Executive Summary, Seminar Nr. 05281
Simulation & Scheduling: Companions or Competitors for Improving the Performance of Manufacturing Systems
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1   Motivation

Scheduling is a critical need for manufacturing and service systems, and it is not exaggeration to say that effective and timely scheduling can be the difference between success and failure in an era when customers demand rapid response, product customization and low prices. As a result, there has been an explosion of Deterministic Scheduling papers over the decade with a strong group of researchers from Computer Science, Operational Research, and Industrial Engineering departments.

Discrete Event Simulation (DES) has become a widely used technique to predict and ultimately improve the performance of manufacturing and service systems. In particular, DES is often used in capacity planning, to evaluate order release policies, and to evaluate dispatching policies. However, deterministic scheduling approaches are not often evaluated in this way. There is a well established research community focused on DES issues in Manufacturing and Services, mainly from Computer Science and Industrial Engineering departments. Further, advances in simulation design and analysis methodology is making optimization of DES models feasible.

While both of these research communities are working to improve manufacturing and service system performance, the two groups rarely work together. Our goal was to bring these two communities together to see if synergistic results from interactions between them can be identified. In particular we set out to investigate issues common to both communities such as:

- Should these techniques be used in combination? There is a clear indication that using simulation to evaluate scheduling approaches in a dynamic factory environment can be very fruitful. In the project "Scheduling of Wafer

Fabrication Facilities", which was funded by the Semiconductor Research Corporation and International Sematech, a scheduling prototype based on the Shifting Bottleneck Heuristic was developed. There, the majority of the performance testing of this scheduling approach was done by simulation because it was important to see how well the scheduler behaves in an almost realistic environment.

– If the techniques are used in combination, what is the right way to combine these techniques to obtain an optimal result with respect to factory performance, i.e., improved cycle times and on-time delivery? Due to the fact that little research is done in this area of combining scheduling and simulation there are a lot of open issues, including how to provide both simulator and scheduler with a consistent model of the system on which they are working. It is unclear whether both approaches need the same system model or if different levels of abstraction are useful.

– Is there more than simply validating scheduling approaches by simulation? For instance, can simulation be used to schedule as well as to evaluate scheduling algorithms? Or can simulation be used to determine appropriate planning horizons for scheduling algorithms in the presence of uncertainty? Or could simulation be used to evaluate schedule robustness to uncertainty? Runtimes for computer simulations are becoming smaller as computers get faster. Thus, it becomes possible to use simulation not only for validating schedules but also for decision making inside a scheduling method. This is quite different from using simulation or sampling to optimize a deterministic scheduling problem (as occurs in Genetic Algorithms, for instance). Rather, simulation of the schedule is a component of the search for a good schedule.

– Why has there been so little interaction between the scheduling and simulation groups? What are impediments to more interactions? We see a lot of potential in this interaction, in particular, when practitioners from industry and simulation software developers join the group. The practitioners bring up-to-date problems, while the software developers provide the conduit for technology transfer from research to practice.

The desired outcomes of the conference were:

– Ideas for collaborative research
– Plans to organize sessions at future open conferences
– Special issue(s) of journal(s) based on the conference
– Decision on whether or not to apply for future Dagstuhl Seminar

2   The Seminar

A total of 25 researchers from academia and industry attended the seminar, 32% which were young researchers under the age of 35. Of the participants, 14 were affiliated with institutions from EU member states, 8 from the US, 2 from Singapore, and 1 from Israel. Of the EU participants, 12 were from Germany, 1

from the UK, and 1 from Poland. Five of the participants were from industry and the rest from academia (see Appendix).

Given that there were only 25 attendees, it was planned for every participant to give a talk. The seminar was divided into five main sections: 1) keynote overview talks, 2) detailed individual talks, 3) breakout sessions , 4) report out from breakout groups, and 5) wrap-up and discussion of next steps. Each of these will be discussed below.

2.1   Keynote Overview Talks

After brief introductory remarks by Oliver Rose and introductions by all participants, John Fowler gave a talk that provided a framework for seminar discussions on the relationship between deterministic scheduling and simulation. Five basic elements were discussed: a) simulation-based schedule generation and refinement, b) emulation of deterministic scheduling via simulation, c) evaluation of deterministic scheduling via simulation, d) deterministic problem instance generation through simulation methods, and e) simulation for support of scheduling.

Next, two overview talks were given to provide basic knowledge of simulation to the deterministic scheduling participants and to provide basic knowledge of deterministic scheduling to the simulation participants. Barry Nelson gave the simulation talk and John Fowler (substituting for Mike Pinedo who could not attend at the last minute) gave the deterministic scheduling presentation. These talks filled Monday morning.

2.2   Detailed Individual Talks

Monday afternoon and all day Tuesday were devoted to individual talks by the participants. The talks were almost evenly divided between talks on deterministic scheduling, talks on simulation, and talks that discussed aspects of both. Please see the seminar web page for abstracts and PowerPoint slides.

2.3   Breakout Sessions

Late Tuesday, the participants decided that there should be four breakout groups. A list of eight possible breakout themes was developed and then reduced down to four. The breakout groups were formed around the following themes:

- Simulation-Based Scheduling
- Emulation of Scheduling via Simulation
- Evaluation of Scheduling via Simulation
- Infrastructure for the Support of Simulation.

The breakout groups were given the following charge:

- Identify issues relevant to topic
- Determine key issues to address

- Develop a list of future needs
- Generate ideas for future collaboration

The groups spent Wednesday and Thursday mornings meeting among themselves.

2.4   Reports from Breakout Groups

On Thursday afternoon, the groups reported on their activities. The PowerPoint presentations are all posted on the seminar web page. All of the groups did a good job of meeting the charge they were given. Each group decided that they would develop a journal article around their topic.

2.5   Wrap-up and Next Steps

Friday morning was devoted to discussing next steps from the seminar. The group decided that the following next steps were appropriate:

- Organize sessions for the Simulation-Based Scheduling track of the Winter Simulation Conference
- Organize sessions at the next MISTA conference
- Continue to look for other opportunities for organizing sessions at major simulation, deterministic scheduling, computer science, and operational research conferences
- A Special Issue of Journal of Scheduling devoted to the seminar
- A Special Issue of Simulation: Transactions of the SCS devoted to the seminar
- A proposal for another Dagstuhl Seminar on this topic in 2007

Efforts are currently underway on all of these recommendations.

3   Participants

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