OR Practice in Australia and New Zealand

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Andrew Mason (U. Auckland),
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IFORS 2011 Conference, Melbourne

Australian OR
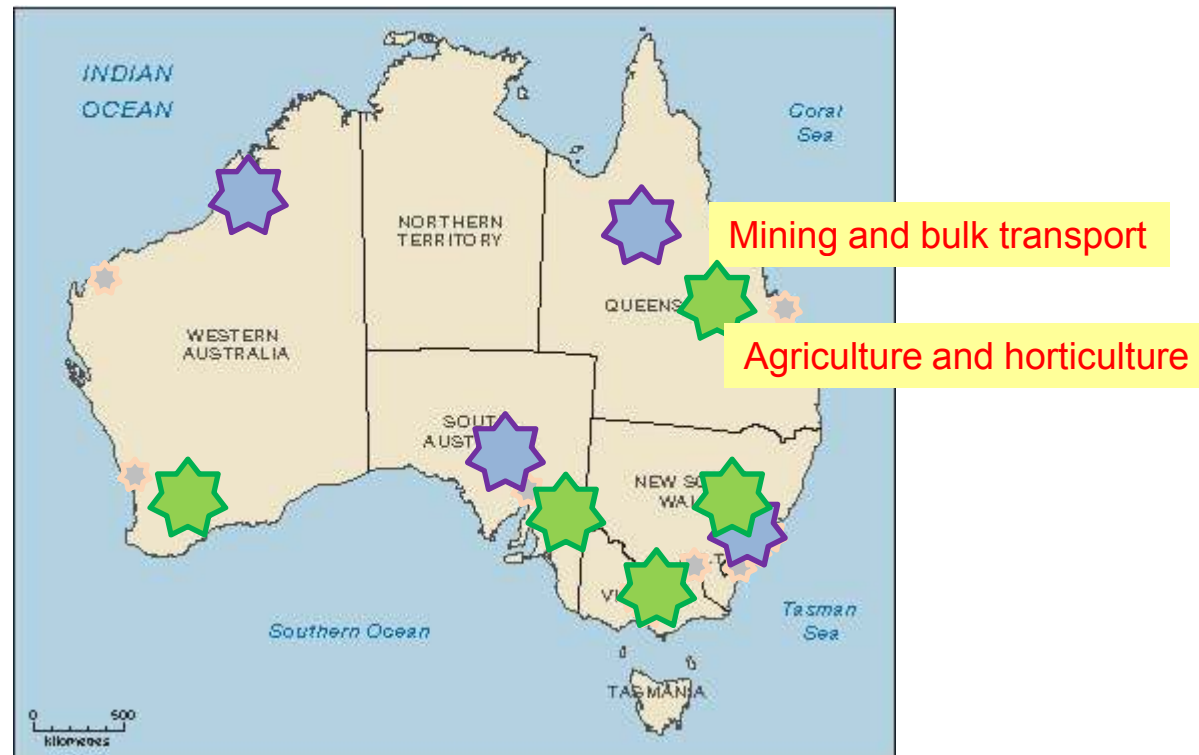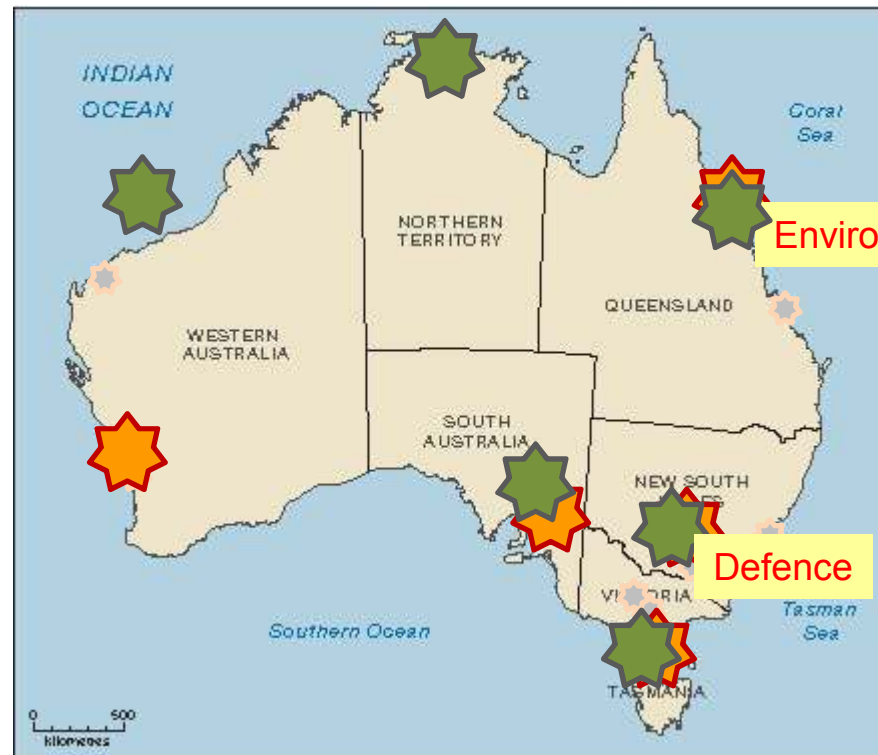
- Major locations – research teams

Australian OR

- Major locations – application domains

Mining and bulk transport

Agriculture and horticulture

Australian OR

- Major locations – application domains

Australian OR

- Major locations – application domains

Air, rail and urban transport
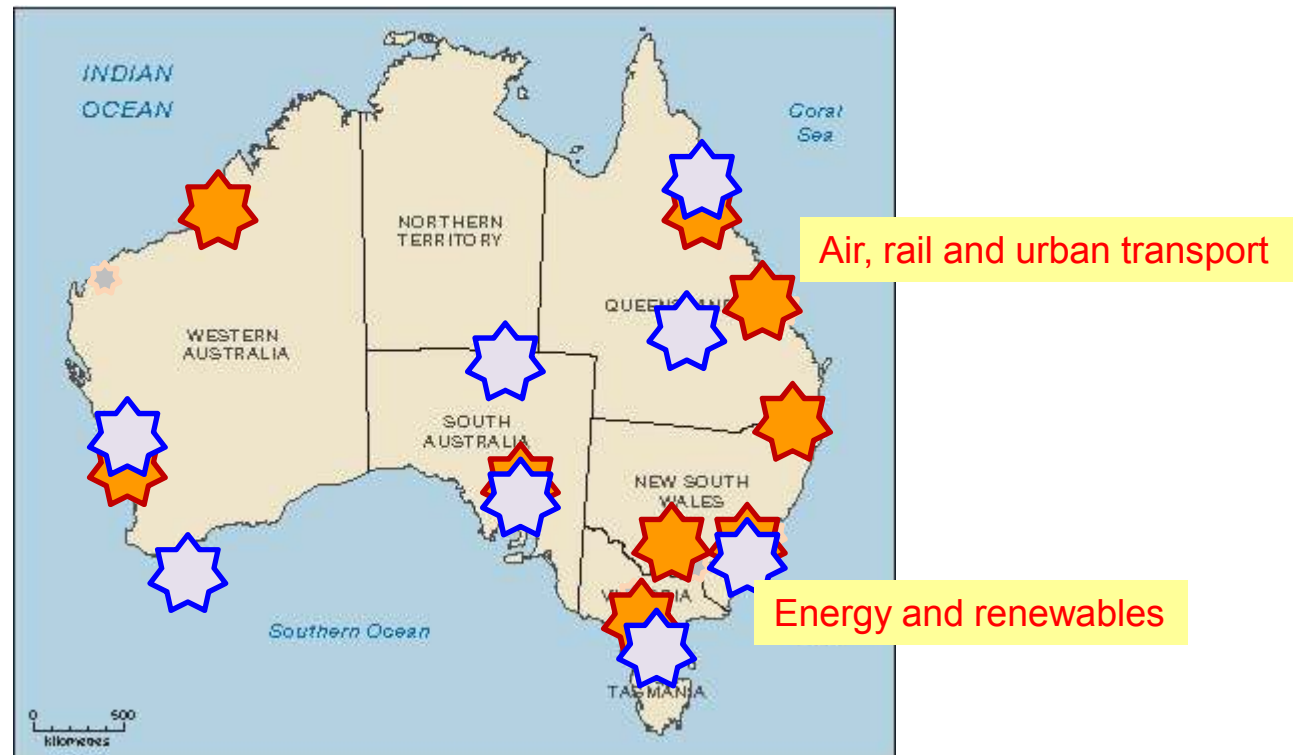
Energy and renewables

IFORS Survey Results

- Low response rate from Australia

- There are practitioners who identify with OR but with whom the research community is not engaging well

- A raft of software tools in use, both general-purpose and domain-specific

- *"Most Operational Researchers work in very specific fields and don't professionally categorize themselves as such - there are very few that are generalist OR people... I would imagine those working in other areas would equally have a long list of software developed specifically for their analyses."*

- *"Biggest issue ... is a lack of awareness of OR, and how it can be used to improve business performance ... my skills are under-utilised in my organisation because there are few other people that have an awareness of OR."*

Some APORS data

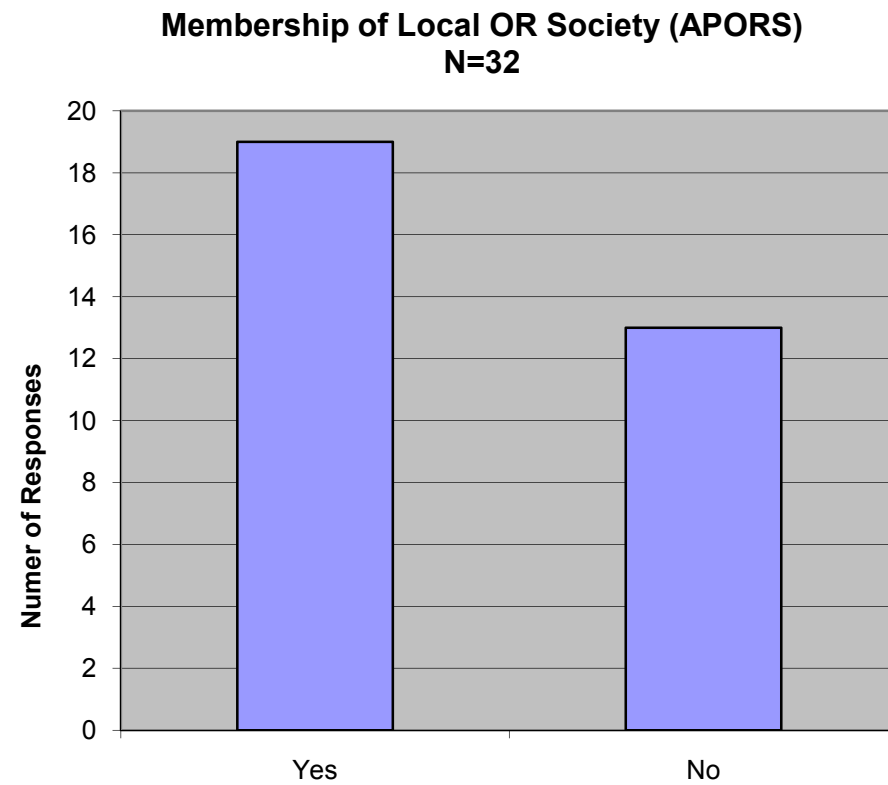- APORS data appears qualitatively representative of OR in Au

Size of the Group (APORS)
N=27
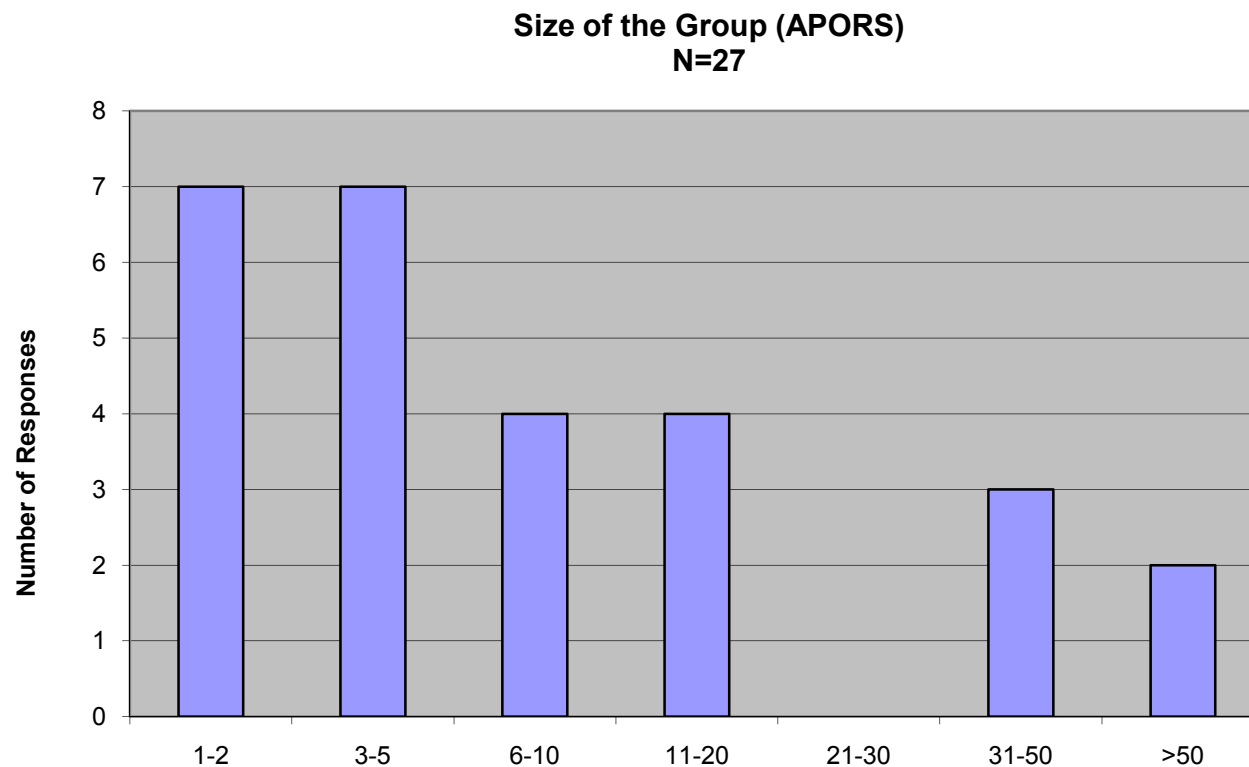
APORS: society membership

Membership of Local OR Society (APORS)
N=32

APORS: age distribution

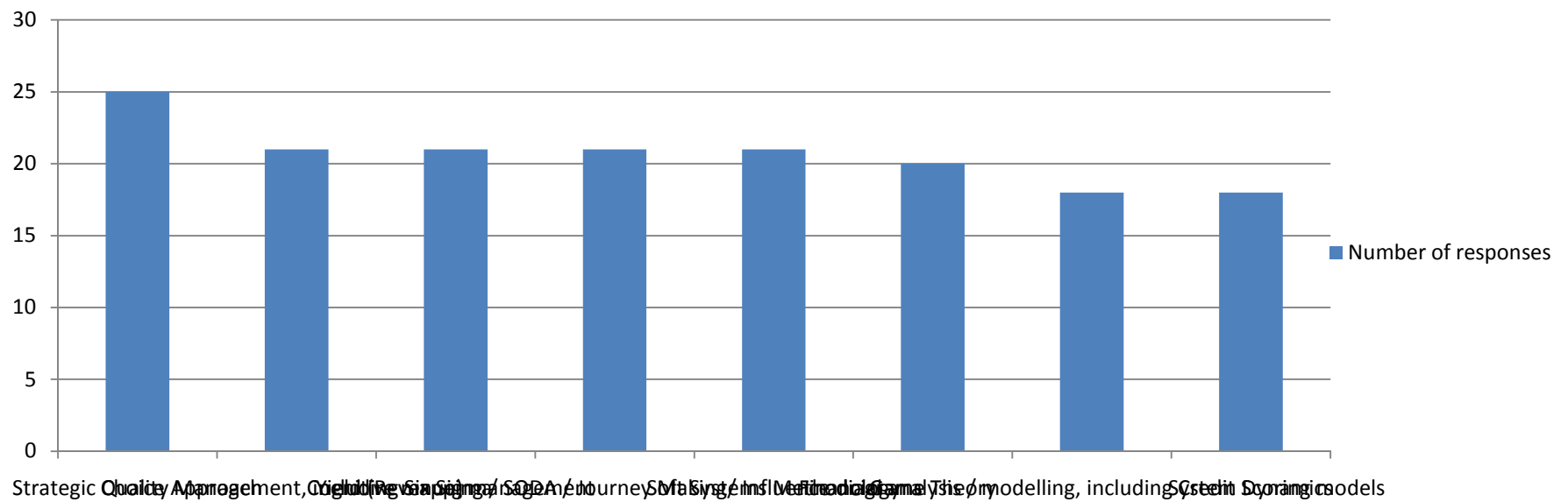Age of Respondents (APORS)
N=33
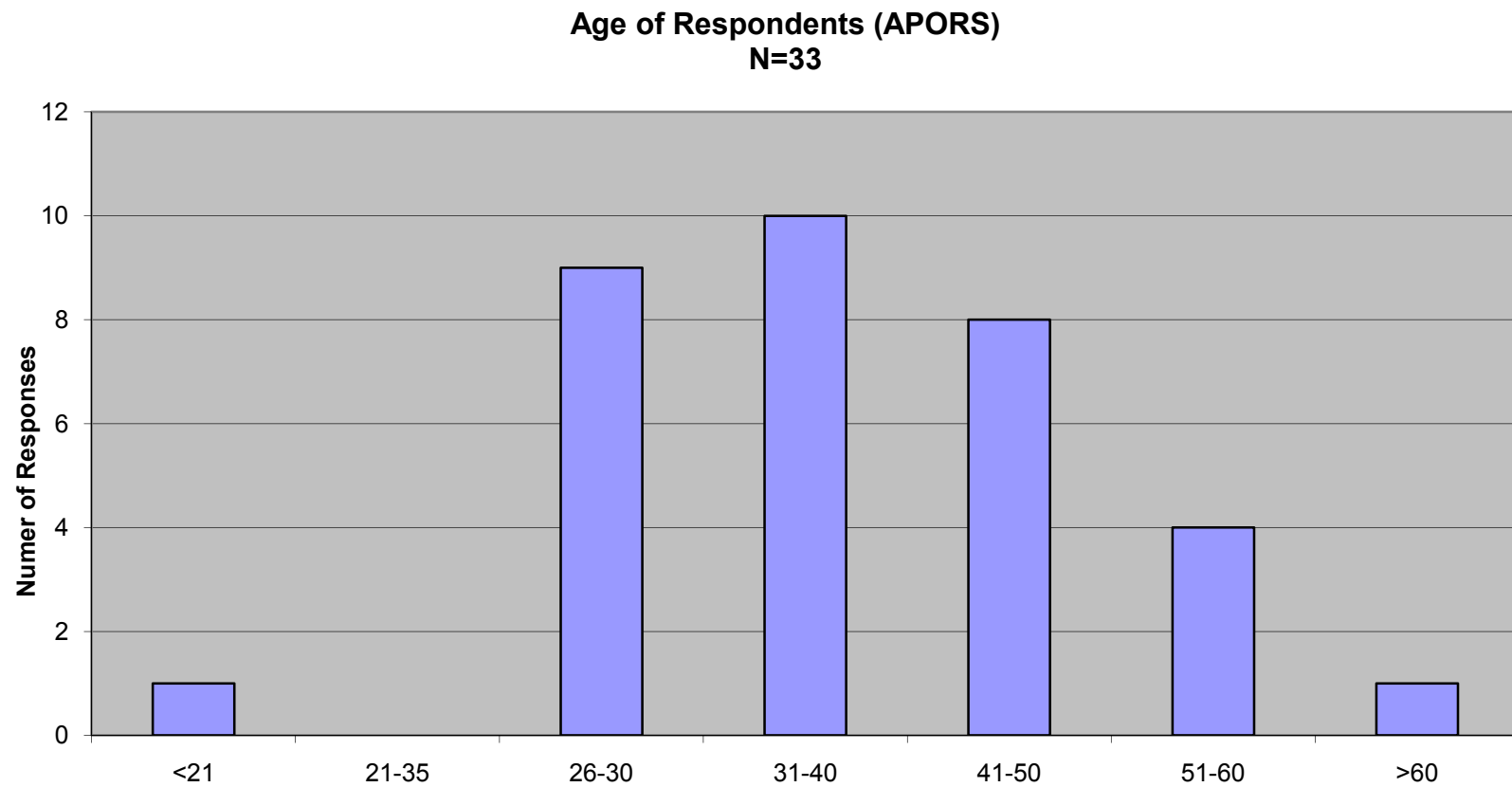
APORS: techniques

Your Personal Understanding and Use of OR and related techniques
Top 8 techniques (APORS)

Strategic Quality Management, including Six Sigma / SODA / Journey Making / Influence diagrams / Game Theory modelling, including System Dynamics models

The Australian situation

- Diversified research organisations who have significant OR teams
- Diversified management and technical services organisations with teams using OR and/or developing OR products/services
- "Traditional" academic research groups
- Australian SMEs (or local branches of international firms) in the planning and scheduling space operating in multiple domains
- Specialist domain-specific businesses providing product and/or service offerings to industry and government
- OR practitioners and like-minded individuals embedded within organisations large and small

Selected Australian (and Trans-Tasman) Case Studies

Energy Futures Modelling

ESM: an economic model based on linear programming. It is used to find least-cost emissions reduction solutions for the transport and stationary energy sectors

Legend:
- Landfill gas
- Biomass
- Biomass Cogen
- Wind Non-urban
- Wind Urban
- Solar PV Commercial
- Solar PV off-grid
- Solar PV Residential
- Biogas
- Diesel off-grid
- Diesel Urban
- Gas Trigen Residential
- Gas Trigen Commercial
- Gas Cogen Residential
- Gas Cogen Commercial
- Gas Cogen Industrial
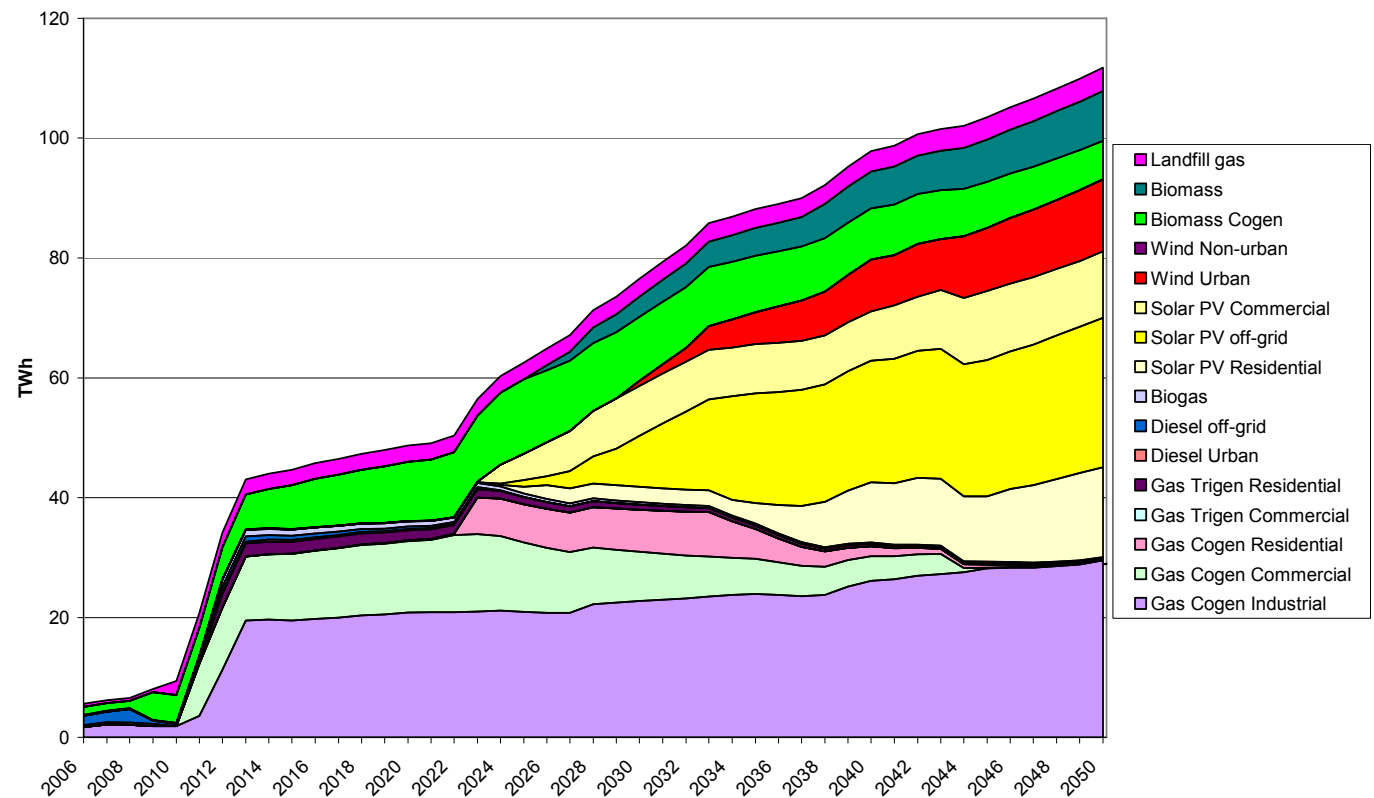
Wind Energy Storage

Optimised control strategies for turbine-battery systems. Currently being trialled at wind farms in NSW.
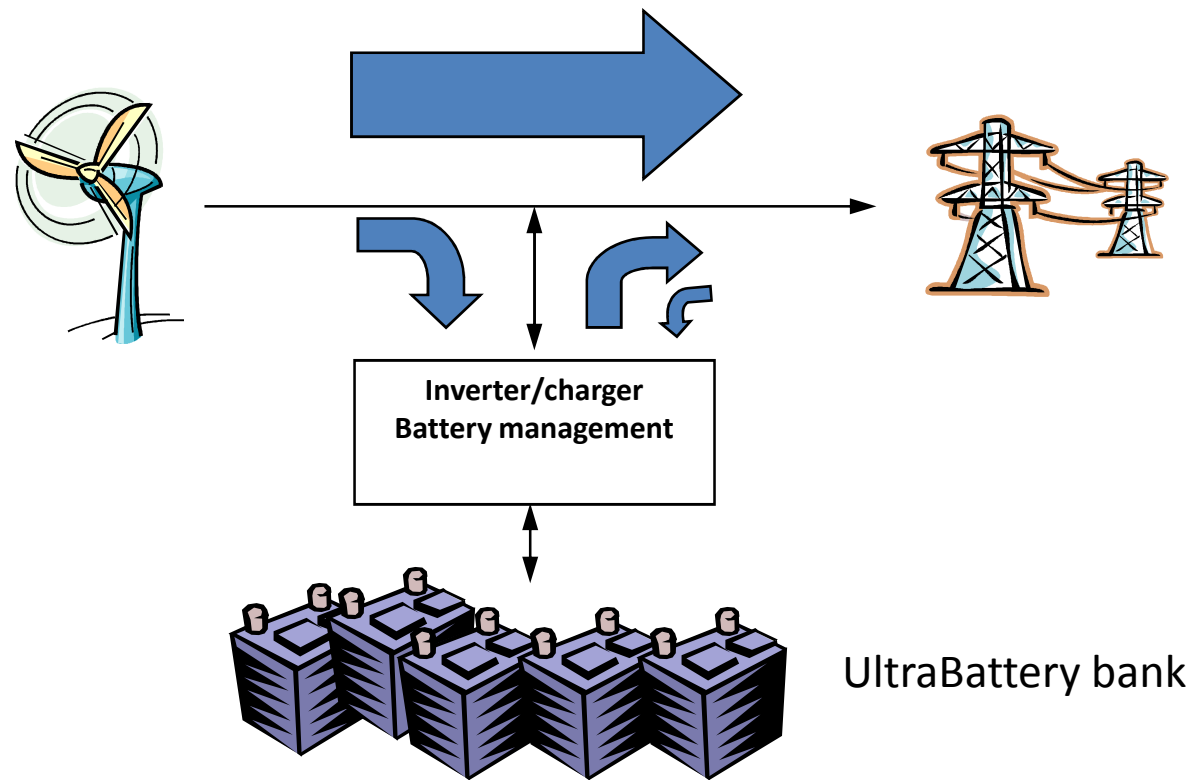
"Ramp rate" excursions reduced by 10^2.

Inverter/charger
Battery management

UltraBattery bank

An Optimal Harvesting Strategy for Scallop Resources

Supported by Department of Primary Industries

Operations Research Group

Problem

The problem is to maximise the benefit from catching scallops over time. As many scallops as possible should be caught before they die of natural causes, and these scallops should be as large as possible. In addition, enough of them should have spawned to replenish the stock. The costs associated with scallop fishing include traveling to and from fishing grounds and loss of potential revenue by taking scallops which are below the legal size limit.

Solution Approach

The dynamic nature of the problem led us to develop the following dynamic programming model.

Product

The dynamic programming model has been solved for five regions and 26 fortnights using the OSL solver in GAMS. Solution for the all regions left to future studies.

Significance

Determination of a management strategy. What time of the year a region should be open to fishing? Maximum benefit that can be earned from catching scallops over time.

Fortnight (t)	Region (i) 1	2	3	4	5						60
1	0	0	1	0	0						
2	1	1	0	1	0						
3	1	1	1	1	0						
4	0	1	1	0	0						
5	0	0	0	0	1						
6	1	0	1	0	1						
7	0	0	1	0	1						
8	0	0	0	0	1						
9	0	0	1	1	1						
10	1	0	0	0	1						
11	0	1	1	0	1						
12	1	0	0	1	0						
13	0	0	0	0	0						
14	1	0	0	1	1						
15	0	0	1	0	1						
16	0	0	1	0	0						
17	0	0	1	0	1						
18	1	0	1	1	1						
19	0	0	0	0	0						
20	0	0	0	0	0						
21	0	0	0	0	0						
22	0	0	0	0	0						
23	0	0	0	0	0						
24	0	0	0	0	0						
25											

Mining and minerals supply chains

- Underground mine planning

- Optimal extraction schedules

- Stockyard optimisation

- Bulk freight transport scheduling

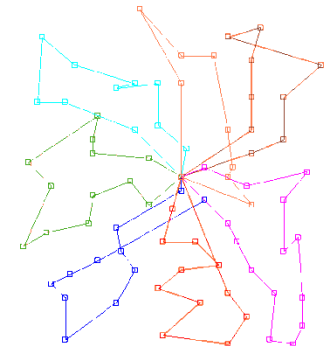- Port and rail system simulation

- Supply chain simulation

VRP systems based on Constraint Programming

- Generalized Vehicle Routing Problem
  - Multiple Time windows
  - Multiple Commodities
  - Heterogeneous vehicles
  - Compatibility constraints
  - Fatigue rules and driver breaks
  - Vehicle re-use
  - Loading/unloading times
  - Docking constraints

Pre-IFORS workshops

- IP Down Under – Local Presentations:
  - New perspectives on instances and computational experiments
  - IP methodological improvements
    - Finding feasible integer solutions
    - Multi-objective integer programming
  - Application to task scheduling
  - Application to supply chains
- Continuous and Non-Smooth Optimisation workshop in Ballarat
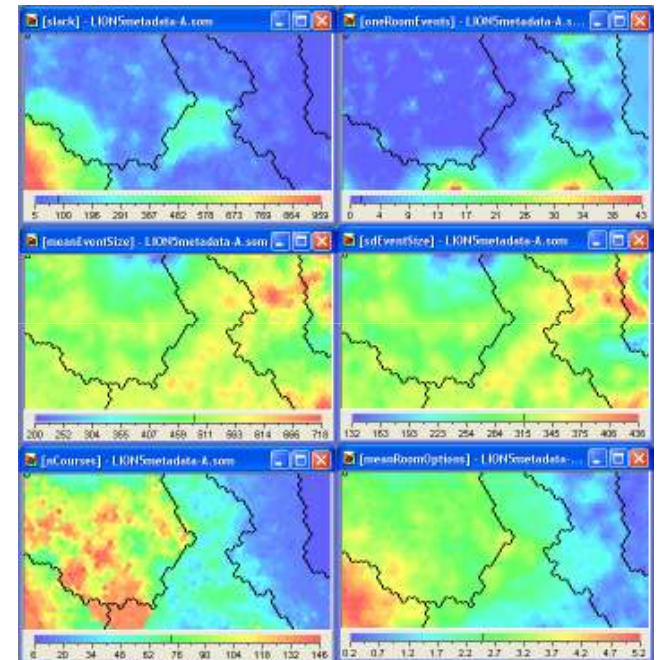
Recreational vehicle rentals

- Match vehicles to bookings, schedule relocations, upgrades, etc., country-wide over 12-18 months
- Multiple installations covering thousands of vehicles:
    - Britz and Maui campervans
    - Apollo Motorhomes
    - Australia and New Zealand
- System used in real-time to:
    - Check availability for any potential booking
    - Respond to any change to vehicle availability or new booking
    - Continuously re-optimise vehicle assignments
- Business benefits:
    - **20% increase in fleet utilisation**
    - **5% reduction in operating costs**

Wine grape harvesting, fermenting and bottling

- Multiple R&D teams providing products and services in Australia and NZ

- Simulating/projecting future vintages

- Forecasting grape maturation

- Scheduling harvests, harvesters, wineries

- Tank-farm optimisation

- Bottling-line optimisation

Operations Research in New Zealand Companies

IFORS OR Survey 2011

Andrew Mason
Department of Engineering Science
University of Auckland

OR in New Zealand

- Niche Software Products
  - The Optima Corporation - ambulances
  - Derceto – water distribution optimisation

- Operations Research within Companies
  - Air New Zealand
  - Norske Skog (Pulp and Paper)
  - Electricity Generators
  - Defence Sector
  - Fonterra (Milk products)

The Optima Corporation
www.theoptimacorporation.com

- ## University of Auckland spin-off company
  - Many graduates from Engineering Science Dept, University of Auckland, with BE(Hons), Masters, PhD

- ## Ambulance simulation+optimisation software
  - Used in NZ, Australia, Denmark, UK, Canada, USA

- ## 15-20 people

- ## Annual Turnover: <$5M

- ## Using bespoke software with COIN-OR solvers

Derceto

www.derceto.com

- Derceto "supply advanced scheduling optimisation [software] for water utilities to schedule production, control pumps and valves in real time, often using real-time energy prices and working with live SCADA systems to automatically control operations."

  – Used in NZ, USA

- Many graduates from Engineering Science Dept, University of Auckland, with BE (Hons) + Masters

- 15-20 people

... using ... ash Express and IBM OSL

Air New Zealand

www.airnewzealand.co.nz

- **Bespoke Pilot and Crew Scheduling software**
  - Developed by Air NZ OR Group and Professor David Ryan, Engineering Science
  - Smaller OR group now (4-5 people) to maintain software
    - Lead by Paul Keating BE, ME
- **Bespoke 0/1 Set Partitioning ZIP solver**
- **Using SAS, Ilog Tools, Oracle Database, CBC,GLPK**
- **Edelman Finalist 2000**

Norske Skog

- Norwegian-based Pulp and Paper company
  - Turnover $101m - $1000m, 100-1000 employees
- OR 'group' = Graham Everett, Energy Mgr (BE+MOR)
  - Collaboration with Prof. Andy Philpott, Engineering Science
  - Electricity usage optimisation
  - Strategic models
- Edelman Finalist 2009

Others

Electricity Markets

- Market cleared using an LP/IP Model
  - Major contributions from Grant Reid, Canterbury University
- Extensive modelling of markets used by...
  - Electricity generators
  - Transmission company
  - Government regulators
  - Private consulting firms

Defence Sector

- Intelligent agent simulations

Engineering Consultancies

- Transport modelling (simulation)

Fonterra

- Major milk products player
- Internal Group
- Production planning etc

Academia

- **University of Auckland**
  - Dept of Engineering Science, within Engineering
    - 8-10 Faculty Staff
    - 25-35 OR-skilled Engineering Science graduates/annum
    - 3-4 Masters+PhD students per annum
  - Statistics De
  - Business School: Reducing emphasis on quantitative modelling
- **University of Canterbury**
  - Management Science department, within Business
    - 8-10 Faculty Staff
  - Small numbers of students
  - Earthquake impact...
- **Victoria University, Wellington**

Thank you for your attention