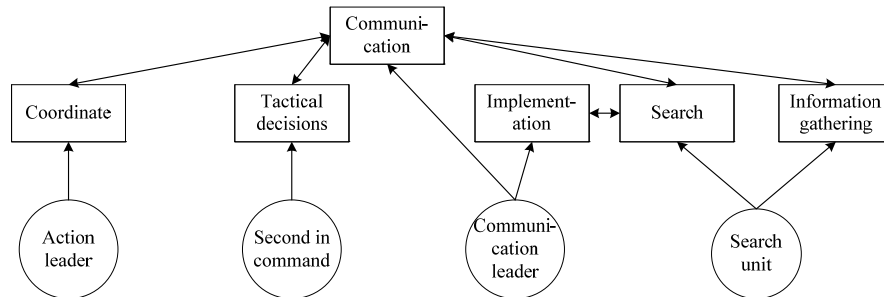
Challenges for IT-support in emergency situations

- Limited time
 - Difficult conditions
 - Extreme temperatures
 - Harsh sun
 - Lack of mobile coverage
 - Attention demanding situations
 - Chaotic shifting situations
 - Knowledge-based decision support systems are best suited for narrow domains (frame problem)
- “The rescue leader must be creative and free himself from written guidelines”
- Security critical information

Building a decision support system

- Define the target/goal
 - What are the decisions that need supporting?
- Task modelling
 - What are the tasks involved in these decisions?
 - What roles are responsible for which tasks?
 - What information is used and who owns it?

Example: roles and task in search and rescue



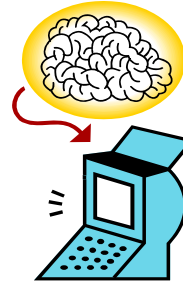
- CommonKADS task model of tasks and roles in command area during search & rescue

Information and knowledge gathering

- Data extraction
 - Capture raw data using sensors, logging
 - How can extracted data be used in knowledge base for future operations?
 - Is additional information needed (i.e., knowledge)?
 - If so, how and when can it be obtained without hindering emergency personnel?
 - Before, after or during operations?
- Knowledge acquisition
 - Capture human expertise
 - Manual/computer-based tools
 - Structured/unstructured interviews
 - Observe

Knowledge representation and reasoning

- Representing human knowledge
 - Facts
 - Procedures
 - Rules: Bayesian belief networks, neural networks



References

- Task modelling techniques
 - <http://www.commonkads.uva.nl/frameset-commonkads.html>
 - <http://www.troposproject.org/>
 - <http://www.dia.fi.upm.es/grupos/I&K/KSM-home.htm>
- Decision support systems
 - <http://www.hjelpekorps.org/disko/>
 - <http://www.dsb.no/Article.asp?ArticleID=2465&oppslag=1>