Aalto University
School of Science

A Seminar on Case Studies in Operations Research

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What is Operations Research?

- ”Operational research is the attack of modern science on complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defense.”

- ”Its distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as change and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management determine its policy and actions scientifically.”
  OR Quarterly 3(3): 282, 1962

WHAT IS OPERATIONS RESEARCH?

In a nutshell, operations research is the discipline of applying advanced analytical methods to help make better decisions.

By using techniques such as mathematical modeling to analyze complex situations, operations research gives executives the power to make more effective decisions and build more productive systems based on:

- More complete data
- Consideration of all available options
- Careful predictions of outcomes and estimates of risk
- The latest decision tools and techniques

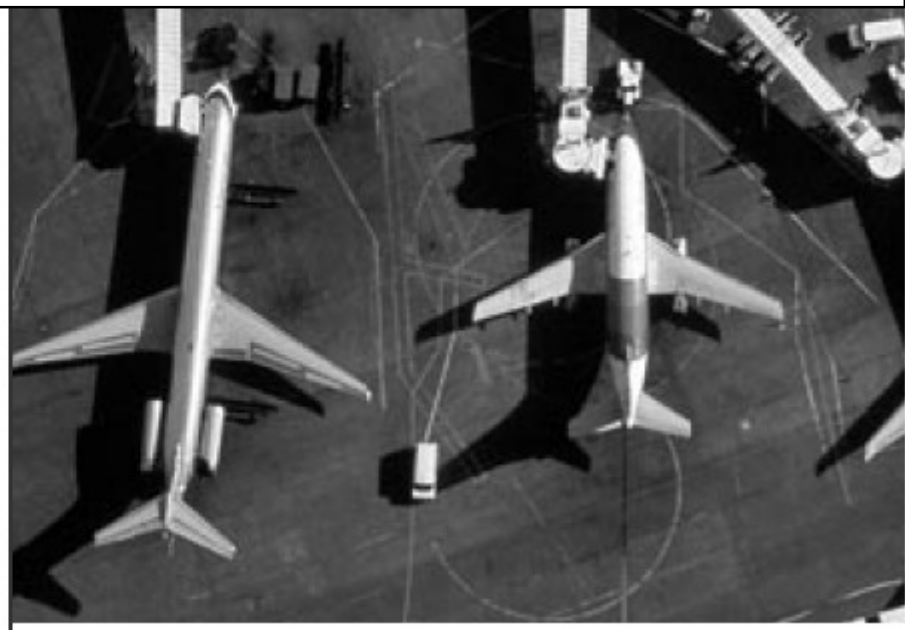
A uniquely powerful approach to decision making

You've probably seen dozens of articles and ads about solutions that claim to enhance your decision-making capabilities. You may not realize it, but the best of these solutions are based on O.R.

When it comes to technology that assists decision making, O.R. is unique. It's best of breed, employing highly developed methods practiced by specially trained professionals. It's powerful, using advanced tools and technologies to provide analytical power that no ordinary software or spreadsheet can deliver out of the box. And it's tailored to you, because an O.R. professional offers you the ability to define your specific challenge in ways that make the most of your data and uncover your most beneficial options.

(continued on page 5)

http://www.scienceofbetter.org/



CONTINENTAL AIRLINES SPEEDS RECOVERY AFTER 9/11

Operations research firm CALEB Technologies worked with Continental to develop a decision support system to generate near-optimal crew recovery solutions for responding to emergencies.

Continental estimates that the system helped it save $40 million in 2001. And thanks to the system, Continental led the American airline industry in recovering operations after September 11, 2001.

Learn how Continental and others have applied O.R. to improve decision making while reducing expenses at www.scienceofbetter.org.

The McGraw-Hill Companies

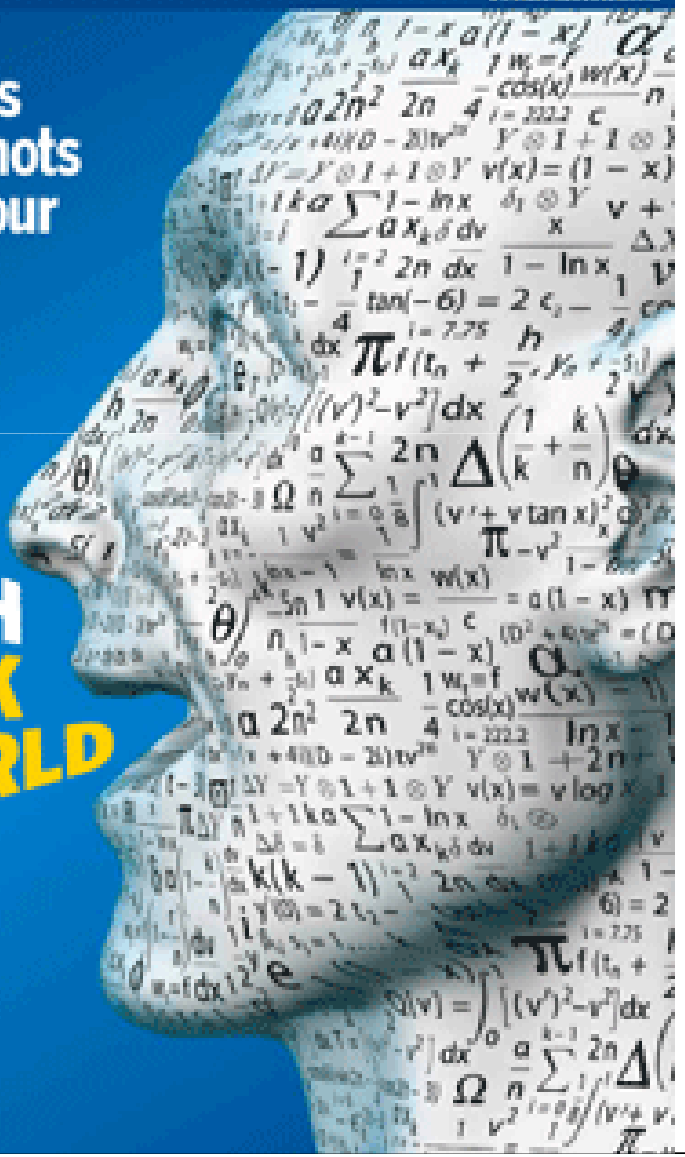
BusinessWeek

JANUARY 21, 2008 www.businessweek.com

More math geeks are calling the shots in business. Is your industry next?

BY STEPHEN BAKER @ 54

WHY MATH WILL ROCK YOUR WORLD



SYSTEMS ANALYSIS LABORATORY

AALTO UNIVERSITY SCHOOL OF SCIENCE

Ahti Salo

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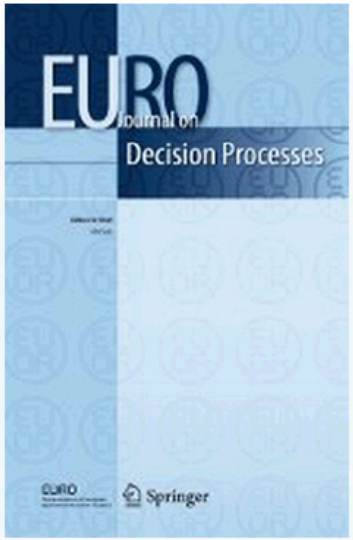
Ahti Salo

Professor
Doctor of Technology, Vice Head of Department



Professor Salo has worked extensively on the development of decision analytic methods and their uses in resource allocation, innovation management, risk management, technology foresight, and efficiency analysis. He has published widely in leading international journals (including Management Science and Operations Research) and received awards for his research from the Decision Analysis Society of the Institute for Operations Research and the Management Sciences (INFORMS). He is the Editor-in-Chief of the EURO Journal on Decision Processes and on the Editorial Boards of Decision Analysis and five other refereed journals. Professor Salo has directed a broad range of basic and applied research projects funded by leading industrial firms, industrial federations, and funding agencies. He has been a visiting professor at the London Business School, Université Paris-Dauphine and the University of Vienna. In 2010-11, he was the President of the Finnish Operations Research Society (FORS) and served as the European and Middle East representative of the International Activities Committee of INFORMS. He is a jury member of the EDDA 2012 Doctoral Dissertation Award of the Association of European Operational Research Societies (EURO). He has been on the Board of the Association of Parliament Members and Researchers (Tutkas) since 1999.

http://www.sal.tkk.fi/en/personnel/ahti.salo/

Call for Papers: Special Issue on Student Projects with Industry (SPI)

Recently many academic programs have begun to include Student Projects with Industry (SPIs) as part of their curriculum. These courses offer an initial consultative opportunity for students under faculty guidance and oversight. The experience has the potential to be very valuable for students in helping them to understand the challenges and opportunities for analytic applications in the business world, and for clients who can benefit greatly from such projects. However, for faculty members the challenges associated with such experiences include far more preparation and engagement throughout the process because designing and guiding a successful SPI program is far removed from the traditional classroom environment.

This ITE special issue focuses on best practices for creating successful SPIs, with the goal of allowing readers benefit from colleagues' experiences, insights, and lessons learned. While each article may not cover all the aspects mentioned below, our vision is that the special edition as a whole will capture the following aspects of the SPI experience:

- Preparing Students for SPIs
  - Is there a formal course associated with the project? If so, what is the content of this course? Textbooks? Guest speaker/faculty guests? Case studies or practice projects?
  - What is the duration of SPIs? How is progress tracked?
  - How important are good project management and/or presentation skills to the success of an SPI? Do students receive training or coaching in these areas as part of the experience?
  - How is success defined for SPIs? How often and who assesses whether goals are achieved consistently across projects? How are grades assigned?
  - Does student motivation and maturity affect faculty decisions about project selection?
  - What methods are essential for placing students in a position to succeed?
- Faculty Involvement
  - What role do faculty play in the process of supporting successful SPIs?
  - Are faculty members eager to get involved in creating SPIs? If not, how can faculty be motivated to participate in SPIs?
  - What preparation is essential for putting faculty in a position to be successful?
  - Do student projects lead to publications for faculty and/or students? Who publishes with students? Are project mentors expected to publish? Where?
- Client Engagement
  - How are potential projects identified and selected? How do faculty members set appropriate expectations with clients?
  - What types and levels of investments (money, time, data, human resources, etc.) are needed from clients?
  - How do faculty, students, and clients work together to develop realistic deliverables?
  - What types of problems emerge most often, and how are they addressed?

Rationale for the Course Mat-2.4177

- Other Mat-2 courses focus on theoretical and methodological skills
  - Optimization, simulation, decision and risk analysis, time-series analysis
- Operations research is typically applied in collaborative projects
  - Better understanding of phenomena
  - Formulation of decision alternatives
  - Development of decision recommendations
- Many competencies needed to tackle problems
- Collaboration, communication and presentation skills are important

Learning Objectives

- The seminar seeks to impart the students with skills for planning, managing and executing projects in which operations research is used for solving real problems posed by an external client

1. Principles of project management
   - Organization, planning and management of project-based activities

2. Execution of projects based on real client need
   - Each project carried out by a team of 4-5 students
   - 4-6 projects carried out each year
   - 60 projects completed since 2002

Mat-2.4177 Operaatiotutkimuksen projektityöseminaari L (5 op)

Kurssin etusivu
Kurssiesite
Uutiset
Tulokset

Luennot

Vuoden 2012 projektityöt
Aiemmat seminaarit
Tieteellinen kirjoittaminen

Vuoden 2012 projektityöt

Kurssi Oodissa

Vuonna 2012 projektityöseminaarissa on alustavasti tarjolla seuraavia aiheita:

1) Optimaalisen tarkastusvälin määrittäminen suun terveydenhuollossa / Nordic Healthcare Group

2) Evidenssin yhdistely todennäköisyyspohjaisessa päättelyssä (esimerkkinä ydinpolttoaineen loppusijoituskapselin luotettavuuden arviointi) / VTT

3) Sähkönjakelujärjestelmän toimintavarmuuden parantaminen / Puolustusvoimien Teknillinen Tutkimuslaitos

4) Luottoluokitusten siirtymätodennäköisyyksien estimointi ja kalibrointi / OP-Pohjola

Päivitetty 16.01.2012 klo 19.19

Tulostettava versio

Yllä
Ma Ris
Ma Luc
Ma Sov erik
Ma Pää
Ma Opt
Ma Op pro
Ma Sys mat
Ma Sys

FINAL REPORT

DETERMINING OPTIMAL RECALL INTERVALS FOR ORAL HEALTH CARE

Mat-2.4177 Seminar on case studies in operations research

Client: Nordic Healthcare Group

Project Team: *Ville Poikolainen*
Vesa Riekkinen
Joonas Tarpila
Janrik Öberg

DEPENDENT EVIDENCE IN PROBABILISTIC REASONING

Interdepencies in the Non-Destructive Testing of Canisters for Depositing Nuclear Waste

Backlund, Ville-Pekka
Piironen, Juho
Tuovila, Henri (Project manager)
Wolf, Sebastian
In collaboration with VTT

Project Presentation May 11th 2012

Aalto University
School of Science

Aalto-yliopisto
Perustieteiden
korkeakoulu

Securing the Reliability of Electricity Distribution Networks – Project Report

11.5.2012

Antti Aikala, Teemu Känsäkangas,
Ilmari Pärnänen (Project Manager),
Outi Pönni and Anton von Schantz

Systeemianalyysin
laboratorio

Aalto-yliopisto
Perustieteiden
korkeakoulu

Pohjola

Estimation and calibration of credit rating transition probabilities

Janne Kunnas (project manager)
Raul Kleinberg
Mikko Kotilainen
Joonas Parjanne
Tuomas Nikoskinen

11.5.2012

Stakeholders

- Clients
  - Have a real problem which is to be addressed
  - Interact with project teams, assist in scoping, provide feedback
  - Host excursions for students and teachers

- Project teams
  - Consist mostly of MSc students from the Degree Programmes in
    ❶ engineering physics and mathematics and ❷ industrial engineering and management
  - May have doctoral students as well

- Teachers
  - Provide support, guidance and feedback to project teams (literature, methods, tools)
  - Help teams address any difficulties that may arise

Project Manager

- A student on the project team
  - Selected by the team itself
  - Receives 2 additional credits on top of the 5 credits given to all
- Responsibilities
  - Ensures that the project makes progress
  - C ommunicates with the client, the teachers and the shadow team proactively
  - Ensures that all team members make a solid contribution
  - Contacts teachers if major difficulties of any sort are encountered
- Benefits
  - Resembles real-life practices ⇨ A more realistic learning experience
  - Simplifies communication patterns

Shadow Teams

- Each project team is being monitored by a shadow team, which provides comments on the activities and deliverables of a selected project team

- Responsibilities
  - Presents oral comments during client excursions
  - Writes a brief commentary on the deliverables of the other team

- Benefits
  - Students get a chance to monitor projects they are interested in
  - Teachers do not have to deliver all critical comments
  - Teaches students to make use of results produced by others

Project Deliverables

- Project plan (about 5 pages + presentation)
  - Template structure

    1) Background – 2) Objectives – 3) Tasks – 4) Schedule – 5) Resrouces – 6) Risks

- Interim report (about 3 pages + presentation)
  - Summarizes what has been accomplished
  - Provides updates to the project plan as necessary

- Final report (about 30 pages + presentation)
  - Presents the results overall
  - Accompanied by a two-page self-assessment of 'lessons learned'
    - » What was achieved? What was the actual work effort?
    - » In what ways was the project successful? What could have been done better?

Course Schedule

Activity / Role	*Clients*	*Teachers*	*Project teams*
November-January	• Identification of prospective clients • Screening of project topics		• Registration for the course
Kick-off meeting, end of January	• Presentation of the clients' activities • Description of project topics	• Description of course arrangements • Assignment of student to project teams	• Exchange of contact information • Selection of the project manager
February	• In-depth discussions with the project team • Delivery of data	• Meetings with teams to check the viability of their project plans • Suggestions for literature, methods, tools	• Problem formulation • Project planning • Literature review • Development of project plans
First excursion, end of February	• Presentation of the host client and its OR activities • Feedback to project teams	• Feedback to project teams	• Presentation of project plans • Feedback from the shadow teams

Course Schedule (cont'd)

Activity / Role	*Clients*	*Teachers*	*Project teams*
March	• Guidance to project teams	• Support when requested	• Work on projects • Preparation of interim reports
Second excursion, end of March	• Presentation of the host client and its OR activities • Feedback to teams	• Feedback to teams	• Presentation of interim reports • Feedback from the shadow teams
April	• Guidance to project teams	• Support when requested	• Work on projects • Writing of final reports
Third excursion, early May	• Presentation of the host client and its OR activities • Feedback to project teams	• Feedback to teams	• Presentation of final reports • Feedback from the shadow teams
May	• Approval and clearance of projects	• Final approval of project deliverables • Grading	• Implementation of required corrections to final reports • Feedback on the course

Implementation Issues

- Some clients require non-disclosure agreements

  ⇨ Students must know about this when expressing their preferences

- Some clients require reports in Finnish

  ⇨ Language issues need be addressed when forming teams

- Deliverables are in the public domain

  ⇨ They must not contain confidential information

- IPR is owned by the students

  ⇨ Clients need to negotiate with the students directly

Implementation Issues (cont'd)

- There are no payments to students

  ⇨ No one can complain for being assigned to a team with lower pay

- Project topics must be screened in advance

  ❶ Real ❷ Feasible ❸ Instructive

- There can be failures on the client side, too

  ⇨ Adjustments may be necessary

- Grappling with ambiguity can be an instructive learning experience!

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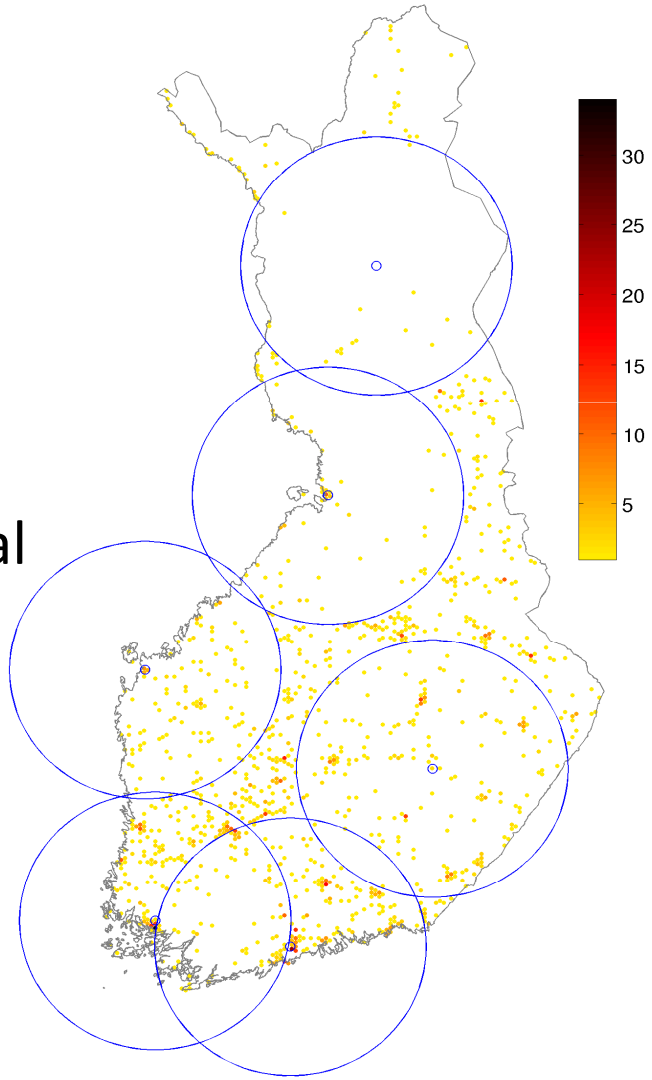
Planning of Helicopter Emergency Medical Services

- There were 6 helicopter bases in 2010
- Each was operated by an non-profit association
- Activities were not on a sound financial foundation



FinnHEMS

- HEMS = Helicopter Emergency Medical Services
- Founded in 2010 by medical districts for the purpose of managing the renewed operation of helicopter emergency medical services
- Responsible for the planning of medical helicopter services and the competitive tendering of subsequent helicopter operations

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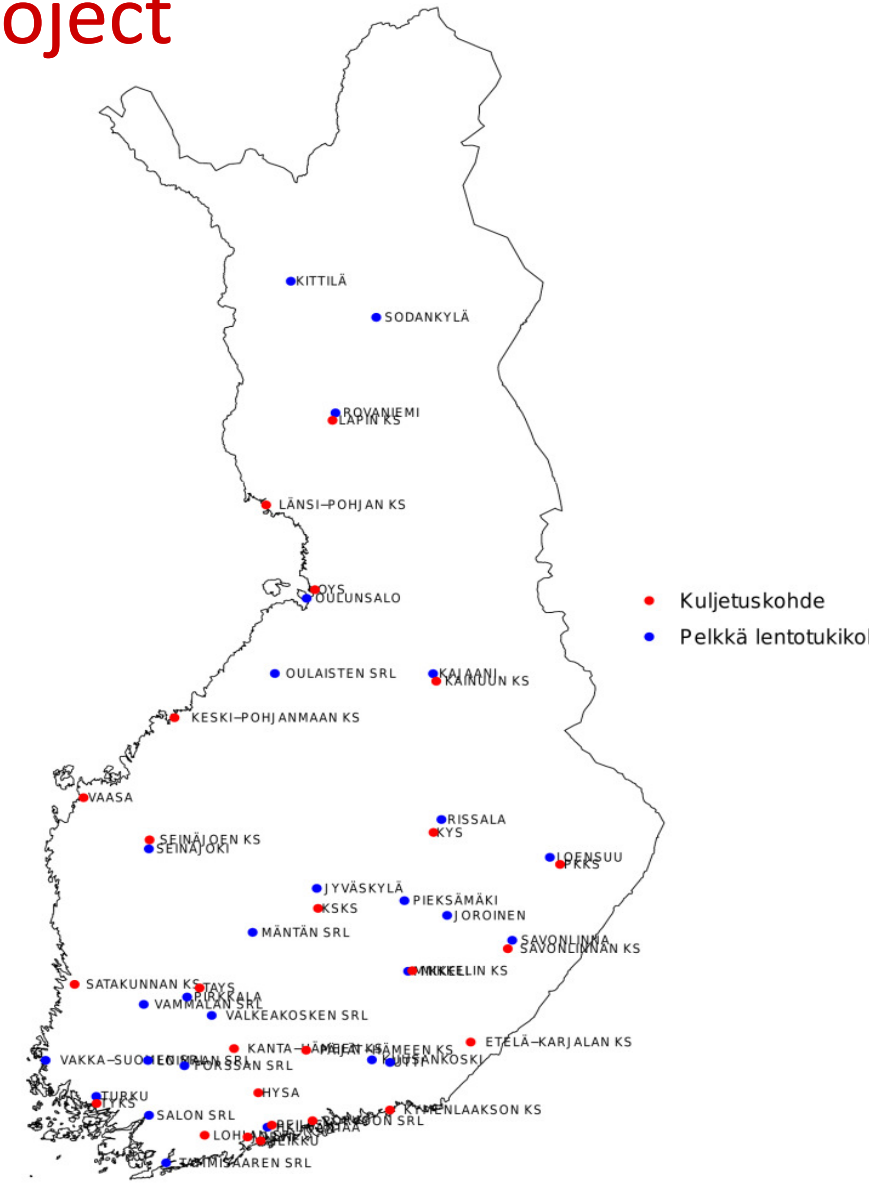
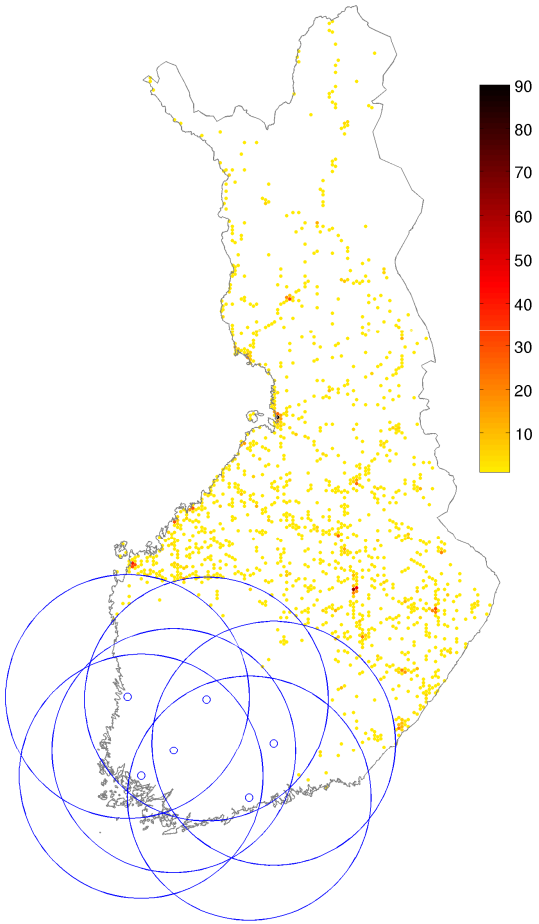
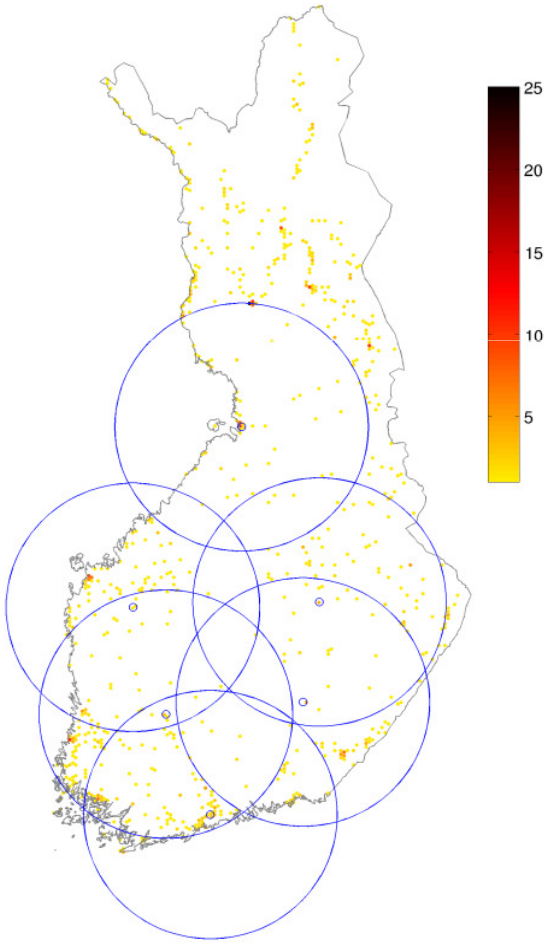
Objectives of the FinnHEMS project

- What kinds of helicopters are suitable? (9 alternatives)
- Where should the helicopters be based? (52 bases)
- How ’good’ is the current situation?
- How much better could it be?

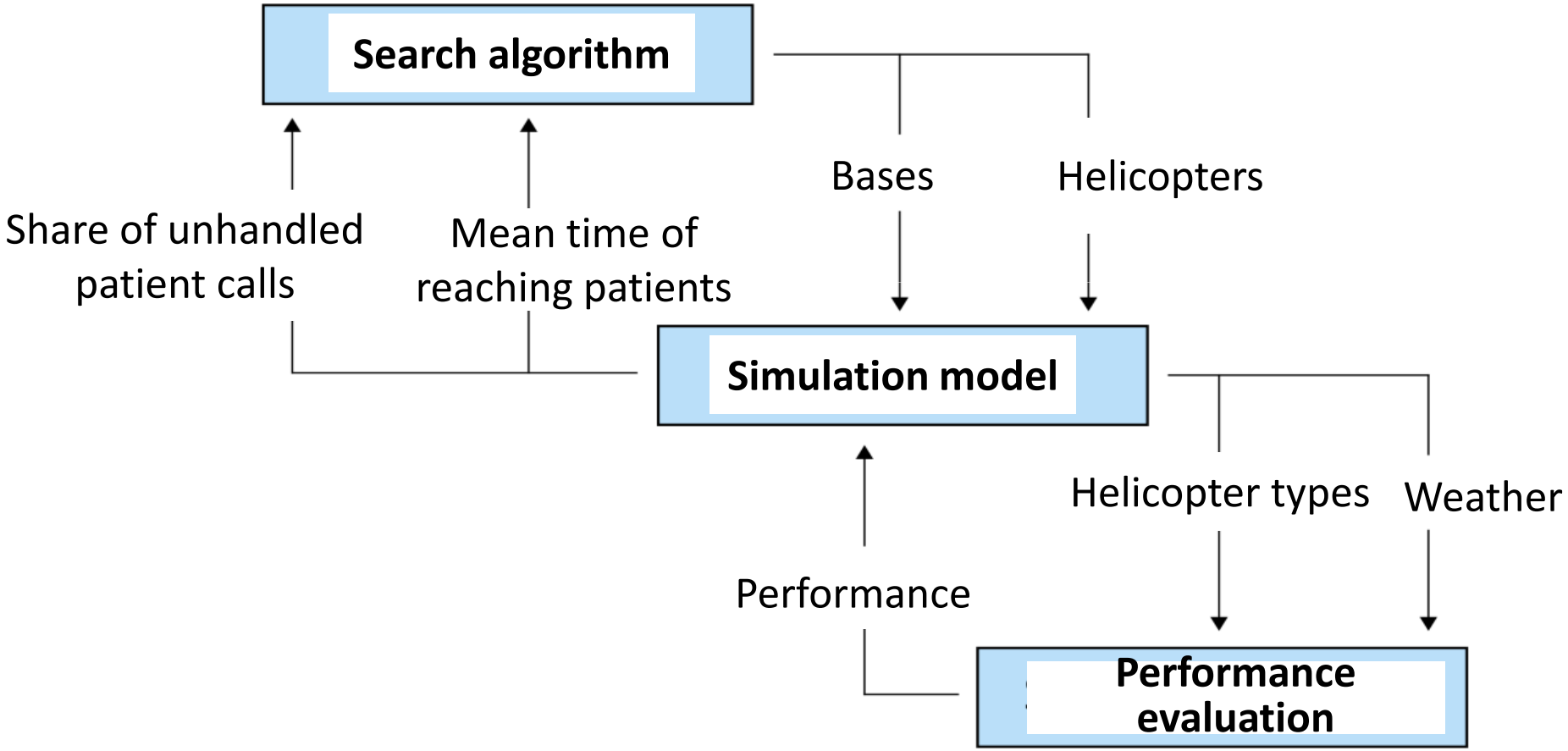


Examples of Alternative Sitings of Helicopter Bases

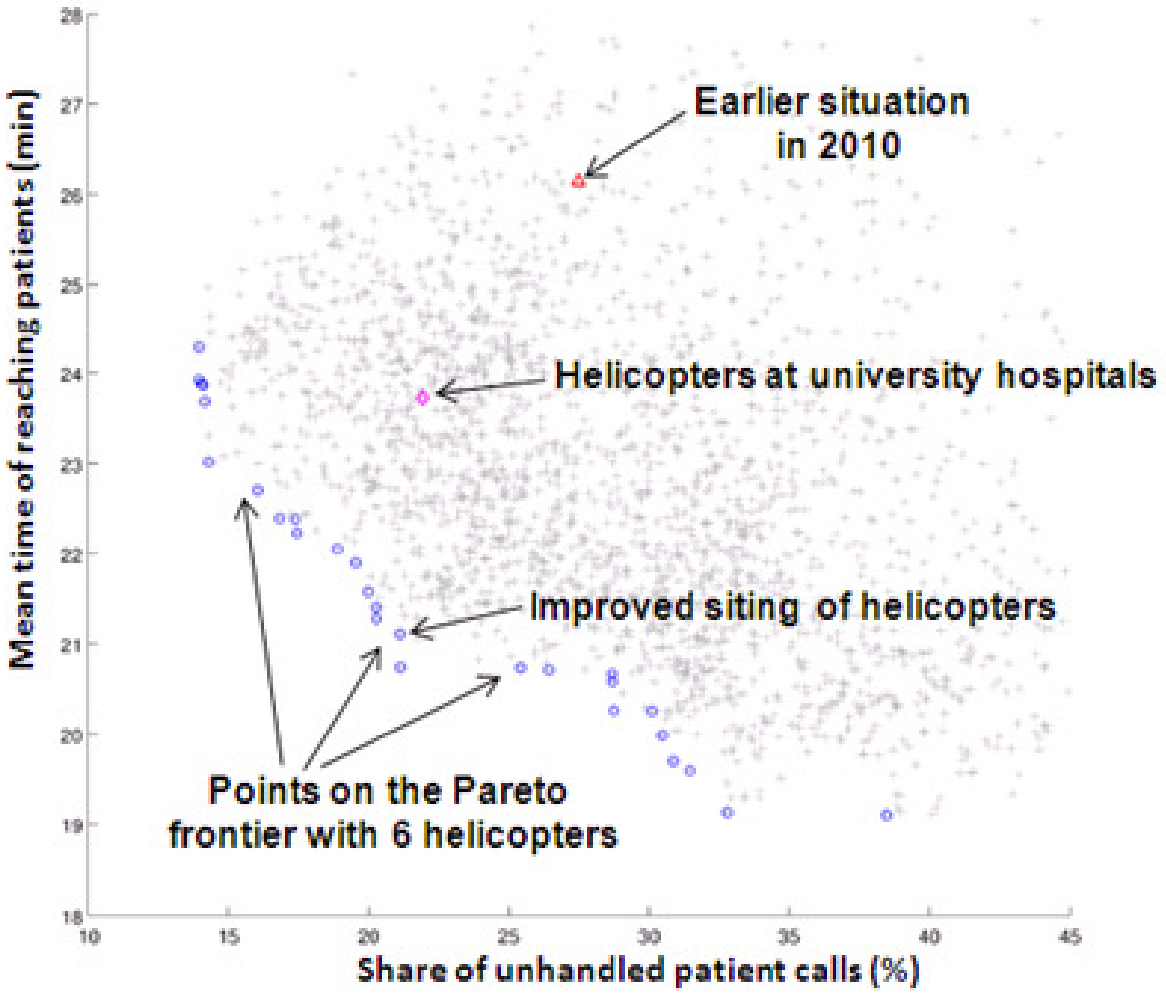




Structure of the Simulation and Optimization Model



Efficient Frontier



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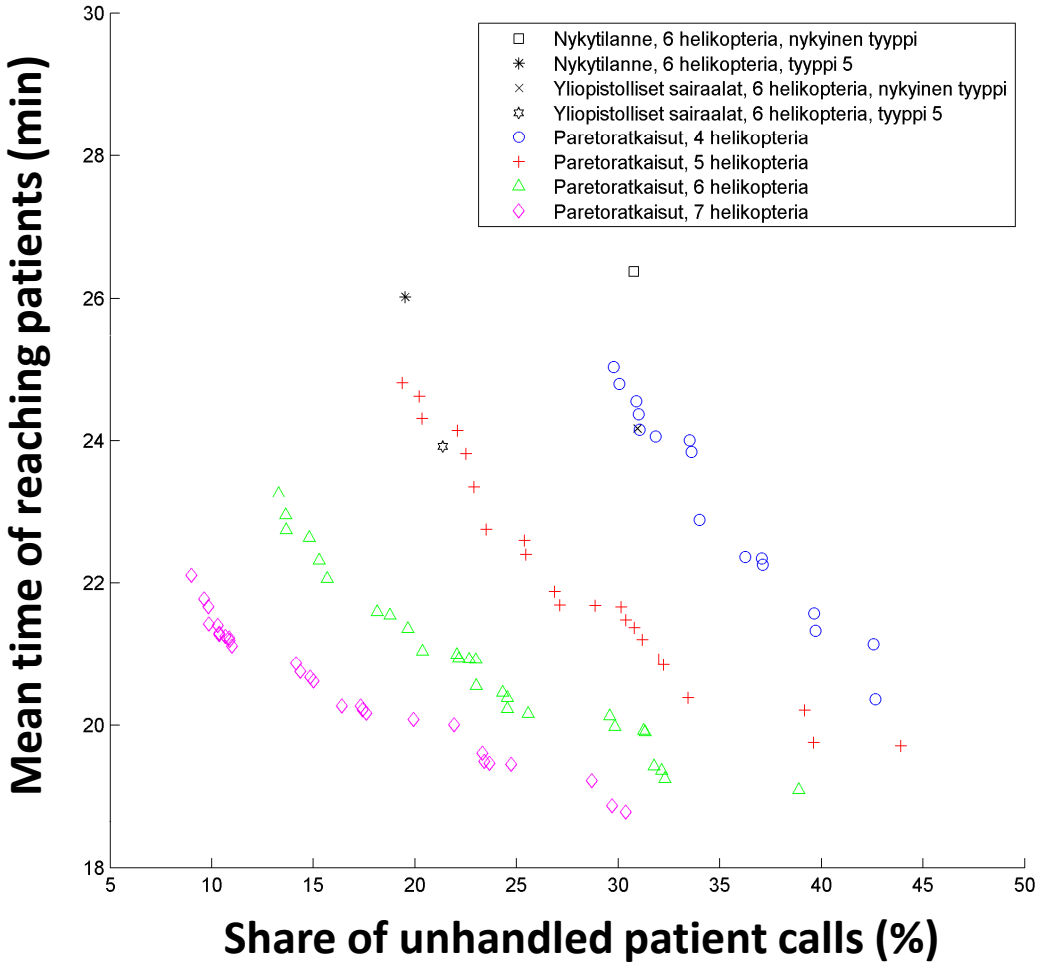
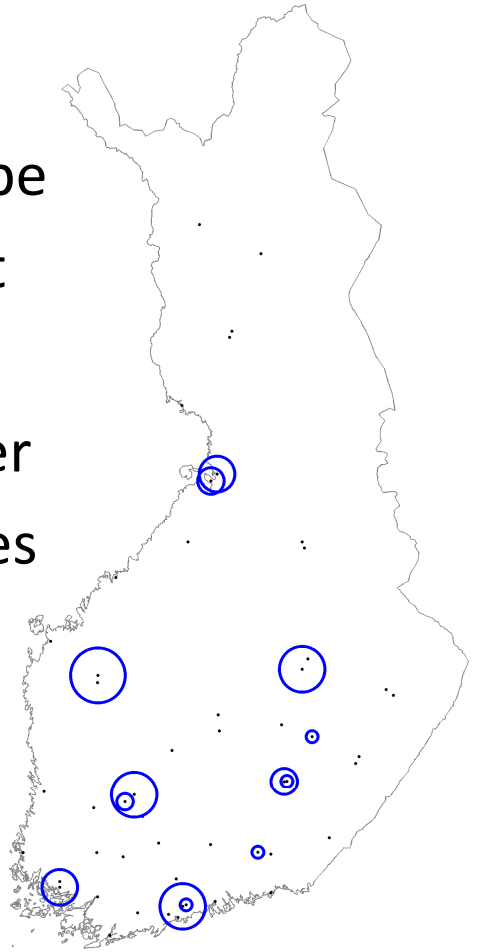
More Helicopters Would Improve Performance



Share of Helicopter Bases in Efficient Alternatives

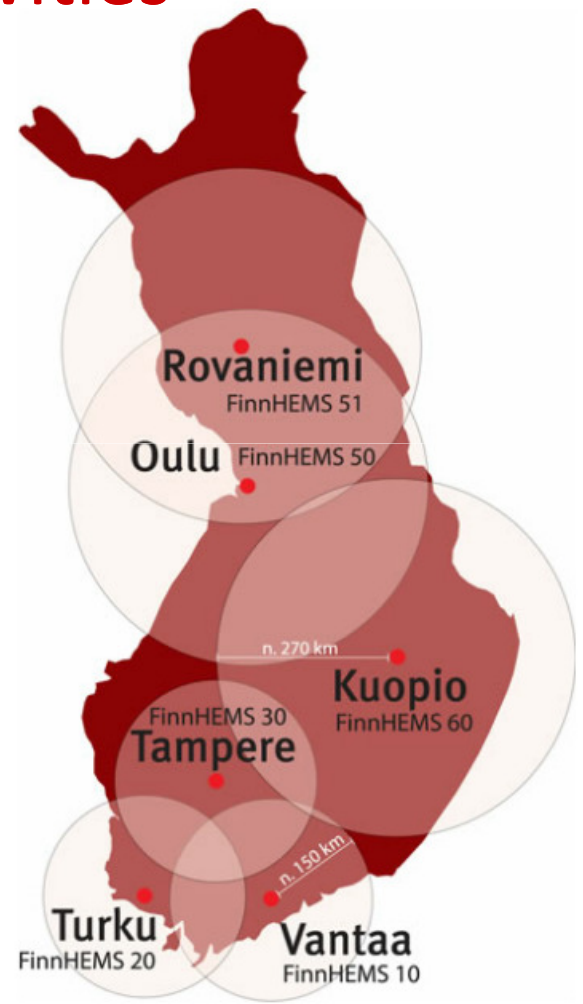
- Efficient alternative =
  A combination, consisting of ❶ a helicopter type and ❷ selected helicopter bases, which cannot be improved simultaneously with regard to both evaluation criteria by choosing some other combination of helicopters and helicopter bases

- Evaluation criteria
  - ❶ Share of unhandled patient calls (%)
  - ❷ Mean time of reaching patients (min)



Project Results and Later HEMS-activities

- As a rule, helicopters are sited near university hospitals
- Support for this decision was given by the results of the project
- Final report of the course project was appended to the final FinnHEMS report

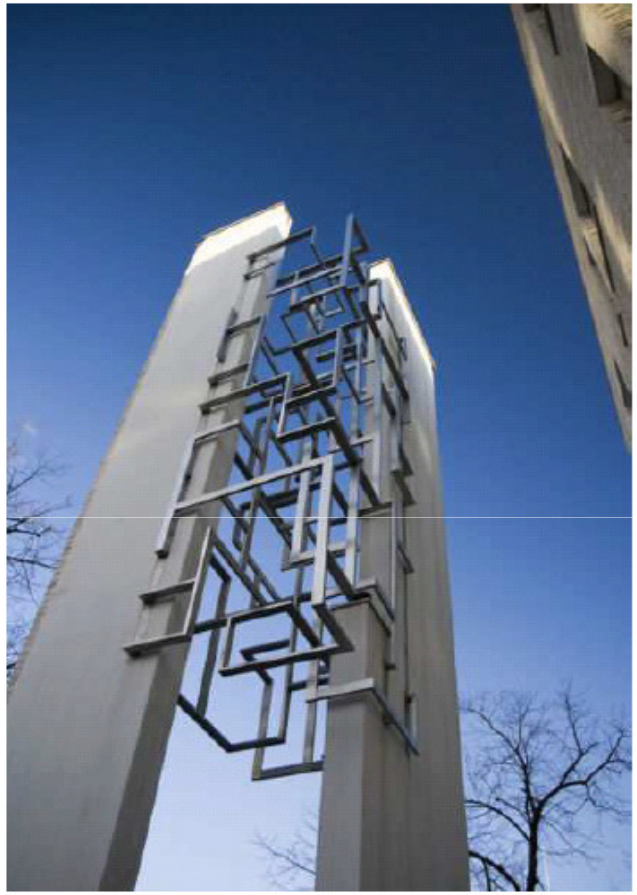


http://www.mediheli.fi/finnhems/

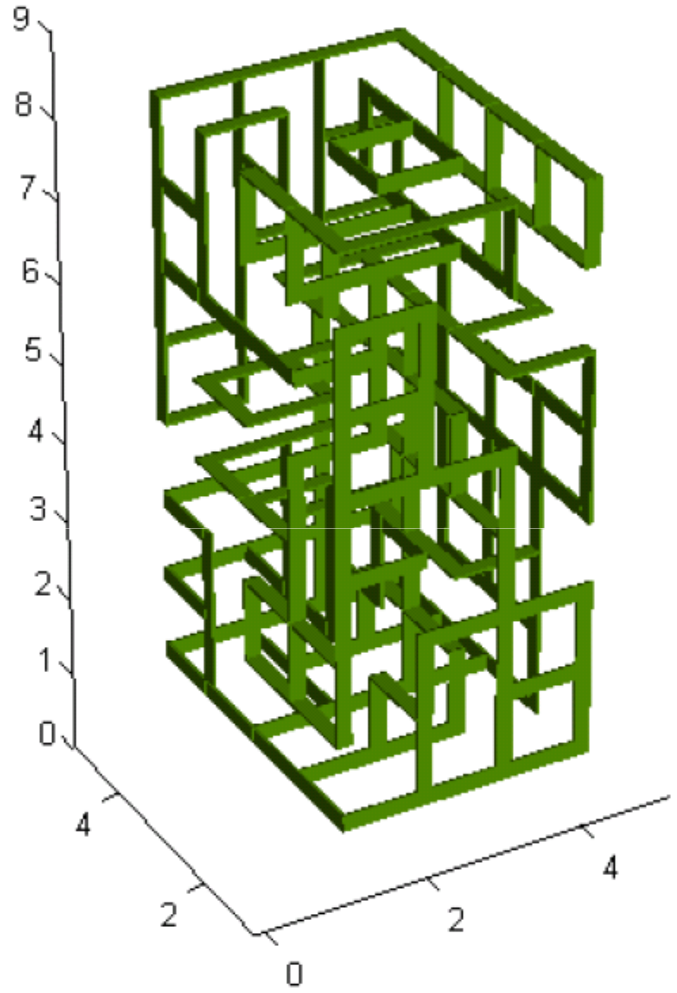
Building Impact

- Case studies have lead to commissioned research projects
  - Multi-criteria optimization of road pavement projects, 2004
- Some have resulted in refereed publications
  - ... but usually only if there are doctoral students on the team
- Numerous students have been employed by clients
- There is a growing number of repeat 'alumni' clients
- Clients propose real problems only if they expect real solutions

  ⇨ Strong methodological skills are absolutely essential!



”Fuuga”
by Anna-Kaisa Ant-Wuorinen, 2008



A feasible lattice structure by the team
T.H. Saari, J. Leppänen, J. Mangs. T. Mutanen
and A. Savelainen, 2008