OR and Decision Aiding

Some (personal) thoughts on our field and its future

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Operational Research

- Young discipline
  - ORQ, Vol. 1, n° 1, March 1950
- Many scientific and practical achievements… but
- A discipline not without problems…
  - Without press
  - That has not worked on its history
  - That has been vigorously attacked
    - The future of Operational Research is past, JORS, 1979, R. L. Ackoff: “In my opinion, OR is dead even though it has yet to be buried”
  - That started as being applied and interdisciplinary and evolved differently
  - Game Theory, Decision under uncertainty
Some Unanswered Questions

● What is OR?
  ➢ What does it mean to be *interdisciplinary*?
  ➢ What does it mean to be an *applied science*?
  ➢ Does this call for a specific epistemology?

● How to teach OR and train OR analysts?
  ➢ What should be the standard curriculum in OR?

● Should we remain isolated or try to ally with some sister disciplines (Computer Science, Statistics, Management, etc.)?
  ➢ ROADEF: around 200 members

● Should OR societies try to organize the profession?
  ➢ “Labeled” OR consultants?
Outline

● A view on OR
● OR in history
● What to do?
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OR main model

★ Build and solve models of the type

★ Solving:
  ➢ Finding an optimal solution
  ➢ Finding all optimal solutions
  ➢ Finding solutions “close” to the optimal solutions
  ➢ Finding robust solutions

★ How are such models built?
★ What is their relation to real decision processes?

Maximize $f(a)$
s.t.
$a \in A$
Example

● **Workforce Scheduling at Aéroport de Paris**
  - High cost of labor
  - Strong unions
  - Many legal and technical regulations
  - Demand highly variable throughout time
  - Highly competitive industry

● **One category of persons**
  - “bagagistes”
  - persons taking care of luggage from planes to customers
Demand Curve (normal weekday)
Classic problem

● Cover demand with a minimum of operators

Parameters

\[ t = 1, 2, \ldots, T \] periods

\[ C_t = \text{demand in period } t \]

\[ h = 1, 2, \ldots, H \] possible shifts

\[ a_{ht} = \begin{cases} 
1 & \text{if shift } h \text{ covers period } t \\
0 & \text{otherwise}
\end{cases} \]

Decision variables

\[ x_h = \text{number of persons hired according to shift } h \]
Solve the problem

\[
\text{minimize} \quad \sum_{h=1}^{H} x_h \\
\text{st} \\
\sum_{h=1}^{H} a_{ht} x_h \geq C_t \quad t = 1, 2, \ldots, T \\
x_h \geq 0 \quad (\in \mathbb{N}) \quad h = 1, 2, \ldots, H
\]
An optimal solution
“Data”

- Definition of candidates shifts
  - Implicit Constraints
    - Legal / Union agreements / Habits / Convenience
    - Hard / Soft constraints
  - Dealing with perturbations
    - Illness / Late / Strikes / Overload
  - In practice?
    - Who decides? When?
    - Affectation of shifts to persons (auctions, seniority, etc.)?
  - Days / Weeks / Months
    - One model or several models?
    - Combination?
“Data”

**Demand curve**

- How is it built?
  - Implicit Rules
    - type of plane $\times$ destination $\times$ time of the day
  - Implicit Standards
    - Quality?
    - What is an acceptable waiting time?

- Coping with uncertainty
  - Late planes
  - Changes of planes
What is the “problem”

● Why is it raised now?
  ➢ Malfunctioning
  ➢ Opportunity

● What objective(s)?
  ➢ Increased productivity?
    ● How to share the gains?
  ➢ Negotiations?
    ● Possible Shifts
    ● Timetable of fights

● Implementation
  ➢ Who handle the problem?
  ➢ How is it handled?

● Who will use the model?
  ➢ How often?
  ➢ To do what?
Use of optimization model

● Optimal solution is not necessarily central
  ➢ Many unforeseen constraints
  ➢ Many constraints difficult to model
  ➢ High uncertainty / Many implicit aspects
  ➢ Multiple heuristic adjustments of the solution

● Model as an exploration tool
  ➢ current practices / frontiers of system / objectives

● Indirect use of model
  ➢ Possible, frequent and legitimate
  ➢ Model as a tool to understand and/or dialogue

● Necessary contextualization of solutions outside the model
In summary

- OR analysts have a very naive strategy of intervention
- OR has no specific doctrine of implementation
Strategy of the OR analyst

- Faced with the complexity of real decision processes and organizations, the answer of the OR analysts is essentially *pragmatic et non-formalized*
  - Workforce scheduling (what to formalize and what to leave outside the model?)

- Two “heroic” hypotheses
  - It is possible to have a positive role in organizations using a decision model that is essentially *individual* (optimization)
  - Use “common sense” and “know how” to deal with implementation issues
Doctrine (lack of)

- OR is an applied science...

- But OR analysts have not elaborated a doctrine of intervention let alone an autonomous discourse on organizations
  - How to justify the naive strategy?
  - How did we react to the transformation of organizations?
  - What have we learnt on organizations?
  - How to train OR analysts

- Supply chain, IS, Marketing, Strategic Management
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Models as “rational myths”

● Unavoidable conflict between the logic of the model and the logic of the organization

● The model is a porte d’entrée in the organization and a lever for change
  ➢ OR models are good for doing so because they are rational myths
    ● Myth: “Symbolic fable that is both simple and striking”
    ● Rational: “Performance” + high internal consistency

● Models used unfreeze and recompose organizational structures
  ➢ Learning / Contextualization / Implementation

Hatchuel & Molet, 1986, EJOR
What does this view bring to OR?

- **Historical perspective**
  - Successes and failures of other rational myths

- **Doctrine: modeling and intervention**
  - Modeling process
    - Learning
    - Constructivism
  - Implementation
    - Not always required
    - Beware of “compulsive implementation”
Anatomy of a “rational myth”

- Rationalization project: 3 main components
  - Formal structure
    - What is the underlying logic?
  - Management perspective
    - What aspects of organizations are concerned?
  - Simplified view of organizations
    - What is the implicit view of organizations?

- OR
  - Formal structure
    - Pure decision theory
  - Management perspective
    - Rationalize decisions
  - Organization
    - Organizations as collections of decision makers
Management perspectives: Evolution of rational myths

Work : Taylor
Decisions : OR
Costs : Audit
Markets : Strategic Management
Data : EIS / Data Mining
Flows : Supply chain
Quality : TQM
Products : ECR
Knowledge : AI / KM
?? : ??
OR in context

- OR is part of a long history of “rationalization projects” in organizations
  - Competition between “rationalization projects”
  - We may and should learn from other fields
  - They should be able to learn from our field

- What to do?
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Short term

- **Pay attention to competing “rational myths”**
  - IS, Supply chain, TQM, AI, ECR, Data Mining, etc.
    - INFORMS vs. EURO
    - ERP and OR
  - Work on history of OR

- **Pay attention to the evolution of organizations**
  - Doctrine on organizations
  - 1st step: Who asks for OR?
    - Legal evolutions (deregulation / privatization)
    - Technical evolutions (transports / NICT)

- **Classic techniques/models do not define OR**
  - The nature of the *rationalization project* should govern the choice of techniques
Short term

● Be proactive: “We know how to handle that”
  ➢ Prevention of industrial risks
  ➢ Evaluation of public policies
  ➢ Electoral reforms
  ➢ Security
  ➢ Social Security reforms
  ➢ Globalization
  ➢ Climate change
  ➢ etc.

● Or do we want to leave that to others? (economists, political scientists, sociologists, etc.)
  ➢ Are they really better equipped than we are?
OR’s competitive advantages

- OR survived fashion effects
  - 50 years of experience
- OR remains close to production processes
- Scientific developments
  - Global Optimization, Heuristics, Complexity, Polyhedral analysis, etc.
- Prestigious journals
  - Management Science, Operations Research
Long Term

- Formal structure: Pure decision theory
- Management perspective: Rationalizing decisions
- Organizations: Collections of Decision Makers

- Theoretical challenge
  - What is the present state of decision theory?

- Practical challenge
  - Is decision the right concept?
Pure decision theory

- The very idea of a “rational behavior” undergoes a major crisis in decision theory
- Going from individual to collective model is a formidable challenge
Independence axiom

If

\( \frac{1}{2} x \) is preferred to \( \frac{1}{2} y \) is preferred to \( \frac{1}{2} z \)

then (for \( p > 0 \))

\( \frac{1}{2} k \) is preferred to \( \frac{1}{2} k \) is preferred to \( \frac{1}{2} k \)
Independence axiom: Mom’s choice

Peter 1/2
Mary 1/2

Preferred to

Peter
Mary

BUT

1
Peter

1/2
Peter

1/2
Mary

Preferred to

Mary

1/2
Mary

1/2
Mary
Games with perfect and complete information

(A ; B)

(1 ; 1)

(0 ; 3)

(2 ; 2)
There are other possible and interesting management perspectives.

The bulk of management literature is not about decisions.

It is not at all obvious that “decisions” are central any more in organizations.
How CEO spend their time?

- 15% transports
- 5% visits
- 5% individual meetings
- 30% internal collective meetings
- 10% external collective meetings
- 10% meals
- 15% telephone
- 5% mail
- 2% writing
- 2% reading
- 1% thinking alone (6 min /day)
- 0% computer usage
Rationalizing collective action

- Deciding
- Structuring
- Planning
- Coordinating
- Controlling
- Inventing incentives
- Contracting
- Managing risks
Possible (necessary?) widening of OR’s rational myth

- What decision should I take?
- How to
  - Be organized
  - Coordinate with others
  - Plan while remaining reactive
  - Control results
  - Manage risks
  - Remain informed

in order to be efficient?
Possible New Key Words

- Production
  - Conception / Quality / Environment
- Planning
  - Control / Incentives / Contracts
- Scheduling
  - Equity / Motivation / Robustness
- Markets
  - Competition / Pricing / Strategy
- Transports
  - Sustainable development / Spatial equity
- Rationalizing collective action
  - Politics