The **newsletter** of the Massachusetts Institute of Technology
System Design and Management program

vol. 8, no. 1 spring 2013

sdm pulse

MITsdm

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- Women in SDM (WiSDM) Video
- SDM Alumnus Yoav Shapira and Happier.com
- Visit sdm.mit.edu

System Architectures for NASCAR Chassis Setup and Development

By Scott Ahlman, SDM '01

Problem statement: The complex system encompassing a high-performance race car, its driver, and the track involves thousands of parameters and variables that affect a car's performance, drivability, balance, and tire life. To complicate matters, conditions are constantly changing, and data acquisition is limited during races. Choosing the right metrics at the right time is critical because vehicle dynamics models and analyses rarely output holistically accurate values for speed, balance, and drivability. Success on the track depends on weighing these variables and, for example, making split-second rate recommendations for springs, damping front and rear roll, as well as suspension alignment, kinematics, and tire pressure.

Photo: Orlando Echeverria

Goal: To determine when to use which metrics and which models, so that variables can be weighed effectively and appropriate choices made.

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http://

Watch for the red dot indicating expanded stories online

sdm.mit.edu

Welcome

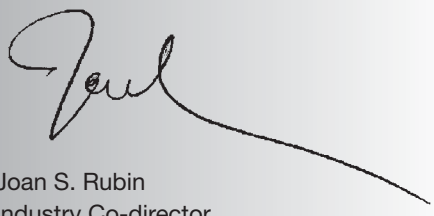
This edition of the SDM Pulse clearly demonstrates the increasing use of systems thinking to a wide range of complex problems—as well as the increasing diversity of employers that are coming to MIT's System Design and Management (SDM) program to learn about the methodologies and the SDM fellows who can apply them.

In this issue you will find articles on:

- applying systems thinking and systems architecture to Ford's NASCAR entry;
- the U.S. Military's use of systems thinking for network analysis of terrorist organizations;
- an SDM fellow's one-year internship at Intel, in which she helped to research best practices in global business ecosystems, identify internal areas of strength to build upon, and suggest new methodologies to introduce within the company;
- SDM's newest cohort of fellows;
- the employment report for SDM fellows in the classes of 2011–2012;
- SDM Tech Treks to Silicon Valley; and
- SDM's upcoming systems thinking conference, webinars, and events.

We invite you to read, to learn, and to join us by participating in SDM internships, tech treks, events, and more!

Sincerely,



Joan S. Rubin
Industry Co-director
MIT System Design and Management program
jsrubin@mit.edu

Preview

sdm conference

2013 MIT SDM Conference
The Massachusetts Institute of Technology's annual Conference on Systems Thinking for Contemporary Challenges, sponsored by the System Design and Management program, will focus on addressing complexity and innovation in industry. The aim of the conference is to provide practical information from multiple disciplines that will spark ideas for how to implement systems thinking and innovation to address complex challenges, whether in industry, academia, government, or the world at large.

When:
October 10, 2013

Where:
MIT campus

Details available in early summer at sdm.mit.edu

For information on conference sponsorship, contact
SDM Industry Co-director
Joan S. Rubin, jsrubin@mit.edu or 617.253.2081

Related Events:
October 10, 2013
SDM information session, open to all interested in learning more about SDM's flexible masters program, which leads to an M.S. in engineering and management. Information and registration at sdm.mit.edu

October 9, 2013
SDM-only alumni reception

SDM Internship at Intel: Operating Successfully within a Global Business Ecosystem

The business challenge: The old approach to product development, where one company manages everything, including requirements, design, development, marketing, and sales, no longer works in today's global business environment—especially in high-tech fields like mobile devices.

The goal: Identify and understand how successful business ecosystems are created and how they affect design and implementation of an organization's product strategy, then use this information to develop future competencies needed by Intel's product development teams.

MIT resources: Intel contacted Prof. Steven Eppinger, SDM co-director, to find a graduate student/intern with significant industry and research experience in technology, business, and systems thinking. Rutu Manchiganti, SDM '11, former software engineer for Motorola mobile devices, was selected.

The approach: Manchiganti conducted a one-year research project at Intel where her responsibilities included the following:

- literature review
- corporate benchmarking
- internal capability assessment
- research at the intersection of products, technology, users, markets, and business fundamentals
- interviews with 25 senior managers in Intel and managers at AT&T, Cisco, GE Energy, Motorola, SAP, Siemens Corporate Research, and others
- information analysis, informed by her studies in disruptive innovation and systems dynamics to analyze how business ecosystems involve multiple, interacting components that evolve over time

The findings: Companies create only a piece of the solution themselves and engage other companies or even consumers to build the rest. "This is what is meant by operating in a business ecosystem," said Manchiganti.

To control market position, companies must design and orchestrate entire business ecosystems if they want to control their market position. "If it happens organically, a company could risk not moving fast enough or even going in the wrong direction," said Manchiganti. "As importantly, it risks simply reacting to, instead of proactively driving, the ecosystem's direction."

The deliverables: Based on her research, Manchiganti provided a literature review of the primary books and articles on the subject of business ecosystems, produced a report defining the current challenges Intel faces with respect to ecosystems, wrote a series of Intel case studies based upon product group experiences in developing ecosystems, and created a final best-practices report and presentation. All deliverables will be used to inform the Intel product development community and serve to establish a foundation for future business ecosystem capability development.

The value of an SDM intern: "The work that Rutu helped complete has already benefitted Intel in a number of ways: we understand the business ecosystems challenges we are facing, we have found and documented internal areas of strength to build upon, and we have discovered new practices to introduce to Intel," said Intel's Chris Galluzzo

If your company is interested in sponsoring an SDM internship, contact SDM Industry Co-director Joan S. Rubin, jsrubin@mit.edu, 617.253.2081.

Investigating the Efficacy of Terror Network Visualizations

By Christopher W. Berardi, SDM '11

An urgent challenge: Military intelligence analysts are increasingly tasked to sift through enormous volumes of data to identify the proverbial intelligence "needle in a haystack." One specific domain exemplifying this new intelligence paradigm is network analysis of terrorist organizations. This area of intelligence analysis uses mostly commercially available software applications to leverage the powers of social network theory against large terrorism data sets.

An additional challenge is the fast paced development cycle for new sensors that are capable of collecting data at unmanageable rates. Therefore, analysts are in dire need of new analytical techniques that give them the ability to effectively and efficiently transform the collected data into intelligible information and subsequently, intelligence.

Background: Intelligence is only of value when it is available and contributes to, or shapes, a decision-making process by, "providing reasoned insight into future conditions or situations" (Joint Chiefs of Staff, 2012). However, this does not hold true for raw data. Therefore, the burden is on the intelligence analyst to transform raw data into intelligence. This transformative process begins with the collection of data from sensors.

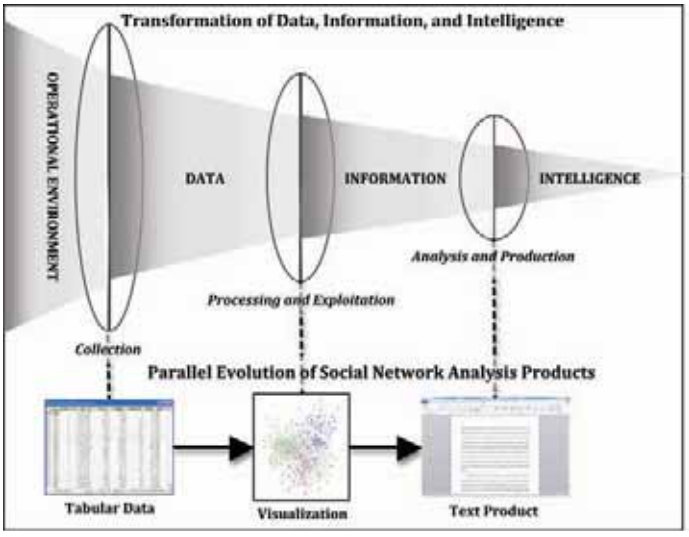


Figure 1 - Parallel evolution of social network analysis products

The first step is to process the raw data into a form intelligible by an analyst. Depending on the type of raw data, this step is either automated as in the production of an image from a camera, or requires an analyst, in limited cases, to transform the raw data into information such as language translation. In the context of social network analysis, this stage typically involves transforming the tabular raw data into a visualization, or series of visualizations. This specific transformative process (data → information) is also known within the intelligence community as processing and exploitation[1].

During the processing and exploitation phase, as shown in Figure 1, an analyst most commonly transforms the data into a node-link visualization. However, little to no emphasis is given to creating alternating modes of visualization that could result in a more effective transformation of data to information. Furthermore, there is little existing research into the effectiveness of one form of visualization over another in the domain of intelligence.

About the Author

Christopher W. Berardi is an active duty officer in the U.S. Air Force. He currently works as a program manager for multi-million dollar intelligence, surveillance, and reconnaissance weapon systems. Berardi holds an MIT M.S. in engineering and management, earned through SDM in 2013 and a B.S. from the United States Air Force Academy.

> For Bibliography, please visit:
>
> sdm.mit.edu

http://

[1] Defined as, the process by which raw data is transformed into information that can be readily disseminated, used, and transmitted by an analyst.

[2] Assessment is defined as, a prediction of the future state of an organization, individual, or adversary.

After data is transformed into information, the subsequent information can be integrated and analyzed to produce intelligence. Once information is evaluated, it is ready for analysis. During analysis, assessments[2] are made by comparing already integrated and evaluated information; these assessments are combined and used to discern patterns or links. Finally, the analysis and production process concludes with interpretation, which is a largely inductive reasoning process in which available information is evaluated.

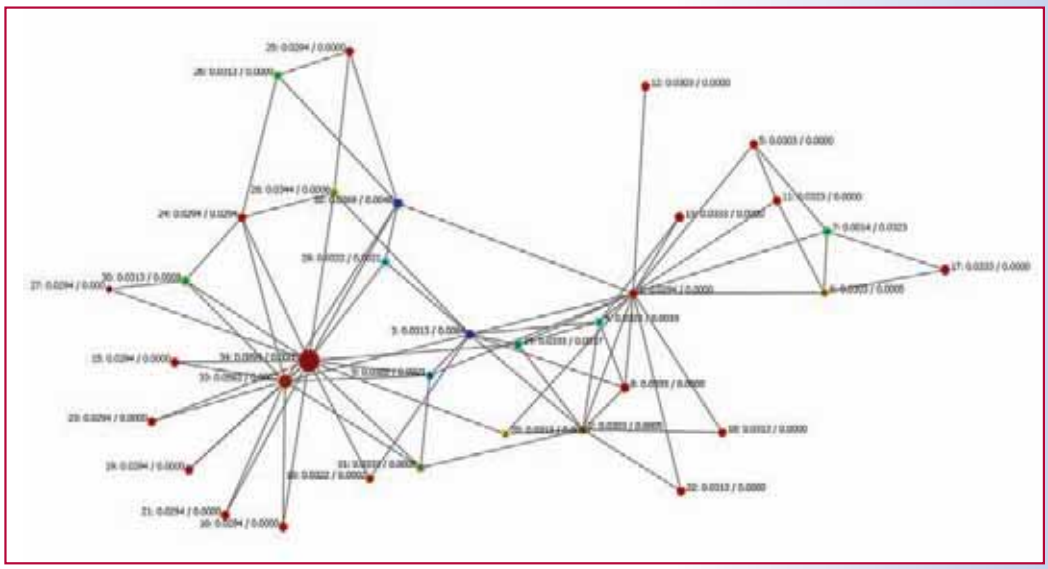


Figure 2 - Node-link visualization

From this sequence of integration, evaluation, analysis, and interpretation, intelligence is finally produced. Although, this is a generic process which applies to all forms of intelligence, within the context of social network analysis, analysis would be conducted by evaluating multiple visualizations of social networks and interpreting the information resident in each of those visualizations to create a prediction about the terror network, or networks, being analyzed (see Figure 1).

Research goal: Investigate various visualization methodologies for terror network analysis.

Research scope: Comparison of two visualization methods:

- Node-link visualization (Figure 2) serves as control, as it is the most ubiquitous method of terror network visualization used within the intelligence domain today (Freeman, 2000; Wasserman & Faust, 1994).
- Matrix network visualization (Figure 3), a promising method of social network visualization studied commonly within the academic community (Ghoniem, Fekete, & Castagliola, 2004; Henry & Fekete, 2006).

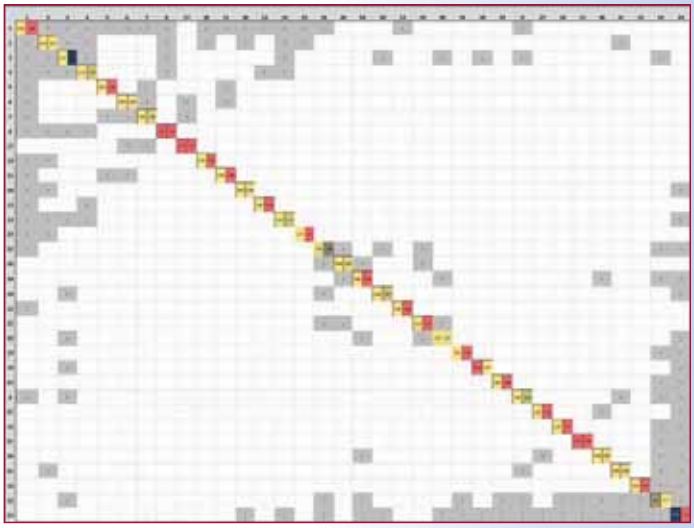


Figure 3 - Matrix network visualization

The experiment: To test the visualizations' effectiveness, an experiment was conducted in which participants exploited matrix and node-link visualizations constructed from a surrogate terror data set (Zachary, 1977).

The 60 participants were all Air Force airmen who hold the Air Force specialty code of intelligence analyst. Each participant was given one of the forms of visualization and asked to accomplish two tasks:

1) Identify leaders within the network, and
2) Identify clusters or subgroups within the network.

These two tasks were chosen because of their reoccurring importance highlighted in both a literature review and a hybrid cognitive task analysis conducted prior to undergoing this research.

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Solution: Ahlman's team used Design of Experiments, many-parameter and variable optimization, and basic systems engineering tools like chunking, aggregation, and hierarchy. The team also used standard goals definition and requirements cascades that show functional requirements cascade down a system hierarchy from system through subsystems to components.

Lessons: A systems perspective is important for recognizing non-technical and non-strategic influences like human behavior, assigning these influences more credence, and coping with or even shaping, the influences.

Clear goals + specific system, subsystem, and component requirements = successful design journey and clear destination.

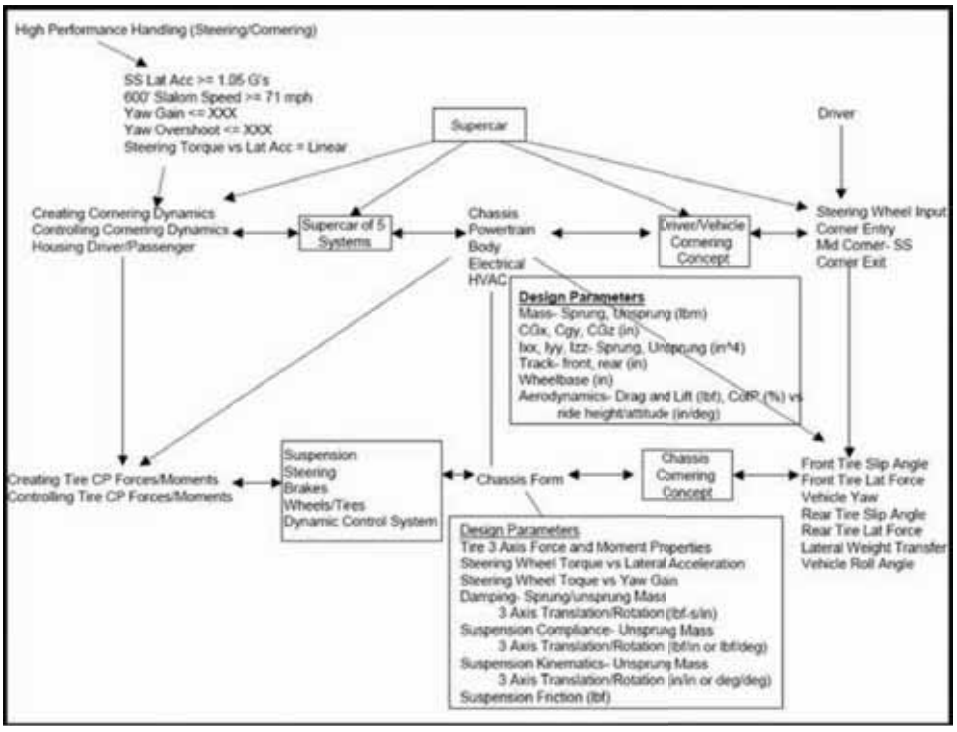


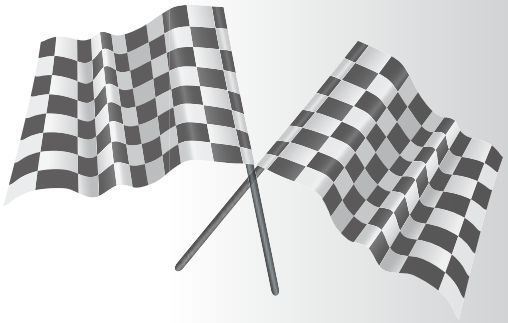
Figure 1: This concept map of high-performance passenger car handling shows some of the many parameters and subsystems chassis engineers work with.

Photo: Orlando Echeverria

About the Author

Scott Ahlman, SDM '01, has almost 20 years of experience in automotive product development, performance engineering, and systems engineering. As principal of Ahlman Engineering, he led the Roush-Fenway Racing NASCAR Sprint Cup chassis/vehicle dynamics and systems engineering/optimization through an independent contract with Ford Racing.

Factor Level Setting			Valid Range	
Factor Name	Option 1	Option2	Min	Max
Static Tire Load 1	50	50	50	53
Static Tire Load 2	50	53	50	53
Spring Rate 1	500	450	400	600
Spring Rate 2	500	500	400	600
Spring Rate 3	400	500	400	1000
Spring Rate 4	875	900	600	1000
Distance 1	2	2	1.875	2.125
Distance 1	1.75	1.75	1.625	1.875
Spring Rate 5	75	75	50	100
Geometry 1	10	9	7	10
Geometry 2	8	11	7.5	11
Alignment 1	1	1	0	1



Metrics	Option1	Option2	Opt Score	Wgt Factor	Cost	
Speed 1 Entry	156.18	156.84	1.59	1.00	1.59	Entry
Balance1 Entry	-166.33	-163.03	-7.48	0.50	-3.74	
Balance Consistency1 Entry	-35.18	-25.44	-104.34	0.00	0.00	
Ride Height 1 Entry	0.59	0.48	-69.73	1.00	-69.73	
Ride Height 2 Entry	0.37	0.27	-103.34	1.00	-103.34	
Ride Height 3 Entry	6.86	6.83	-1.80	0.00	0.00	
Attitude 1 Entry	0.22	0.20	-34.08	0.00	0.00	
Aero 1 Entry	30.04	28.57	-18.34	1.00	-18.34	
Dynamic Load 1 Entry	5.86	7.03	75.14	0.00	0.00	
Aero 2 Entry	1325.43	1358.75	9.47	0.00	0.00	
Dynamic Alignment 1 Entry	2.57	2.40	-24.06	0.00	0.00	
Dynamic Alignment 2 Entry	-4.94	-5.06	8.72	0.00	0.00	

Figure 2: This chart shows part of an optimization sheet. It helps engineers to focus on the right things in the right order and to complete difficult optimization of many parameters and variables at once, as a system.

For additional information, visit:

http://sdm.mit.edu/news/news_articles/ahlman-nascar-chassis/ahlman-nascar-chassis.html

http://sdm.mit.edu/news/news_articles/webinar_012813/ahlman-supercar.html

http://

Photo: Orlando Echeverria

Snapshot: SDM Class of 2013

On January 7, SDM welcomed 62 early-to-mid career professionals to its 2013 cohort. As in past years, fellows hail from diverse industries, among them wind energy, the military, automotive, mobile apps, healthcare, fashion, consulting, oil, telecommunications, global shipping, software product accessibility, finance, banking, water and wastewater treatment, forestry, gaming, and wine.

Brian Hendrix

Global lead product development engineer, Ford Motor Company

"At high levels of leadership, systems thinking becomes even more critical due to the complex, open-ended problems you encounter."

Marianna Novellino

Environmental engineer and former product manager, Parkson Corporation

"I want to be one of the new, emerging leaders who understands how technical and management issues affect each other, and consequently the business."

Shingo Kawai, Ph.D.

Senior research engineer, Nippon Telegraph and Telephone

"Research needs to guide the company in the right direction, so even technical managers must be trained in strategy and management"

Chris Babcock

Product manager, Second Wind

"We must develop a more intelligent energy system, and that's what I'm interested in building."

Demographics:

- 49 men
- 13 women

Sponsorship:

- 23 company-sponsored
- 39 self-funded

Program option:

- 28 full-time on-campus students
- 19 local commuter students
- 15 distance students

Citizenship:

Brazil, Canada, Chile, China, France, India, Iran, Japan, Malaysia, Mexico, Nigeria, Singapore, Spain, Thailand, Turkey, United Kingdom, United States, Venezuela

Average previous work experience:

9 years

2013

Suzanne Livingston

Senior product manager, IBM Connections

"Some of our most innovative solutions emerged from business challenges that can be solved with technology, and technology decisions that are influenced by business. My work revolves around connecting both."

Bryan Pirtle

Senior engineer, E&J Gallo Winery

As a distance student, "I will not only learn state-of-the-art systems-thinking theories while working at Gallo, but will also have a chance to apply my newly found knowledge on-the-job."

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Employment Report: SDM Classes of 2011–2012

Each year SDM produces an employment report that focuses on self-funded students. It is designed to provide an overview of the most recent SDM graduating class and the world-class corporations that hired them. As in past years, employers recognize and value the prior work experience of SDM fellows (8-10 years upon entering the program) and SDM's academic rigor. Further, the diversity of thought among SDM fellows equips them to communicate and lead across organizations and to solve complex problems throughout both business and technical domains. Consequently, SDM fellows continue to be hired into technical and managerial leadership positions across a wide range of industries.

Highlights of the 2011-2012 SDM Employment Report include:

- 100% of SDM graduates responding to the 2012 survey are employed.
- 87% accepted offers before graduation; 13% accepted offers within two months after graduation.
- Top job functions include consulting/strategy, product development/management, and engineering followed by project management, IT/software, and operations/logistics.
- Among the employers were returning companies Boston Consulting Group, Deloitte Consulting, A.T Kearney, Verizon, Ericsson, Amazon, Samsung, and several businesses new to SDM such as OATI, Mozilla, Citrix and Telenav.

For details on salaries, bonuses, and more, visit sdm.mit.edu/2011-2012employmentreport.

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Investigating the Efficacy of Terror Network Visualizations

Discussion:

- The node-link visualization resulted in statistically significantly better performance in all studied scenarios where the objective was identifying leaders.
- Although node-link also returned a better performance than the matrix for identifying clusters, there was not a statistically significant difference.
- In all cases, there was not enough difference between the times produced by the node-link and matrix to determine if either offers a statistically significant decrease in the time it takes to complete tasks using either visualization.

Conclusion:

At this time, the matrix should not be universally integrated into the current methodologies used by analysts to exploit terror network visualizations until more research is conducted into the respective strengths and weaknesses within the intelligence domain.

However, analysts should be independently encouraged to explore and adapt new methods of visualization into their current practices and identify new or improved versions of the visualizations identified within this thesis for future testing.

For **Bibliography**, please see sdm.mit.edu

SDM Fellow Elizabeth Cilley Southerlan Receives Award for Leadership, Innovation, Systems Thinking

Elizabeth Cilley Southerlan

On March 14, 2013, the SDM community convened for the presentation of the 2012 MIT SDM Award for Leadership, Innovation, and Systems Thinking.

The award, created by the SDM staff in 2010, honors a first year SDM student who demonstrates the highest level of:

- strategic, sustainable contributions to fellow SDM students and the broader SDM and MIT communities;
- superior skills in leadership, innovation, and systems thinking; and
- effective collaboration with SDM staff, fellow students, and alums.

It also includes a monetary award as well.

All nominees and the winner are selected by the SDM staff. In addition to Southerlan, this year's nominees included Juan Esteban Montero and Alvaro Madero.

Southerlan was acknowledged for numerous contributions to her cohort, the SDM program, and the MIT community at-large. Among them were:

- serving as logistics director for the MIT Career Fair, where she helped increase SDM's visibility in industry by positioning SDM students as front-runners for moderators of company and industry information panels;
- working as an executive board member of Women in SDM (WiSDM), and collaborating closely with colleagues to put together the WiSDM symposium portion of the annual SDM conference;
- organizing, as SDM social chair, several sponsored events for students only and with their families; and
- working with SDM's Marketing and Alumni Relations Coordinator Melissa Parrillo and Industry Co-director Joan Rubin to understand the program's target demographics, gauge SDM's presence by industry and geography, and confer on next steps.

Alvaro Madero

Juan Esteban Montero

Nominee Alvaro Madero was specifically cited for, among other contributions, co-chairing the 2013 SDM Tech Trek and serving as the SDM Industrial Relations Committee's media chair.

Nominee Juan Esteban Montero was recognized for founding the MIT Mining, Oil, and Gas Club which, in under one year, has over 150 members from the MIT student and faculty communities, as well as from industry and academic communities worldwide.

spring 2013 sdmcalendar

sdmpulse

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MIT's SDM program is jointly offered by the MIT Sloan School of Management and the MIT School of Engineering. SDM resides within the MIT Engineering Systems Division.

For further information on MIT's System Design and Management program, visit **sdm.mit.edu.**

MIT SDM Systems Thinking Webinar Series

This series features research conducted by members of the SDM community.

All webinars are held on **Mondays**, from **noon to 1 pm**, and are free and open to all. Details and registration are at sdm.mit.edu.

April 8

Understanding and Designing Complex Sociotechnical Systems
Joseph Sussman, JR East Professor of Civil and Environmental Engineering and Engineering Systems

April 22

Flexibility in Engineering
Richard de Neufville, professor of engineering systems and civil and environmental engineering, MIT

May 6

System Design and the Cost of Architectural Complexity
Dan Sturtevant, Ph.D. and SDM alumnus

May 20

Software Systems Architecture in the World of Cloud Computing
Christine Miyachi, principal systems engineer and architect, Xerox Corporation, SDM alumnus

June 3

Trust Frameworks and Asymptotic Identity Proofing: A Systems Approach
David Hartzband, lecturer, MIT Engineering Systems Division

Event information includes all details available at press time. For more current event information, go to sdm.mit.edu and esd.mit.edu.

2013 SDM Tech Trek

Each year, MIT fellows, faculty, and staff visit best in class companies to discuss global business challenges and to learn directly from their executives how they address them. This year's trek visited Cisco, Amazon, Twitter, E. & J. Gallo, Google, Mission Motors, and Intuitive Surgical. In 2012, they visited Tesla, Yammer, Cisco, First Solar, TIBCO, Google, Silver Springs Networks, and Intel. If your company would like to participate in the 2014 SDM Tech Trek, contact Joan S. Rubin, SDM industry co-director, jsrubin@mit.edu.

AVAILABLE on demand

Pre-recorded **webinars**
sdm.mit.edu/voices/webinars.html

Videos: 2012 MIT SDM Conference on Systems Thinking for Contemporary Challenges http://sdm.mit.edu/voices/videos.html

Also available are videos on SDM's:

Master's program http://sdm.mit.edu/admission/masters/video.html

Certificate program http://sdm.mit.edu/admission/certificate/video.html

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