Contributions to Manufacturing Systems

In manufacturing systems, Prof. Hu pioneered the work in designing innovative system configurations for quality, productivity and responsiveness [1, 2, 3]. He successfully led a group of researchers at the Engineering Research Center for Reconfigurable Manufacturing Systems at the University of Michigan (https://erc.engin.umich.edu/) to develop the fundamental science and methodologies for designing and improving the performance of manufacturing systems. These fundamental sciences are then implemented in a set of highly efficient mathematical methods and algorithms to analyze configurations quickly and accurately. A software package, PAMS – Performance Analysis of Manufacturing Systems, was successfully developed for designing system configurations, evaluating system throughput, and identifying bottlenecks for improvement. PAMS also contains optimization routines to calculate the sizes of buffers and optimally place them in manufacturing systems. These models and algorithms have been applied to machining systems and automotive body assembly systems at GM, Ford, Chrysler and other companies, and are helping them improve their overall system performance at both the design and operations phases.

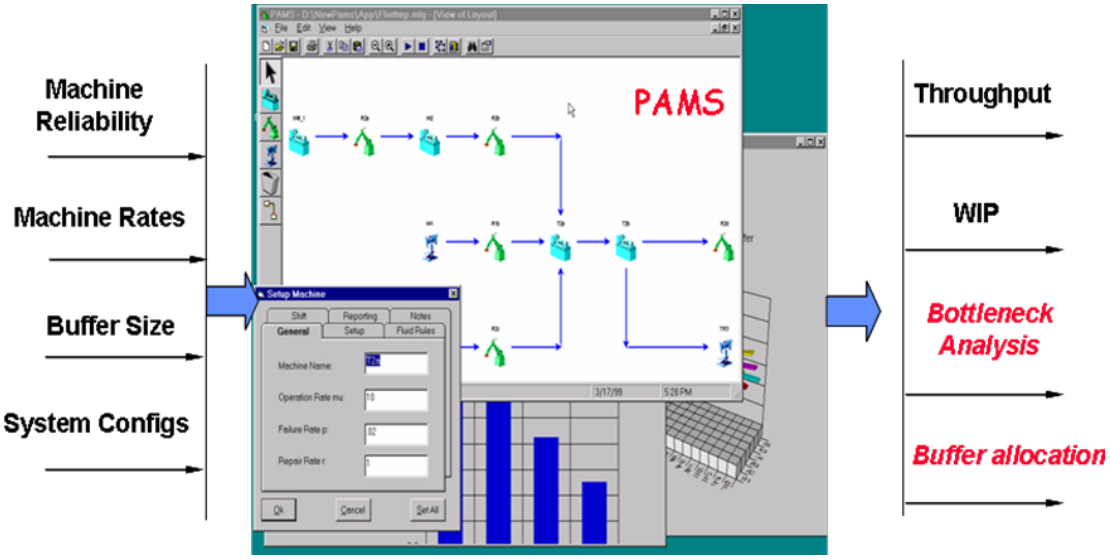

Figure 4. A software system for analyzing manufacturing system configuration for productivity.

From 2011- through 2019, Prof. Hu and his students have been developing automotive lithium-ion battery manufacturing [4]. Lithium batteries are a critical enabling technology for electric and plug-in electric vehicles which have received great attention from industry and governments as we try to reduce the dependence on fossil fuels. A battery "Assembly System Configurator" has been developed for battery assembly system design. Given battery cell configurations (size, weight and shape, e.g., cylindrical vs. prismatic), pack requirements (volume, power requirements, etc) and aided by a pre-designed assembly machine database, the Configurator generates the assembly system layouts and assigns assembly tasks to the stations. It also selects

the assembly machines for the stations by minimizing total investment cost. The Configurator has been validated and has been used by engineers at General Motors to generate assembly system concepts for various battery pack designs.

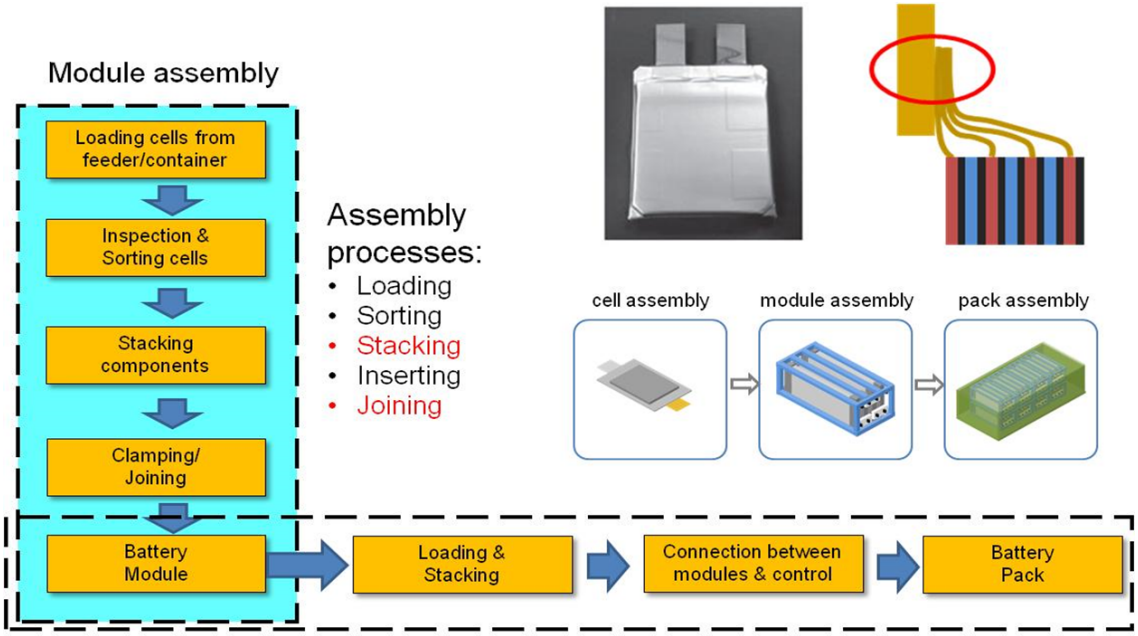

Figure 5. A lithium-ion battery assembly system configurator

Selected Publications

1. Y Koren, SJ Hu, TW Weber, (1998), "Impact of manufacturing system configuration on performance", *CIRP Annals-Manufacturing Technology* 47 (1), 369-372.

2. Maier-Speredelozzi, S.J. Hu, (2002), "Selecting manufacturing system configurations based on performance using AHP", *Transactions of NAMRI/SME*.

3. R.F. Webbink, S.J. Hu, (2005), "Automated generation of assembly system-design solutions", *IEEE Transactions on Automation Science and Engineering*, Vol. 2, No. 1, 32-39.

4. S Li, H Wang, **SJ Hu**, YT Lin, JA Abell, (2011), "Automatic generation of assembly system configuration with equipment selection for automotive battery manufacturing", *Journal of Manufacturing Systems* 30 (4), 188-195.