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Research Summary and New Opportunities on Modeling of Healthcare and Advanced Manufacturing Systems

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Abstract:

We have worked on a variety of research projects with many health systems, in particular, Department of Veterans Affairs, on improving the efficiency of healthcare delivery by applying IE/OR principles and tools. Research results in some selected areas are discussed. (1) For clinic scheduling, innovative scheduling models and solution approaches are proposed by considering patient choice, open access, double-booking, and walk-in patients. Optimization models are also developed for operating room scheduling by considering emergency patient admission. (2) For hospital telephone operations, the approach of limited resource sharing in a highly decentralized system is proposed to optimize the system efficiency, and it is evaluated by discrete event simulation. (3) For co-managing dual care patients between community and VA providers, we propose proactive mechanisms for VA to share dual care patient information with the community providers, and evaluate the effectiveness of the mechanisms.

While we will continue the applied research on healthcare delivery problems, the new opportunities of healthcare research are envisioned, which will drive us to aggressively pursue funding and build visibility. The elaborated discussion focuses on (1) the cross-platform, security, privacy issues of touch screen mobile technology in healthcare, (2) the clinic process re-design due to the nationwide implementation of Patient Centered Medical Home initiative, and (3) big data and data mining research on the growing massive information collected from hospital/clinic operations to support evidence based health care.

Meanwhile, we have accumulated extensive experience in advanced manufacturing research. Two selected areas will be discussed. One is the research on surface integrity of hard machining, a process that greatly reduces the manufacturing steps and improves the product quality and life. Our pioneering work on predicting the surface thermal damage in finish hard machining will be discussed. We have also developed a novel two-step process to improve the surface integrity and thus improve part service life by up to 200%. The other is our research on nano-manufacturing. Important discoveries include (1) for the first time, machining of polycrystalline materials can be analyzed by molecular dynamics simulation, and the inverse Hall-Petch relationship is found to play a significant major role, and (2) the friction behavior on tool-chip interface in nano-manufacturing processes is revealed, which suggests a revisit of friction models developed in conventional manufacturing processes.

There exist great opportunities for additive manufacturing research. We plan to build a research thrust on selective laser sintering to produce metal and ceramic components that have comparable performances as the machined components. We also plan to investigate the post-processing (e.g., machining) issues of selective laser sintered components. Nano-composite materials should also be involved. Moreover, the blending of IE/OR tools in additive manufacturing is critical to the functional design and quality insurance in fabricating products such as porous tissue scaffolds. The entire department is well positioned to grow in this area.

Bio: Dr. Jing Shi received his first Ph.D. in Materials Engineering from University of Science and Technology Beijing in 1998, and another Ph.D. in Industrial Engineering from Purdue University in 2004. He is currently an Associate Professor in the Department of Industrial & Manufacturing Engineering at North Dakota State University (NDSU). His research interests include modeling of healthcare delivery and energy systems, as well as advanced manufacturing. His research has been supported by federal funding agencies and industry for more than 1.6M USD. He has authored and co-authored more than 110 refereed papers in technical journals and conference proceedings. Dr. Shi is a recipient of Alpha Pi Mu teaching award, NDSU CoE research award, NDSU Green and Golden Diversity Award, an organizer of multiple international conferences, and an editorial board member for several international journals.

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