

RESEARCH

Inside IISE Journals

This month, we spotlight two articles from the October 2026 issue of *IISE Transactions* (Volume. 58, No. 10) that showcase how optimization and simulation techniques can improve engineering decision-making in the face of inevitable uncertainty. The first article addresses a critical challenge in circular manufacturing: how to make efficient purchasing and production decisions in the face of uncertain product returns. The research team developed an innovative optimization framework that identifies two intuitive and rigorously justified decision policies. These policies help manufacturers better balance inventory costs, resource utilization and production efficiency under uncertainty. The findings provide practical guidance for designing more efficient, cost-effective and sustainable circular production systems.

The second article tackles one of the most pressing challenges in long-term energy system planning: how to systematically optimize investments in conventional and renewable energy capacity under uncertainty. By seamlessly integrating stochastic optimization with agent-based simulation, the authors introduce an innovative decision-support framework that enables policymakers and planners to make uncertainty-informed investment decisions. The resulting framework supports the development of more efficient, reliable, and sustainable power systems.

Buy or skip? Smarter decisions for the circular economy

A recycling plant manager receives batches of returned materials throughout the day. Some look promising, others less so. Should the manager buy every batch that arrives or turn some away? And once materials are sitting in storage, which type should the production line tackle first to turn them into finished goods? These seemingly simple questions can make or break the economics of a recycling or refurbishment operation.

The circular economy is growing fast. Battery refurbishment, plastic recycling and integrated circuit reuse are rapidly moving from niche activities toward the core of sustainable manufacturing. But unlike traditional factories that order raw materials on demand, circular producers must work with whatever flows back from the market. Too much inventory means spiraling storage costs; too little means the production line sits idle.

Yun-Lei Song, a Ph.D. student, and professor Jun-Qiang Wang, both at Northwestern Polytechnical University, collaborated with



Nicla Frigerio



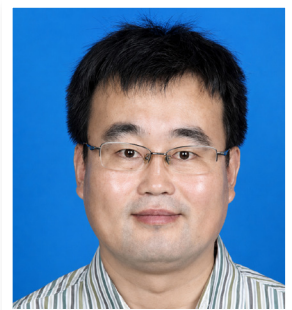
Oktay Karabağ



Yun-Lei Song



Barış Tan



Jun-Qiang Wang

professors Nicla Frigerio of Politecnico di Milano, Oktay Karabağ of İzmir University of Economics and Erasmus University Rotterdam and Barış Tan of Özyeğin University. They present optimal answers to both questions in their article, "Optimal Purchasing and Production Control for a

Circular Production System."

Motivated by real cases in battery cell refurbishment and PET plastic recycling, the team models a facility that handles two types of returned materials through a shared manufacturing center where both are converted into a single finished product. Using a Markov Decision Process and linear programming, they derive optimal policies for both purchasing and production decisions.

The purchasing rule is intuitive: Accept incoming material only if the inventory of that material remains below a threshold. Moreover, the threshold automatically decreases as the inventory of the other material increases, reflecting the substitutability between the two material types.

The production rule is equally straightforward: Always prioritize the material whose product of production rate and holding cost is higher. Tested across 800 scenarios, this rule is optimal or near-optimal in virtually every case.

This research helps translate the idea of circularity into actionable production decisions. For circular economy operators managing unpredictable returns, two simple rules can replace costly guesswork and keep both inventory and profits firmly in check.

CONTACT: Jun-Qiang Wang; wangjq@nwpu.edu.cn; Department of Industrial Engineering, Northwestern Polytechnical University, 127 West Youyi Road, Xi'an, Shaanxi 710072, China

Powering the future: Smart energy expansion planning

The global energy transition is one of today's defining challenges. As power systems increasingly rely on renewable energy, planners face a challenging question: How much conventional, storage and renewable capacity will be needed, and when should they be built? The answer depends on making investment decisions under deep uncertainty about future costs, weather and electricity markets.

Two modeling approaches are commonly used for power system planning problems, but each has its inherent limitations. Stochastic optimization models are excellent at handling uncertainty and finding cost-minimizing investment plans, but they struggle to capture how market participants actually behave and compete. Agent-based simulations, on the other hand, realistically model these market dynamics, but are not designed to optimize long-term investment systematically.

In their article, "Coupling Stochastic Optimization with Agent-Based Simulation: A Framework for Efficient Power Expansion Planning Under Uncertainty," Anil Kaya, a Ph.D. student at Karlsruhe Institute of Technology, together with Aboubakr Achraf El Ghazi of Hessian State Archives, Ulrich Frey of University of Graz and Steffen Rebennack of



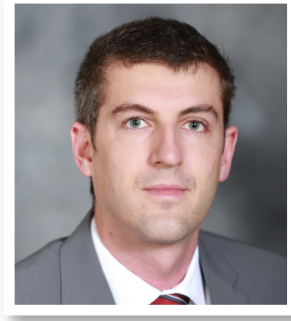
Ulrich Frey



Aboubakr Achraf El Ghazi



Anil Kaya



Steffen Rebennack

Karlsruhe Institute of Technology propose an innovative framework that integrates stochastic optimization with agent-based simulation.

The authors develop a decomposition-based coupling strategy that enables the optimization and simulation components to exchange information iteratively. Their key insight is that combining these two approaches can complement and address each method's weaknesses. A further challenge is that agent-based simulations do not naturally generate the mathematical "signals" (dual values) required by optimization models to coordinate investment decisions. To fill this gap, the authors developed a novel approach that extracts the missing information from an agent-based simulation and feeds it into the optimization model through what are called "affine cuts."

Applied to a case study of the German power system, the framework enables planners and policymakers to analyze both centralized and market-based approaches. The results show that the integrated simulation-optimization strategy consistently outperforms pure optimization alone. While the percentage improvement appears modest, it translates into substantial economic savings when scaled to real-world power systems. For practitioners, the takeaway is clear – as energy systems grow more complex, combining optimization and simulation can lead to meaningfully better investment decisions.

CONTACT: Anil Kaya; anil.kaya@kit.edu; Institute for Operations Research, Stochastic Optimization, Karlsruhe Institute of Technology, Karlsruhe, Germany

This month, we highlight two articles from *IJSE Transactions on Occupational Ergonomics and Human Factors* (Volume 14, No. 3), a Festschrift for Professor Svend Erik Mathiassen. In the first, Straker et al., review the development and effects of the “Goldilocks Work” paradigm. In the second, Jackson, et al., provide important new evidence regarding the effects of implementing job rotation in a field setting.

‘Goldilocks’ work: Finding the right balance for safety and health

Traditional occupational safety and health approaches have aimed to reduce injury through reducing exposures to work elements to zero. This is appropriate for work elements that are always harmful, such as carcinogens and sexual harassment. However, for many work elements where both too little and too much can be harmful, a new approach was needed. Sitting, mental workload and social interactions are examples of work elements where a “just right” amount of exposure would enhance worker safety and health.

To support better work design, Leon Straker from Australia, Andreas Holtermann from Denmark and Svend Erik Mathiassen from Sweden developed the Goldilocks Work paradigm. In their paper, “The Goldilocks Work Paradigm: Conception, Experience, Refinement, and Future,” they describe how the paradigm has developed during seven years of activities across multiple industry sectors.

The refined aims of Goldilocks Work are fourfold. First, design jobs to have a “just right” combination of physical, mental and social work elements, rather than aiming for zero exposures. Second, have an explicitly positive impact on health, rather than mainly focusing on reducing risk by removing negative impacts. Third, create work systems

that lead workers into “just right” behaviors, rather than relying mainly on individual motivation and resources. Fourth, design productive work to contribute to socially and economically sustainable production, rather than taking time away from production.

The Goldilocks Work paradigm provides a new way of thinking about the design of work, and the consequences this can have on the sustainability of both health and production. In doing so, it is positioned to advance its goal of addressing critical social challenges such as socioeconomic inequities, occupational health burden and the impacts of multimorbidity and an aging population on productivity.

This positive view of work supported by Goldilocks Work has been enthusiastically greeted by practitioners in ergonomics and human factors, managers, supervisors and workers.

CONTACT: Leon Straker, Curtin University, Australia

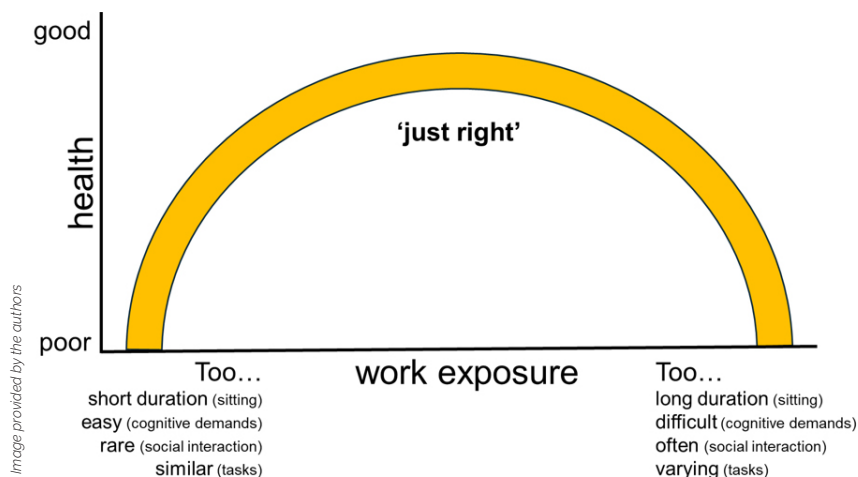


Svend Erik Mathiassen

Job rotation for increased variability and better health: Evidence from a Swedish laundromat

Job rotation is a common organizational approach for injury prevention and health promotion. It is expected to improve health by redistributing sufficiently diverse tasks across workers to increase exposure variability within workers. However, scientific evidence for job rotation effectiveness is limited, largely due to poor consideration of variability within workers, insufficient task diversity and/or incomplete implementation in prior studies.

Occupational Health Science researchers Jennie Jackson, Leticia Januario and Svend Erik Mathiassen, all from the University of Gävle in Sweden, worked closely with management and workers (n=60; approximately 50% women and 50% foreign-born) at a laundromat to co-create a team-based job rotation that specifically addressed company challenges, including musculoskeletal disorder rates, production quality and gender and social inequality. The design was guided by the Goldilocks Work paradigm, which proposes that work can be organized so



An international team of researchers developed the Goldilocks Work paradigm to support design of work elements where too little or too much resulted in poor productivity, safety and health outcomes.



Jennie Jackson

physical, mental and social exposures move towards a "just right" structure for promoting health, organizational performance and sustainability. Aims of the rotation were to increase within-worker exposure variability, improve equality in on-the-job training access and ultimately improve worker health, production quality (through a better understanding of production processes) and gender and social equality.

The researchers assessed conditions prior to company-led implementation of the job rotation and again after 12 months of implementation, as detailed in their recent paper, "Effects of a Job Rotation Intervention on Muscle Activity Variability and Health: A Case Study in a Swedish Commercial Laundromat."

While the company aimed to include all production workers, it only succeeded for teams performing tasks with shorter learning curves (less than one month), representing 65% of the workforce. Job rotation teams assigned tasks requiring longer learning curves were not yet able to perform all tasks. Rotating workers showed an average increase in muscle variability of 27% across the four recording sites (19% in both forearms; 30-41% in the trapezius muscles). Further, over 45% of workers reported decreased work demands, fatigue and need for recovery at follow-up compared to baseline.

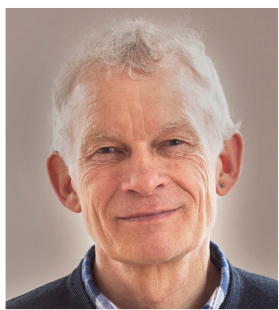
The study provides important new evidence for a team-based job rotation as an effective approach for increasing exposure variability within workers and improving health-related outcomes.

CONTACT: Jennie Jackson; Jennie.Jackson@hig.se; Department of Occupational Health, Psychology and Sports Sciences, University of Gävle

Judy Jin, a Fellow of IISE, is the Director of Manufacturing Program of Integrative Systems and Design Division and a professor in the Department of Industrial and Operations



Leticia Januario



Svend Erik Mathiassen

Engineering at the University of Michigan. She is editor-in-chief of IISE Transactions, (link.iise.org/iisettransactions) IISE's flagship research journal published monthly.

Maury Nussbaum, a Fellow of IISE, is HG Prillaman professor at Virginia Tech in the Department of Industrial and Systems Engineering and former editor-in-chief of IISE Transactions on Occupational Ergonomics and Human Factors (link.iise.org/iisettransactions_ergonomics). Ranjana Mehta is a professor and director of the NeuroErgonomics Lab in the Department of Industrial & Systems Engineering at the University of Wisconsin-Madison and current editor-in-chief of the quarterly journal. It is devoted to compiling and disseminating knowledge on occupational ergonomics and human factors theory, technology, application and practice across diverse areas.

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