

An Agenda for Project Management and Scheduling Research

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Outline

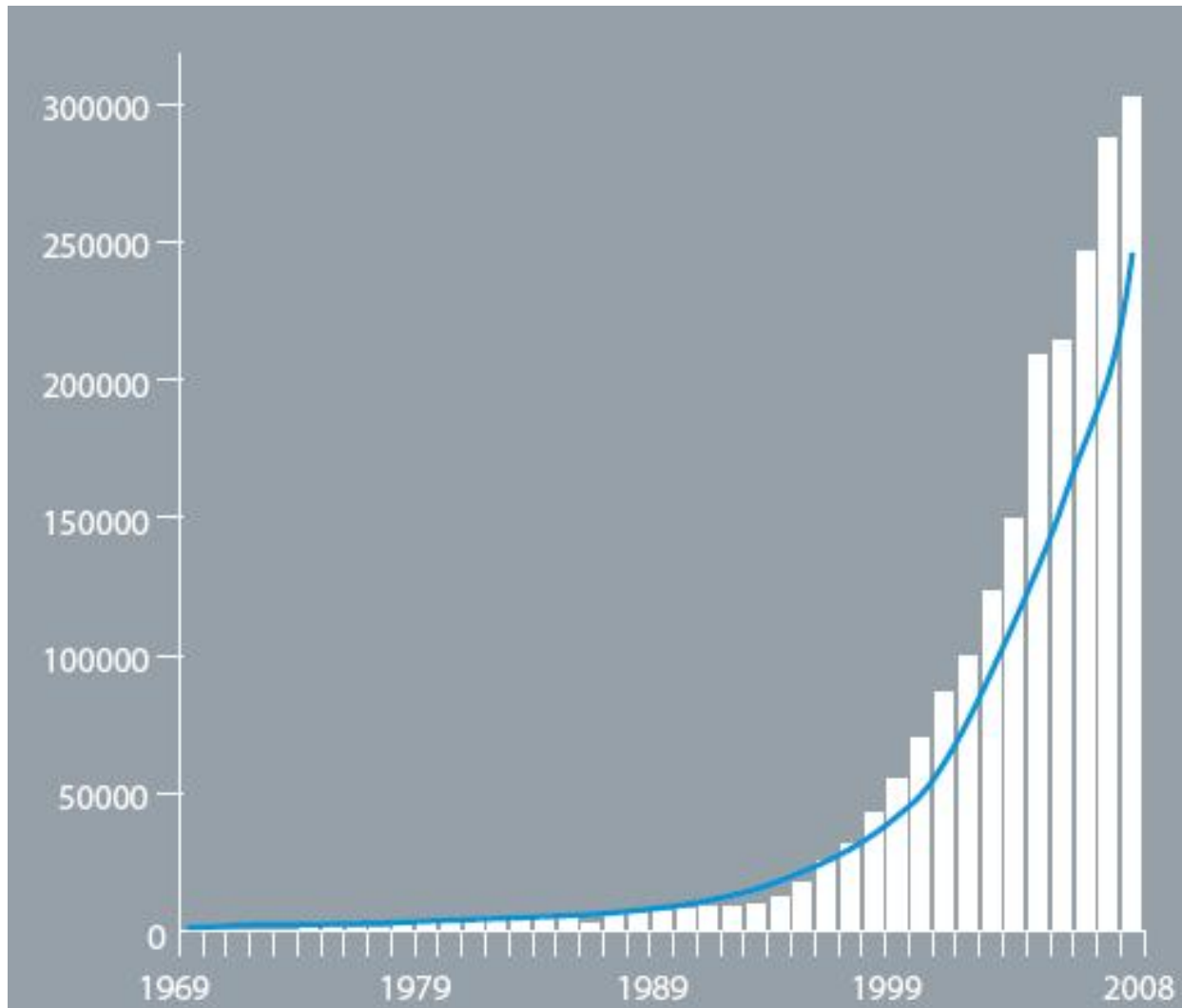
- **I: My mission for project management**
- II: Research opportunities in project management
- III: Research opportunities in scheduling
- IV: Transition to project management
- V: Final comments

Project Management Statistics

- **One-fifth** of the world's economic activity is organized as a project, with an annual value of **US\$12,000,000,000,000**.
- The value of economic activity *at risk* from a shortage of skilled project managers will reach **US\$4,500,000,000,000** by 2016.

[*Project Management Institute report, 2013*]

Membership in Project Management Institute



In 2014,
estimated
at
550,000

My Mission for Project Management

- Identify modern project management problems that need better research.
- Publish modern project management research.
- Reintroduce project management as a high priority subject for the OR/OM community.
- As an editor, support the publication of project management research in top journals.
- Encourage Ph.D. research on project management.
- Share recent research with the project management practitioner community.
- Teach and disseminate an innovative course.⁵

Project Management Teaching Materials Dissemination Map





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Research Opportunity 1: Buffer Sizing in Critical Chain PM

- CCPM redefines PM as buffer management.
- Buffers that are too large add costs to the project and make bids unacceptable.
- Buffers that are too small result in financial penalties or expensive crashing and outsourcing.
- Critics of CCPM argue that its buffer sizing rules are unscientific and lack robustness.
- Newbold (1998) proposes two rules: “cut and paste” and root mean square.
- Tukul et al. (2006) introduce project complexity and resource tightness to develop two new rules.

RQ: Is it possible to develop more robust buffer sizing rules, e.g. using asymmetric costs, and also rules for real time buffer size adjustment?

Research Opportunity 2: Design of Early Completion Incentives

- Parkinson's Law: "Work expands to fit the time available."
- In traditional project management, early task completion does not get passed on.
- CCPM claims to remove, or at least reduce, the effect of Parkinson's Law, by eliminating the traditional focus on due dates at the task level.
- Still, the mechanism by which early task completion is encouraged is not convincing.
- Moreover, the setting of expectations for future performance needs to be considered, especially in view of the low safety times used in CCPM.

RQ: Is it possible to design an incentive mechanism that resolves Parkinson's Law in both CPM and CCPM?



Research Opportunity 3: Learning Between Projects

- Learning within project management is inhibited by the unique aspects of projects.
- Because of time pressures and newly arriving projects, companies frequently devote insufficient resources to the documentation of *lessons learned*.
- There is no formal way to optimize the investment in learning for similar future projects from undertaking a given project.

RQ: Is it possible to develop economic models of learning between similar projects? 10

Research Opportunity 4: Cooperation in Project Management

- Successful completion of a complex project requires the cooperation of many task operators, including for crashing decisions.
 - The overall benefits of crashing must be used to compensate operators with expensive crashing.
 - False reporting (for example, exaggerating crashing cost) needs to be overcome.
- RQ:** Is it possible to develop cooperative game models for cooperation between the task operators, and incentives for truthful reporting?

Research Opportunity 5: Real Options Analysis of Project Risk

- Real options is highly developed within finance, but not widely used in project management.
- Traditional NPV calculations do not value an option to abandon a project after initiation.
- However, ROA calculations can explicitly value an option to abandon, delay or modify a project.
- Decision tree implementation by Loch and Bode-Greuel (*R&D Management*, 2001) quantifies major sources of value.
- A leader is Hewlett-Packard. Current applications are mainly for procurement and other low risk, contract-protected decisions.

RQ: Is it possible to use ROA to model changes in risk level as projects evolve over time?

Research Opportunity 6: Earned Value Analysis

- A cost control and accounting system for projects (U.S. Dept. of Defense, 1962).
- Based on easily calculated metrics: actual cost of work performed, budgeted cost of work scheduled, budgeted cost of work performed (i.e., earned value).
- Does not distinguish critical activities.
- Does not include asymmetric costs.
- Simulation study of different EVA forecasts (Vanhoucke and Vandevoorde, *JORS*, 2007).

RQ: Is it possible to develop a better control and accounting system that evaluates the impact of delays both on the critical path and on other paths that are close to critical?

Research Opportunity 7: Effect of Work Breakdown Structure

- Globerson (1994) identifies the importance of a good WBS design for project performance.
- He also discusses an application with five different WBSs, with (a) different tasks and precedence relationships, and (b) different resource requirements at different times.
- Examples: break down by location, by function, by subsystem and by project phase.
- The time and cost performance of the project is likely to vary significantly between these designs.
- Need to decide the hierarchical sequence in the WBS design, and the granularity of the tasks.

RQ: Is it possible to model the link between WBS design and project performance scientifically?



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Research Opportunity 1: Supply Chain Scheduling

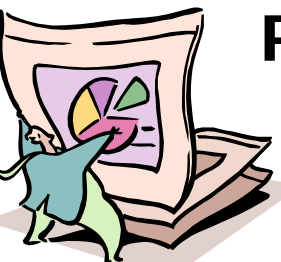
- Supply chain scheduling studies scheduling decisions that influence the coordination level and performance of a supply chain.
- Hall and Potts (*Operations Research*, 2003) has about 300 citations.
- Google Scholar finds about 1,200 results on “supply chain scheduling”.
- Recent work extends the supply chain scheduling concept to various scheduling environments.
- More recent work has integrated the study of incentives and various game theory concepts.

RQ: There are many additional issues to be studied and models that can be developed within supply chain scheduling.

Research Opportunity 2: Scheduling with Multitasking

- In many scheduling applications, distraction or lack of focus leads to inadvertent multitasking, where a scheduled job is interrupted.
- Especially, waiting tasks create a distraction.
- Under multitasking, many algorithms that are optimal for classical problems no longer work.
- Some efficiently solvable classical problems become intractable under multitasking.
- New algorithms are needed, along with models for evaluating the increase in schedule cost or value due to multitasking.

RQ: There are many additional issues to be studied, and many models that can be developed for scheduling with multitasking.



Research Opportunity 3: Scheduling with Energy Issues

- U.S. manufacturing spent \$96 billion on energy in 2009, with a 40% increase projected by 2030.
- Energy cost is significant in scheduling problems.
- The problem is complicated by different rates charged by utility companies at different times.
- The literature on dynamic voltage scaling studies tradeoffs between processing speed and energy usage in computer applications.
- But manufacturing applications have multiple resources, contract penalties, ready times, etc.

RQ: There are many issues to study in the integration of energy issues into manufacturing scheduling systems.

Research Opportunity 4: Operating Room Scheduling

- Cardoen et al. (KUL working paper) provide a thorough review of this increasingly important and very practical research area.
- A unique feature of this area is the combination of deterministic data (scheduled surgery) and stochastic data (emergency surgery).
- Hence, a key issue is how much capacity should be allocated to scheduled surgery vs. reserved for emergency surgery.
- Another key issue is coordinating the upstream and downstream processes with the operating room.

RQ: These two issues can support many valuable research studies in operating room scheduling.

Research Opportunity 5: Scheduling with Positional Effects

- Rustogi and Strusevich (*EJOR*, 2012) discuss models where cost is the product of processing time and a positional weight.
- This environment models positional learning or positional deterioration.
- Applications exist in financial management, steel processing, national defense, and medicine.
- Similarity to the general linear assignment problem and matching solves some variations efficiently.
- However, more efficient algorithms are available using a special case linear assignment problem.

RQ: The limits of the proposed method for modeling learning and deterioration effects in scheduling should be explored.

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Transition to Project Management (1 of 4)

- Background: Associate Editor of *Operations Research* (1991 --), 6 Distinguished Service Awards; Associate Editor of *Management Science* (1993 --2008); processed over 200 papers.
- Work on project management or scheduling could be published in either the Optimization or Operations area of either journal.
- The Optimization area of *O.R.* currently focuses on depth and originality of mathematics.
- The Operations area of *O.R.* has moved towards a more empirical focus, such as “what is the empirical basis for your model?”

Transition to Project Management (2 of 4)

- Classical scheduling research does not necessarily meet either standard. Part of the problem is that the area is mature, i.e. the most credible problems have already been studied.
- Project management is more credible as a “real problem”. However, it is an “old problem”, so you need to be specific about “what is new”.
- Business developments in project management that are not yet rigorously evaluated have opened up many interesting research questions.
- So, overall it should be easier in the future to publish in these journals on the topic of project management than on scheduling.

Transition to Project Management (3 of 4)

- It is my observation that the most contented professors are those whose activities are synergistic: that is, their research, teaching and third activity (book writing, consulting, ...) are mutually reinforcing.
- With scheduling, this is impossible if you are working in a U.S. business school.
- However, with project management, it is easy.

Transition to Project Management (4 of 4)

- Both research and teaching in project management are under-served. Few new researchers have entered the area in the last 15 years. Yet there is more and more business activity, and there are more and more interested students. This is creating great opportunities.
- Graduating Ph.D. students should be “able to teach project management”, irrespective of their thesis topic. They can help to satisfy the under-served need described above.
- On a more technical level, the variety of techniques used in project management research is broader than in scheduling.



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Final comments (1 of 2)

- Trends making project management *harder* include: increased competition, shorter product and service life cycles, tighter budgets, unfamiliar nondeterministic applications, and global and multicultural project teams.
- Trends making project management *easier* include: better project management training, publication of best practices information, and better software support.
- Underestimation of the need for project management research over the last 20 years has resulted in research *falling behind* recent business innovation and the growing range of applications.

Final comments (2 of 2)

- Important recent developments on the business innovation side of project management are not yet well supported or validated by research.
- Leading journals in OR/OM have published relatively few articles on project management in the last 10 years, but this situation may improve.
- Practice and research have diverged, and not enough new researchers have entered the field.
- These developments have generated numerous interesting research and academic career opportunities for the next 10 years!

Project Management Research Agenda Papers

1. Hall, N.G., "Project Management: Recent Developments and Research Opportunities", *Journal of Systems Science and Systems Engineering* 21(2), 2012, 129-143.

2. Hall, N.G., "Project Management: Further Research Opportunities", Chapter 53 in *Handbook of Project Management and Scheduling*, ed. C. Schwindt and J. Zimmermann, Springer, 2013.



Project Management Research Opportunities Website

The website linked below provides an overview of the topics discussed in these two publications, along with a few representative references.

<http://fisher.osu.edu/~hall.33/PMRO/mysite2>

Appreciation

Thanks for support from: Fisher College Summer Fellowship Program, and the National Center for the Middle Market.

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Thank you for your attention!

**Copies of the speaker's work
discussed in this presentation
are available by writing to:
hall.33@fisher.osu.edu**



Are there any questions?

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