



Engineering & management solutions at work

SUSTAINABLY DRIVEN SUPPLY CHAINS

Taking big green steps
toward reducing your
logistics costs

August 2011

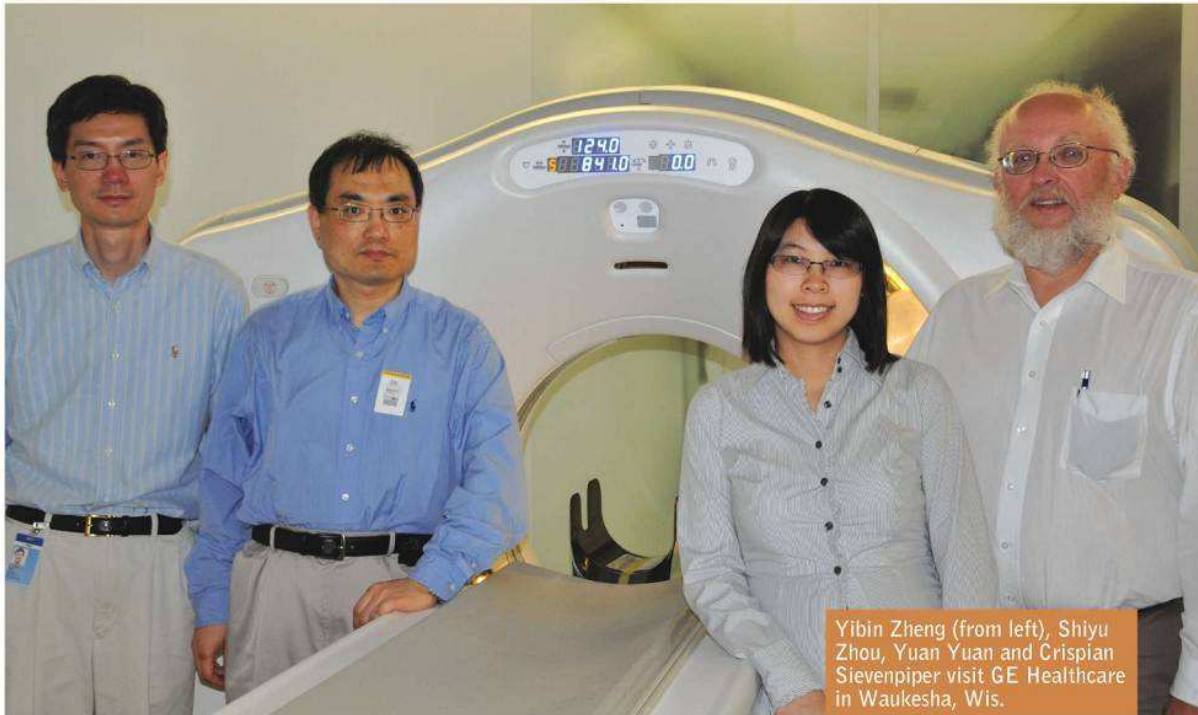
VOLUME 43 : NUMBER 8 : \$11.00

IN THIS ISSUE

Time studies bring speedier results
Aligning personnel and company goals
The right lean for the right job
Stick with Six Sigma in new economy

Research

EXECUTIVE SUMMARIES : EDITED BY SUSAN ALBIN



Yibin Zheng (from left), Shiyu Zhou, Yuan Yuan and Crispian Sievenpiper visit GE Healthcare in Waukesha, Wis.

This month our research highlights focus on industrial engineers who work to improve the reliability of systems — in both the small scale and the large scale. The first paper uses process information to predict the failure occurrences of medical equipment, like a CT scanner. The second paper discusses metrics for estimating reliability of extremely large networks, such as the Internet. These articles will appear in the September issue of IIE Transactions (Volume 43, No. 9).

Modeling and predicting medical equipment failures

When your computer crashes, it may just be an inconvenience. When medical diagnostic imaging equipment, such as a computed tomography (CT) machine, fails, it's an expensive debacle. The leading providers of medical equipment, such as General Electric Healthcare, have been well aware of this and have strived

to minimize unexpected equipment failures through sophisticated after-sales maintenance and service operations. A critical component of an effective after-sales service operation is to predict correctly the impending occurrence of the failure with statistical confidence. Unfortunately, predicting such failures in medical diagnostic equipment is currently a complex, imprecise process.

In "Event Log Modeling and Analysis for System Failure Prediction," doctoral student Yuan Yuan and professor Shiyu Zhou from the University of Wisconsin-Madison and Crispian Sievenpiper, Kamal Mannar and Yibin Zheng from the Global Service Technology group of GE Healthcare developed an effective way to use data from the GE Healthcare automated information system to predict failure occurrences.

The data, called "system event logs,"

include various machine activities and behaviors, critical system failures, operator/user actions, task status, etc. Although the data contain rich information about the equipment condition, the overabundance of data makes it difficult to determine critical events that actually indicate machine problems. Engineers must study the entire event sequence — a time-consuming and unreliable exercise.

In order to establish a more practical method, the research team applied data mining techniques and a statistical model typically used in biomedical studies to determine which treatment options have the best patient survival rates. By treating the machines like human patients, with system failure equating death, the team described the relationship between machine activities and failure events and used them to predict failures. In their article, numerous

technical issues from variable selection and model fitting to model-based failure prediction are discussed in detail. The developed technology thus enables GE Healthcare to identify opportunities to fix a medical device before it breaks.

CONTACT: Shiyu Zhou;
szhou@engr.wisc.edu; (608) 262-9534;
Department of Industrial and Systems
Engineering, University of Wisconsin-
Madison, Madison, WI 53706-1572

Network reliability metrics for modern systems

The last decade has seen an immense increase in the size of systems that support our way of life. Consider, for example, the Internet, the power grid and interconnected critical infrastructures and social networks. These systems can contain millions of interacting elements. From our perspective, these systems have a common network structure consisting of nodes and links to provide a benefit to society, such as enabling communication, delivering a service or supporting social interaction.

In "A New Holistic Method for Reliability Performance Assessment and Critical Components Detection in Complex Networks," doctoral student Chi Zhang and professor Jose Emmanuel Ramirez-Marquez from Stevens Institute of Technology point out that when considering the reliability of these large-scale networks, traditional metrics likely will fail to provide relevant information at the network level. For example, two-terminal, k-terminal and all terminal reliability metrics are not adequate to provide a description of reliability in these types of networks. Due to the size of the networks, tech-



niques such as minimal cut/path set identification, reliability simulation and component importance ranking may prove difficult to implement.

So how can reliability engineers help in answering questions such as: What are the most critical contributors to a social network? How do failures in the transportation network affect the flow of exports and imports through our nation's ports? The reliability techniques presented in the article are a starting point for answering such questions. The article provides an approximation approach for the reliability of a complex network and uses multiobjective optimization to identify sets of components that can cause the highest damage to network behavior. These new techniques can be used as a guide to prioritize component/design improvements or to build protection in the most vulnerable parts of the network.

CONTACT: Chi Zhang;
czhang5@stevens.edu;
Jose Emmanuel Ramirez-Marquez;
jmarquez@stevens.edu; (201) 216-8003;
System Development & Maturity Lab,
School of Systems & Enterprises,

Chi Zhang (left) and professor Jose Emmanuel Ramirez-Marquez worked on reliability techniques for complex networks.

Stevens Institute of Technology,
Castle Point on Hudson,
Hoboken, NJ 07030

Susan Albin is a professor at Rutgers University in the department of industrial and systems engineering. She is editor-in-chief of IIE Transactions and a fellow of IIE.

ABOUT IIE TRANSACTIONS

IIE Transactions is IIE's flagship research journal and is published monthly. It aims to foster exchange among researchers and practitioners in the industrial engineering community by publishing papers that are grounded in science and mathematics and motivated by engineering applications.

To subscribe, call (800) 494-0460 or (770) 449-0460.