Options and Option Products

Black-Scholes Call Option Pricing Formula

\[ F(S,t;E,\sigma,\Gamma,T) = SE^{-r(T-t)} \Phi(x_1) - E\Phi(x_2) \]

where:

- \( \Phi(x) \) is the cumulative normal probability density function.
- \( x_1 = \frac{\log(S/E) + (r + \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}} \)
- \( x_2 = x_1 - \frac{\sigma}{\sqrt{T-t}} \)

The Birth of Modern Finance
This spring, MIT Sloan celebrates the centennial of the founding of Course XV. In recognition of this exciting time, we are featuring special anecdotes and images from the School’s history—including a sample of the top innovations from MIT Sloan—throughout the magazine as we celebrate our past, discuss the present, and look toward the future.

For more information on the 100-year anniversary, including centennial events around the globe that culminate in a special Colloquium at MIT Sloan on June 7, 2014, visit http://mitsloan.mit.edu/100years.
New Courses: Expanding the Curriculum

MIT Sloan students are gaining insights and perspectives on global management strategy and practice through a variety of new courses. Here, we highlight just a few of the offerings in the areas of operations, big data, finance, and entrepreneurship.

Sink or SWIM: The Case Study

For the three student co-presidents of Sloan Women in Management (SWIM), the annual conference was to be the realization of months of hard work and planning. But when Mother Nature stepped in and forced its cancellation, they were provided with an opportunity to write a case study on their experience and discovered valuable insights in the process.

Faculty Share Excerpts from Their Recent Research

Excerpt:

Opening Up the Innovation Process
Yasheng Huang: A Key to Bringing Capitalism to China
Bill Aulet, SM ’94: Disciplined Entrepreneurship

The Birth of Modern Finance

As part of MIT Sloan’s celebration of the 100th anniversary of the founding of Course XV, we have published a commemorative book that examines and celebrates the lasting contributions of our community. Here, we reprint an excerpt from that book, highlighting the significant work of the MIT Sloan Finance Group.

Message to Our Alumni
Letter from the Dean
The Takeaways
Perspectives on Innovation and Invention

DEAR ALUMNI AND FRIENDS,

What an exciting year we are having here at the MIT Sloan School of Management. This fall, we hosted 11 Course XV Centennial events in cities around the world. These events were a tremendous opportunity to not only share in the history of MIT Sloan, but also hear inspiring stories from our alumni about their time spent at the School and since graduation. If you haven’t had the chance to attend one of these events—please join us in Seattle, San Francisco, Los Angeles, Chicago, or Houston, or at the Course XV Centennial Colloquium on campus on June 7, 2014.

This Colloquium will focus on the same themes that we showcase in this issue of MIT Sloan Alumni Magazine—the research, innovation, and brilliant activity going on every day in the hallways, classrooms, and offices of MIT Sloan. As you know best, our faculty members address the cutting-edge global challenges that impact our economies and our societies. We relate a few examples of the faculty research happening at the School in “Innovation at Work.” At the same time, they push our students to challenge themselves, to innovate during their time at MIT Sloan, and to explore their individual interests, a theme we explore in “Sink or SWIM: The Case Study.”

In addition to the work going on at the School today, we continue to celebrate the contributions of our faculty and students over the past 100 years. The feature article in this issue, “The Birth of Modern Finance,” gives you a sneak-peek at the commemorative book that we are publishing about the School’s first 100 years. It includes highlights from the chapter on finance, economics, and accounting at MIT Sloan, and provides information on ordering your own copy of the book.

As we compile the content for MIT Sloan, we are always inspired by the work of the School and the vitality of our community. We hope that you will enjoy this issue as much as we have enjoyed creating it.

Best regards,

Cathy & Kristin

Catherine Canney
Associate Dean, Dean’s Initiatives and Brand Strategy

Kristin LeClair
Director, Donor Relations and Communications
Dear Alumni and Friends of MIT Sloan,

On April 9, 2014, Course XV will celebrate its centennial anniversary. Last fall, alumni, students, faculty, and staff came together in cities around the world to honor this milestone. It has been humbling and inspiring to hear your stories—stories about what the School has done for you, what you have done for the School, and how our community has come together to improve the world. While we are diverse in backgrounds and perspectives, within our community there is a similarity of intention and spirit. It is what moved each of us to choose MIT Sloan. It is a shared principle that, I believe, began with the words of the Institute's founder, William Barton Rogers.

Course XV was part of William Barton Rogers' original intent for MIT. In the spring of 1861, the legislature of the Commonwealth of Massachusetts approved the charter for the Massachusetts Institute of Technology, which Rogers had authored and submitted. It read:

... a body corporate by the name of the Massachusetts Institute of Technology, for the purpose of instituting ... a school of industrial science, and aiding generally, by suitable means, the advancement, development, and practical application of science in connection with arts, agriculture, manufactures, and commerce ...

Unlike many other management schools, MIT Sloan was not developed through outside influence, but rather was mandated by our Institute's founder. He knew that to be successful a school of industrial science must forge strong and productive relationships with industry, commerce, and the world. Rogers' innovative ambition— to combine a rigorous education with practical application to industry—led to the establishment of Course XV in 1914. Today, we remain driven by these ideals and committed to bringing the world's greatest inventions, created here at MIT, to the global marketplace.

We are MIT's school of management, a role and responsibility we take seriously. As you read this month's feature, the historic anecdotes throughout the magazine, and the pieces that talk about current activity at MIT Sloan, you will see the ways in which MIT Sloan has stayed close to its roots while innovating and inventing for the future.

With deep respect and admiration for the vision of our predecessors and the promise of our future,

David Schmittlein
John C Head III Dean
A Lens on the Classroom

Each year, MIT Sloan seeks to expand its curricular offerings to students through the creation of innovative new courses—and sometimes the re-creation of courses that were offered years ago. These courses span disciplines and programs, providing our students with new insights and perspectives on global management theory and practice. Highlighted here are just a sampling of the School’s latest offerings.

15.071x EdX: Analytics Edge
Faculty: Dimitris Bertsimas, Allison O’Hair, PhD ’13

“Providing students from around the world with exposure to the quickly growing area of analytics is incredibly exciting. The virtual classroom conversations and work I anticipate in this course will, I imagine, change my own perspectives on classroom teaching.” – Dimitris Bertsimas

From the Bulletin: In the last decade, the amount of data available to organizations has reached unprecedented levels. Companies and individuals who can use this data together with analytics give themselves an edge over the competition. In this class, we examine real-world examples of how analytics have been used to transform a business or industry. These examples include Moneyball, eHarmony, the 2012 Presidential Election, the Framingham Heart Study, Twitter, IBM Watson, and American Airlines. Through these examples and many more, we cover the following analytics methods: linear regression, logistic regression, trees, text analytics, clustering, visualization, and optimization.

CURRICULUM
Analytics Edge teaches students how to affect their lives and work using the power of analytics. In a world that has an increasing amount of data, this class teaches students how to use it most effectively. It’s a class that’s pioneering in scope—not only in terms of subject matter, but also in terms of how many people can participate. Why can it reach such a large audience and what makes it an exceptional MIT Sloan experience? This is the inaugural course that the School will offer through EdX, a nonprofit founded by MIT and Harvard that brings the best of higher education to students around the world.

THE STUDENT EXPERIENCE
Analytics and big data are areas of increasing importance to management. IBM has spent $24 billion in analytics, and many other major global companies are also investing heavily in this area. As data availability explodes across sectors, corporations are looking at how this new information drives business decision making. By exposing students from around the world, and from a wide variety of industry sectors, to Analytics and the edge it creates, the School anticipates that these students will see how the course impacts their careers and perhaps lead some of them to create new analytics-driven businesses. Finally, and unlike many other classes, Analytics Edge will start with a real-world application and will use real-world data to build models that lead to improved, impactful decision-making in organizations.

RESEARCH DRIVERS
Professor Dimitris Bertsimas, who designed this course together with Allison O’Hair, PhD ’13, explains how his research plays a role in the class: “We developed analytics-based methods for personalized diabetes management, for designing clinical trials, for asset management and personal finance, and for designing health benefits for companies, among others.” Because this course will cover all these topics and more, students will gain cross-industry perspectives that will enhance conversation in the virtual classroom.

Dimitris Bertsimas is the Boeing Leaders for Global Operations Professor of Management, Professor of Operations Research, and Co-Director of the Operations Research Center.
Allison O’Hair, PhD ’13 is Lecturer of Operations Research and Statistics.
15.395 Global Entrepreneurship 1: 
Entrepreneurship Without Borders
Faculty: Simon Johnson

“MIT Sloan has a very internationally oriented student body. This course is a great avenue to explore the many perspectives and experiences that our students bring with them to the School. And we see great interest, from both students and partner organizations, continuing to strengthen our interactions. Students create solutions, and this course gives them the theory and knowledge in the classroom that make those solutions a productive reality.” – Simon Johnson

From the Bulletin: Examines opportunities and problems for entrepreneurs outside the United States, including in Europe, Latin America, and Asia. Covers the linkages among the business environment, the institutional framework, and new venture creation. Students apply the analytics of finance for startups in emerging markets. In addition to discussing a range of global entrepreneurial situations, student groups pick one particular cluster on which to focus and to understand what further development would entail. Classroom interactions are based primarily on case studies.

Curriculum
Entrepreneurship without Borders is having a rebirth. In the late 1990s, the School realized the importance of having a course that looked at global entrepreneurship. That course, focused on theory and discussion, became Global Entrepreneurship Lab, now the School’s largest Action Learning course with approximately 150 students participating each year. When Professor Simon Johnson proposed reintroducing 15.395 as Global Entrepreneurship I, he had several goals in mind. First, he wanted to bring back the case-based discussions from the original course; and second, he wanted students who were unable to participate in the project portion of G-Lab (now known as G-Lab II) to have exposure to the theories and practice of entrepreneurship on a global level. Finally, he saw this course as a necessary (and required) prerequisite for those students participating in the project-based G-Lab II course.

The Student Experience
This course offers an elevated level of classroom discussion and case-based work for all students. Further, it opens up global entrepreneurship to those students who might otherwise not have an opportunity to learn about the topic. For some in MIT Sloan’s programs, an on-site Action Learning experience in another country during January is not feasible—and that’s where Entrepreneurship without Borders comes in. It brings together students who will (and will not) participate in Action Learning projects and exposes them to the same intellectual underpinnings—the course allows every student at MIT Sloan to be a global learner and to share their perspectives, even if they are unable to travel during their time at the School.

Research Drivers
Professor Johnson’s research looks at global economic and entrepreneurship issues from a macro (country) and micro (individual entrepreneur) level. This course takes that knowledge and brings it into the classroom, helping students understand entrepreneurial systems from top-down and bottom-up perspectives. And as much as it is derived from Johnson’s research, the course also comes from entrepreneurs themselves. For example, students have the opportunity to invite entrepreneurs in their own networks to come and talk to the class about their experiences in multiple regions and economies around the world.

Professor Johnson's research looks at global economic and entrepreneurship issues from a macro (country) and micro (individual entrepreneur) level.

Simon Johnson is the Ronald A. Kurtz (1959) Professor of Entrepreneurship and Professor of Global Economics and Management.
“Whether students are pursuing career opportunities in financial services or any other industry, this course will help them better understand the interconnectedness and dynamics of the entire business ecosystem.” – Andrew Lo

From the Bulletin: This course develops a new perspective on the dynamics of financial markets and the roles that human behavior and the business environment play in determining the evolution of behavior and institutions. Although neoclassical economic theories such as expected utility maximization, rational expectations, general equilibrium, and efficient markets have dominated the literature on economic behavior and market structure, recent advances in the cognitive neurosciences, artificial intelligence, computational social science, and evolutionary biology provide a number of new insights into market dynamics. We will draw on these diverse disciplines to develop a more complete understanding of human behavior in the specific context of markets and other economic institutions. Recent academic research will be the main focus of the course, but topics will be motivated and illustrated by practical applications from financial markets, the hedge fund industry, private equity, government regulation, and political economy. Using the ideas from this new perspective, we will formulate several new hypotheses regarding recent challenges to traditional economic thinking, including: how financial crises are formed and whether or not they can ever be eliminated; why certain investment strategies seem to wax and wane; where business cycles come from; what role ethics plays in financial intermediation; whether capitalism is more sustainable than other political systems; and why financial engineering may be the solution to some of society’s biggest challenges.

Curriculum
A number of exceptions to standard financial theories have emerged over the last couple of decades, the financial crisis being the most prominent, but not the only, example. To understand the nature and origin of these exceptions, Professor Andrew Lo recognized the need to extend and, in some cases, overturn the theories that the School traditionally taught with more sophisticated alternatives. This new framework allows students to examine departures from rationality and efficiency in a systematic way, resolving theoretical contradictions as well as providing a number of concrete implications for business practice.

Research Drivers
The MIT Sloan Finance Group has had a long and illustrious tradition of bringing research into the classroom—in many cases before research is published. The best of this tradition dates back to 1970 when the Black-Scholes-Merton options pricing was first taught to Sloan Master’s students three years before these ideas were published in academic journals in 1973. In this class, Lo is able to bring his research front and center in every lecture. “It’s a real privilege and treat for me to be able to offer a course like this because I can teach what I do in my research, not just in one or two lectures, but throughout the entire semester,” Lo observes. “It’s also one of the biggest thrills for an academic—to have a classroom full of the brightest students in the world, all looking to put these ideas to work when they graduate.”

Andrew Lo is the Charles E. and Susan T. Harris Professor, Professor of Finance, and Director of the Laboratory for Financial Engineering.
15.784 Operations Laboratory  
Faculty: Donald Rosenfield, Zeynep Ton

“Our research agendas have led us to look at companies in certain ways. For example, I do a lot of work on globalization, global strategy, and supply chain management. I think my past work has influenced how I have my current students approach these problems.” – Donald Rosenfield

From the Bulletin: This course provides a hands-on educational and Action Learning experience in implementing operations improvement. Teams, consisting of 3–5 students, act as consultants on operations engagements in small-to-medium-sized Boston-area organizations. Class time focuses on helping the students with their projects and exposing them to methods and techniques that are commonly used in operations improvement. Organizations include small manufacturing companies, service organizations such as hospitals, and nonprofits. These types of environments provide a wide range of real-world operational problems, as well as a hands-on environment.

Curriculum
For years, the School offered Leaders for Global Operations (LGO) and other master’s students a course on the practice of operations management. But last year, following requests from LGO students and others, this course became Operations Laboratory (Ops-Lab). With 27 students in the course’s inaugural session, faculty members Don Rosenfield and Zeynep Ton reached out to organizations in greater New England to identify project matches with an operational focus.

Research Drivers
While Professor Rosenfield has a long history of research in manufacturing, Professor Ton has done more work in the service sector. This division in research interests has been key to the successful partnerships with external organizations. Both faculty members attest to the fact that their research not only influences how their students approach and problem-solve the challenges they encounter, but also empowers their partnering organizations to build a competitive advantage in their industry.

The Student Experience
Operations Laboratory joins a suite of Action Learning courses at MIT Sloan that get students out into the field and give them the opportunity to take theory learned in the classroom and put it into practice. What makes Ops-Lab different? It’s local. Partner organizations that are within driving (or train) distance allow Ops-Lab students to be on-site as often as once per week. This course was consciously designed to give them deep experience, frequent contact, and an opportunity to be involved in a series of operational challenges during the course of the class. By working with small organizations on a wide range of challenges, the students gain a deep understanding of the role that operations plays in the successful management of organizations. Further, the faculty of Ops-Lab provides student teams with one-on-one consultation and support.

Building the Case for Course XV: The Subjects
After its establishment at the turn of the twentieth century, MIT’s Economics Department took off in popularity among students. When a faculty subcommittee met to draft the rationale for Course XV, they proposed courses in several subjects, including political economy and economic problems; financial history; accounts; securities and investments; domestic exchange; manufacturing accounts; taxation; foreign exchange; railroad finance and accounts; note brokerage; and stock, produce, and oil exchanges.

Donald Rosenfield is Senior Lecturer in Operations Management and the Director of the Leaders for Global Operations Program. Zeynep Ton is Adjunct Associate Professor of Operations Management.
Sink or SWIM: The Case Study

Sloan Women in Management (SWIM), a student-run club, works to increase opportunities for all women at MIT Sloan through networking events, speaker series, professional development workshops, mentorship programs, and community-building events. Each year, members of SWIM participate in the planning and execution of a student-run conference, a unique opportunity for the group to host thinkers from a variety of industries and to engage in a dialogue with leading women in business.
In the 2012–13 academic year, three members of SWIM—Lauren Ankeles, MBA ’13, conference chief finance officer; Marine Graham, MBA ’13, conference chief operations officer; and Priyanka Ramamurthy, MBA ’13, conference chief marketing officer—acted as the co-presidents, and were well on their way to planning a conference that would meet, and exceed, the expectations set by their predecessors. Through months of planning, they were tantalizingly close to realizing their vision—only to be thwarted by one of the biggest blizzards in recent memory in Cambridge.

After they made the decision to cancel the night before the conference, Paul Buckley, associate director of Student Life, approached them with an idea—write a case study about their experience. The group jumped at the chance. For Ankeles, it was an opportunity to take a negative and turn it into a positive learning experience. “We had put a lot of effort into an event, and we weren’t able to see the results of that work,” she said. “Working on the case showed us that we still learned a lot from the experience.” For Ramamurthy, the process of planning and then cancelling the conference was a real-world application of all the things they had learned in the MBA program. “In the moment, we didn’t fully appreciate the different areas we were pulling from, but writing the case was a great opportunity for us to step back and evaluate our experience,” she said.

But beyond the learning experience, the group recognized a need for a case study that spoke to the experience of MBA students. Writing the case was a chance to highlight students in decision-making roles, to share stories of female leaders, and to explore the impact of student extracurricular activities. Ramamurthy noted that, “Many of the cases used in business school are from a C-level perspective. Our case was a chance for students to more easily put themselves in the shoes of the protagonists and think through what decisions they would have made.”

Armed with senior lecturer Roberta Pittore as their advisor, the group set out to write the case, compiling timelines of every event they could remember leading up to their decision, and structuring the case in such a way that their decision to cancel wasn’t obvious from the start. The process was challenging at first, forcing the group to turn a critical eye on their experience through the process of gathering the facts and fleshing out the case. Once the bulk of the case formation work was done, they began looking for classes that would be a good fit to present the case, and found a home in senior lecturer Pat Bentley’s course, “Practical Leadership.” The class content—decision making, leadership, constituencies, and peers—was the perfect fit; and with a small number of students, the authors were able to get more feedback from all the participants.

Through class discussions, the group gained a tremendous amount of support and feedback from their peers—and that feedback, in turn, provided perhaps the greatest benefit—a chance to further refine their case. For Graham, teaching the case “helped us to really work through the decision-making process for key points that we had thought were obvious.”

The conference-planning experience, coupled with the opportunity to write a case, was a critical learning experience for all three co-presidents. “It is one thing to learn about the frameworks to make decisions during a crisis, to motivate a team, to sell a product or service, but it’s another thing to actually do it and learn from your mistakes in real time,” said Ramamurthy, a sentiment echoed by Ankeles. “SWIM was the single most impactful part of our experience at MIT Sloan,” she noted. “To be in a situation outside of the classroom where you have to develop your leadership style, to motivate, to take into account individual motivations and rewards supplemented what I learned in the classroom and was critical to my education at MIT Sloan.”

“SWIM was the single most impactful part of our experience at MIT Sloan.”

Priyanka Ramamurthy, MBA ’13
On Thursday, February 7, 2013, after 11 months of planning, the Sloan Women in Management (SWIM) club’s three co-presidents and two conference directors faced a difficult decision. The club’s third annual conference, aptly named “Dare to Fail: Taking Risks When It Matters Most,” was scheduled to begin around the time a winter storm, fortified with up to 50 inches of snow, was predicted to hit the Boston area.

The impending storm was an ironic twist for the conference leadership team that had overcome a number of challenges during the months leading up to the start of the conference. When they began planning the event in March of 2012, the club’s co-presidents took on the roles of chief financial officer, chief operating officer, and chief marketing officer, and the two directors were responsible for speaker recruitment. In addition to navigating tense team dynamics over who had final authority in the decision-making process, the team faced many planning setbacks. Finding available speakers proved difficult and took many months. With an uncertain speaker line-up, marketing the conference was tricky and ticket sales lagged. The team experienced a host of last-minute logistical snags, including the cancellation of one of the conference’s two keynote speakers just one month before the conference was to begin. These challenges were set against a backdrop of high expectations. The club’s 2011 conference, by all measures, had been a roaring success with a sold-out crowd of 400.

Despite the numerous hurdles, with four days to spare, all the pieces of the conference-planning puzzle had come together. The “Dare to Fail” planners had succeeded in selling 500 tickets (100 more than in 2011), had hit their fundraising goal, and had confirmed all 15 speakers. But then came the predictions that a snowstorm of historical proportions was heading toward Boston. At 2:00 p.m. the day before the conference was to begin, with vendors on their way to begin setting up the venue, the leadership team needed to decide whether the conference would go on as planned, be modified, or be canceled altogether. The MIT administration had not yet closed the Institute, and would not comment on whether or not they would. MIT rarely closed its doors; but if it did, no events would be allowed on campus, including the conference.

The decision facing the conference leadership team was not an obvious one. The impending weather was not a certainty. New England weather
forecasts were wrong as often as they were right. While some speakers and attendees were already on their way to Boston, many attendees were asking whether the conference would be rescheduled. The conference leadership team began weighing the potential ramifications of their final decision. They wondered what would happen if the conference was not canceled and MIT ended up closing later in the day. What if the conference was canceled, MIT did not close, and the storm was not the showstopper it was predicted to be? What would be the potential fallout with attendees and corporate sponsors? Would SWIM’s reputation be impacted? If the team opted to cancel the conference, would they be expected to give back ticket revenue? And, if so, how would that affect the bottom line?

While they muddled over their options, the planning team couldn’t help but be reminded that the conference revolved around the theme of coming to the brink of failure and still finding a way to succeed. ● ● ●

To read more, and to download the full case, please visit https://mitsloan.mit.edu/LearningEdge/Leadership/sinkorswim/Pages/default.aspx

Fishbanks

Sustainability pioneer and MIT Sloan faculty member Dennis Meadows developed a board game in 2001 that used wooden chips to represent fishing fleets. The goal was to challenge players to build a profitable commercial fishing business without depleting fish stocks, all while in direct competition with other fleets. Ten years later, in 2011, Professor John Sterman developed an interactive, scalable web-based version available on LearningEdge.

Fishbanks and other board games like the Beer Game—developed in the late 1950s by Professor Jay Forrester, SM ’45, to focus on the illuminating aspects of system dynamics—give MIT Sloan students the ability to explore and participate in the critical management issues facing a range of industries and organizations in a virtual world. The lessons learned in these simulations provide students with tangible experiences that they can apply to their own careers and businesses.

Since its inclusion on LearningEdge, Fishbanks has proved to be one of the most popular management flight simulations available. That popularity has led to the translation of the game into both Portuguese and Spanish through the support of Gustavo Pierini, SM ’87, with the goal of a Chinese translation in the near future.
The Takeaways: MIT Sloan Faculty Members Offer Their Perspectives

Our faculty members generate distinctive and celebrated research that analyzes today’s business challenges and develops transformative solutions and insights. Collected here are perspectives from faculty members pulled from various media sources.

To learn more, check out:
MIT Sloan Experts Blog
http://mitsloanexperts.mit.edu/

Finance Matters:
The MIT Sloan Finance Group Blog
http://mitsloan.mit.edu/finance/blog/

MIT Sloan Newsroom
http://mitsloan.mit.edu/newsroom

MIT Sloan Executive Education Blog
http://executive.mit.edu/blog/

Andy Yap on how space can alter behavior...
“Our bodies are perpetually constrained by our physical spaces. When these spaces are large, we incidentally adopt expansive postures. Such postures—open, widespread limbs that fill the space up—often project high power. Contractive, closed postures—in which limbs are pulled in close to the torso and the body collapses inward to minimize space—tend to project low power. It’s not having something big that makes you feel more powerful; these spaces allow you to have an expansive posture, and that’s what makes you feel more powerful. And the feelings of power are what alter your behavior.”

“Big Chairs Create Big Cheats,” Harvard Business Review, November 1, 2013
Andy Yap is a lecturer.

Zeynep Ton on the good jobs strategy...
“These companies think about employees not as costs to minimize but as capable human beings with the potential to generate sales and profits.”

“Higher Wages Are Good For Companies Too,” The Nation, December 4, 2013
Zeynep Ton is Adjunct Associate Professor of Operations Management.
The Challenges of Using Social Media for Marketing Purposes
Catherine Tucker
The Chicago Tribune, December 13, 2013

In an era when marketers spend billions on managing social media, is that investment worthwhile? Should firms actively guide, promote, and shape online conversations, or leave them to grow organically?

To investigate this, my colleague Amalia Miller from the University of Virginia and I recently studied what happens when hospitals started to actively manage their profiles on Facebook. We focused on Facebook because it’s the most visited media site in the U.S., accounting for 20 percent of all time spent on the Internet. We also chose it because the Facebook Places initiative created a page for every single hospital in the U.S., allowing organizations to choose whether to actively manage their pages or not.

We selected hospitals for two reasons. First, they are so regulated that we have far better data on them than for most other organizations in the U.S. economy. Second, there have been a lot of questions about whether it is wise for healthcare organizations to step into social media, both from a patient privacy perspective and from a cost-benefit perspective.

We found that when hospitals started managing their Facebook pages, they began to receive a lot more likes, visits, and comments—from their employees, not their customers. Conversations involving patients actually decreased.

This may have been because the posts were not, on the whole, client-focused. They tended to highlight things of interest to employees, like recent organizational achievements and events. Client-focused posts only made up around one-fourth of all posts. However, in the rare instances when a hospital did focus on clients in posts, client engagement did increase.

So when you’re thinking of whether to manage your social media presence actively, think carefully about your goals. If you want to encourage internal dialogue with employees, motivate them, and improve communication flows, active management may be the way to go; but if so, human resources should be in charge of it, not marketing or sales.

Our findings apply to sectors where the product is not naturally a “social product,” meaning that—unlike movies or books—it isn’t naturally something people chatter about online. For more sensitive areas like healthcare, those conversations tend to be very fragile and consequently easy to suppress.

Catherine Tucker is the Mark Hyman, Jr. Career Development Professor and Associate Professor of Marketing.

Sinan Aral on social influence...

“People are more skeptical of negative social influence. They’re more likely to ‘correct’ a negative vote and give it a positive vote.” Aral warns, “These positive ratings also represent bias and inflation. The housing bubble was a spread of positivity, but when it burst, some people lost their savings. ... Stock bubbles represent a positive herding, and they can be dramatically bad in the wrong context.”

Sinan Aral is the David Austin Professor of Management and Associate Professor of Information Technology and Marketing.

Jared Curhan on bargaining a better deal...

“If you’re sweating, and your heart rate is up, it’s seen as a sign something is going wrong, that you’re too nervous, off-balance, flustered,” he said. “Whereas we’re showing that something could be very right.”

Jared Curhan is the Sloan Distinguished Associate Professor of Organization Studies.
The U.S. is unflinching in its optimism and ability to move forward after a crisis, such as the 2008 recession. And yet the drawback to this reflex is the ability to quickly forget what landed us in the situation to begin with. As our economy recovers, we potentially risk a growing complacency and inadequate financial oversight.

Just months ago, the country of Cyprus made global headlines as their banks’ ballooning assets grew far beyond what the country could support. Losing over 4.5 billion euros, the Cyprian banks tried to repair the damage by confiscating secure deposits, affecting the assets and the trust of investors throughout Europe and Russia and causing a ripple effect of investment withdrawals. The contagious effects of this crisis are a warning of how interconnected we are, and how one failed system could halt economic recovery elsewhere.

Contagion is Real

MIT Sloan professors and economic experts Kristin Forbes and Roberto Rigobon have proven in their collective work that learning how financial shock in one country permeates the economic stratosphere of another can ultimately teach global financial institutions to communicate and collaborate to prevent a future crisis.

“You cannot entirely prevent another crisis, but you can prevent a crisis from spiraling out of control by learning from our past failures,’’ says Forbes, “and by setting up a system to monitor economic stress while ensuring that countries are working together rather than defensively isolating.”

Kristin Forbes is the Jerome and Dorothy Lemelson Professor of Management and Professor of Global Economics and Management.

Roberto Rigobon is the Society of Sloan Fellows Professor of Management and Professor of Applied Economics.

Duncan Simester on addressing fake online reviews...

“One explanation for the data is that loyal customers may be acting as self-appointed brand managers. ... An alternative explanation is that the deceptive reviews are contributed by reviewers who seek to enhance their perceived social status.”

“Fake Online Reviews Face Court Cases and Big Fines,” The Japan Times (AFP), September 30, 2013

Duncan Simester is the Nanyang Technological University Professor of Marketing.

Paul Osterman on the engineering skills gap...

“[The skills gap] is nowhere near as universal or widespread as we keep hearing it is. But I don’t think the message of our work is that everything is fine.”


Paul Osterman is the Nanyang Technological University Professor of Human Resources and Management and the Co-Director of the MIT Sloan Institute for Work and Employment Research.
Does the return of manufacturing to the U.S. mean more jobs?
David Simchi-Levi
MIT Sloan Executive Education Blog, November 24, 2013

The return of manufacturing to the U.S., also referred to as the “repatriation” or “re-shoring” by American and non-American companies alike, on the surface sounds like good news for employment. However, this is not necessarily the case.

According to research by MIT Sloan Professor David Simchi-Levi, there are a few reasons.

1. The rise in the use of technology as well as plant automation and robotics in manufacturing facilities. More technology and robots means fewer human workers.

2. The types of jobs required for these new, more modern plants are different than jobs needed a generation or two ago. For example, the highly automated manufacturing facilities of today require different types of talent in their employment pool. Today’s plants need more engineers who can fix the robots and less lower-skilled employees who would otherwise do the work that is now automated.

3. In cases where manufacturing plants do require more employees, and hence could boost employment here in the U.S., many people coming out of school are simply not prepared to work in the field of manufacturing. Some might say manufacturing is not in our “mindset.” So, while some manufacturing companies are hiring, the employment pool does not meet the company’s needs—which means no lift in employment.

The bottom line is that the return of manufacturing jobs to the U.S. is still a positive development. Although employment might not rise drastically as a result of this shift, there will be a need for workers in these modern plants. And, American workers can once again look to the manufacturing industry for unique employment opportunities—a notion that a couple of decades ago didn’t seem possible.

Andrew Lo on financing cancer research...
“The funding in biomedicine is declining at the worst possible time, at the time that we are just at the point of making a significant set of transformative breakthroughs.” Lo says, “Instead of declaring war on cancer, what we really ought to be doing is putting a price tag on its head.”

“Can Financial Engineering Cure Cancer?”
Advisor Perspectives, October 29, 2013
Andrew Lo is the Charles E. and Susan T. Harris Professor, Professor of Finance, and Director of the Laboratory for Financial Engineering.

Matthew Marx on the next generation of entrepreneurs...
“If people hadn’t left Xerox and gone off and done their own things, we’d all be using dot-matrix printers today.”

“Cambridge Firm is Fertile Ground for Entrepreneurs,”
The Boston Globe, September 23, 2013
Matthew Marx is the Mitsui Career Development Professor and Assistant Professor of Technological Innovation, Entrepreneurship, and Strategic Management.
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Innovation at Work: Faculty Research at MIT Sloan

The faculty at MIT Sloan are committed to bringing the relevant, timely insights that are driving substantial change on a wide variety of complex issues. In the following pages, Sloan Management Review provides insights into the management revolution that tout outside influencers as the key impetus to change in leading a more effective business. Next, Yasheng Huang provides insight on why China, having recently completed a rare leadership transition, should take the opportunity to move to a democracy. And finally, Bill Aulet tackles the myth that entrepreneurship can’t be taught, and offers specific steps to creating a successful startup.
Opening Up the Innovation Process

MIT Sloan faculty and alumni offer insights into leveraging innovative ideas from outside the organization.

When executives think about leading their businesses more effectively, their first instinct often is to consider what to do within the organization itself: the people, systems, and resources within the company. Increasingly, however, savvy executives are thinking much more broadly about tapping into opportunities outside the limits of the organization, as well. In practice, this might mean collaborating with customers, Twitter followers—and even volunteers with no direct link to the business.

In many ways, the MIT Sloan School of Management is at the center of this open management revolution. The Fall 2013 issue of MIT Sloan Management Review, which contains several articles on innovation and whose authors include MIT Sloan alumni and faculty, underscores this role. Three articles featured in a special section titled, “Leveraging External Innovation,” examine how organizations can use open innovation to generate and select good ideas and how to collaborate with innovators who are not employees and may not be driven strictly by financial incentives.

“Companies are searching for better ways to identify and exploit novel solutions,” write Alan MacCormack, Fiona Murray, and Erika Wagner in their article, “Spurring Innovation Through Competitions.” (MacCormack earned an SM at MIT Sloan and now teaches at Harvard Business School; Murray is the associate dean for innovation, a professor of entrepreneurship, and faculty director of the Martin Trust Center for MIT Entrepreneurship at MIT Sloan; and Wagner is an MIT alumna and former executive director of the X PRIZE Lab®MIT.) According to the authors, companies are “increasingly ... discovering that many of the very best ideas lie outside their organizations, in an ecosystem of potential innovators who possess wide-ranging skills and knowledge. To discover and attract these contributors, organizations are launching competitions and offering prizes.”

Through competitions, MacCormack, Murray, and Wagner observe, organizations are better able to tap external innovators capable of producing new ideas. For example, when Netflix, the on-demand video and DVD rental company, wanted to improve its algorithm for recommending
movies to customers, it announced a $1 million prize. Among the entrants the competition attracted were graduate students from China, researchers from Bell Labs, and retired management consultants. Between October 2006 and July 2009, Netflix received more than 44,000 entries from more than 5,000 teams.

Not all submissions produced better results: During the first 33 weeks of the Netflix competition, more than two-thirds of the entries performed worse than the company’s own algorithm. But several dozen entries beat the benchmark by 5 percent, and the winning entry exceeded the benchmark by more than 10 percent, proving that patience (the competition spanned almost three years), cash ($1 million), and attention to detail (after all, the company had to evaluate 44,000 entries) can produce payoffs. Nonetheless, the authors note, organizations need to understand that competitions can have drawbacks, including potential overlap with ongoing internal activities and uncertainty about who actually owns the intellectual property.

To help managers address these concerns, McCormack, Murray, and Wagner present a five-step process for how to run a competition: (1) frame the problem; (2) establish the prize; (3) select the participants; (4) define the process; and (5) build the platform. In addition, they list essential costs, some of which are more strategic than economic. For instance, businesses running competitions need to think about the disclosure risks involved. “In describing the challenge you seek to address,” they point out, “you are sharing important information with the world, which might be helpful to competitors.”

Both the benefits and challenges of opening up the innovation processes to the wider world are addressed in “Using Open Innovation to Identify the Best Ideas,” an article by two alumni of MIT Sloan’s doctoral program, Andrew King (a professor at Dartmouth’s Tuck School of Business) and Karim R. Lakhani (an associate professor at Harvard Business School and principal investigator of the NASA Tournament Lab). “Many of the best ideas for new products and services no longer originate in well-financed corporate and government laboratories,” they write, but in a wide variety of settings. “Increasingly, organizations are considering using an open-innovation process,” they note, “but many are finding that making open innovation work can be more complicated than it looks.”

King and Lakhani offer a framework for helping executives think through which aspects of the innovation process, if any, to open to outsiders. “When picking an open-innovation strategy, managers must choose whether to open the idea-generation process, the idea-selection process, or both,” King and Lakhani observe. In that choice, managers “can be reassured that their prior experience managing innovation is valuable;
important elements of these processes remain the same. However, each element presents new challenges to managers.”

One such challenge stems from the way in which companies contract with outside idea generators. Contracting with outsiders who have ideas may seem straightforward, but it’s a significant departure from the way businesses typically operate: If a company hires a professional engineering firm to develop a new line of products and subsequently hires an advertising firm to create an ad campaign, there’s no question who owns the ideas created during the engagement. But with open innovation, idea ownership is less clear-cut, which can make outside idea generators hesitant to share their best ideas. What if a company steals their ideas? This lack of trust, the authors explain, is summed up nicely by a principle known as “Arrow’s information paradox.” It is named for Nobel Laureate Kenneth Arrow, who argued, as King and Lakhani explain, that “the value of an idea cannot be assessed unless it is revealed. But once it’s revealed, the potential buyer has it and can decline to pay for it.”

If the best idea generators are worried about protecting their ideas, some will be reluctant to enter competitions. Therefore, businesses holding competitions must find a way to overcome Arrow’s information paradox. The authors offer examples of how to do this. They point out that S.C. Johnson & Son—the company behind household products such as Glade air fresheners, Kiwi shoe polish, and OFF! insect repellent—“has worked diligently to establish itself as an honest buyer of external ideas and thus has succeeded in attracting good ideas from outsiders.”

For organizations lacking credibility on their own, the authors suggest using intermediaries, such as Waltham, Massachusetts-based InnoCentive, which they call “one of the most successful innovation contest platforms,” to connect companies to communities of idea generators. “Because of its track record (it has run more than 1,000 innovation challenges, with awards ranging from $5,000 to $1 million), companies can essentially ‘rent’ InnoCentive’s reputation when engaging in an idea tournament and have ready-made access to tens of thousands of idea generators,” King and Lakhani write. “Inventors know that InnoCentive has every incentive to ensure that ideas aren’t misappropriated; its business model depends on having a reputation for handling contests effectively and honestly.” For protection, it requires clients to submit to intellectual property audits in order to verify that ideas are being properly used and that inventors are being properly compensated.

While financial compensation is understandably important to many outside innovators, money is not the only form of benefit from participating in an innovation process. For example, InnoCentive provides a platform for companies to engage in a contest to find the best idea. The company awards prizes to the winners, but also offers the opportunity to work with the best ideas. This can lead to new partnerships and collaborations. Additionally, InnoCentive provides access to a large pool of potential employees, which can be beneficial for companies looking to hire new talent.
Raasch and von Hippel define “innovation process benefits” as the often-intangible rewards innovators get by being part of an innovation project, including the sheer enjoyment and the knowledge acquired in the effort, as well as the recognition and reputational gains that would come from making a noteworthy contribution. One of the examples the authors cite is a study of Finnish consumer-innovators in which the “process motives” represented an average of 45 percent of the total motivation.

What are the implications of “innovation process benefits” for researchers and businesspeople?

Raasch and von Hippel explain that, “because people are willing to make valuable contributions to a project motivated partly or entirely by innovation process benefits they gain by participation in the innovation development activity itself, a project sponsor can increase—‘amplify’—the labor applied to the project, because he or she is not paying full price for the labor being supplied.” Such “innovation effort amplification” can be applied to a wide range of innovation projects, from corporate contests to Linux open-source software development to scientific research.

However, Raasch and von Hippel note that there are downsides to leaning too heavily on process benefits to motivate and reward participants. “Potential project volunteers who are 100 percent rewarded by innovation process benefits may have reduced concern for the quality of the output they create,” they write, “since they themselves do not have any use for that output.” So what can companies do? They advise project sponsors to “tie project participation rewards tightly to the quality of the output created, from the sponsoring organization’s perspective.”

In general, Raasch and von Hippel conclude that “designing innovation projects with individual volunteers’ innovation process benefits in mind can amplify total investment in R&D and innovation in societies by making it attractive for some consumers to devote some fraction of their leisure time to that purpose. “The net effect is to make innovation cheaper from the societal perspective and also from the perspective of an innovation project sponsor,” they write. “And the net effect of that is that there will be more viable innovation opportunities and more innovation.”

ABOUT THE RESEARCHERS

The Fall 2013 issue of MIT Sloan Management Review features research by several MIT Sloan alumni and faculty in a special report entitled, “Leveraging External Innovation.”

Alan MacCormack, SM ’92; Fiona Murray; and Erika Wagner, SM ’02, PhD ’07 are the authors of the article, “Spurring Innovation Through Competitions” (URL: http://sloanreview.mit.edu/x/55117). MacCormack, who received an SM from MIT Sloan and a DBA from Harvard Business School, is the MBA Class of 1949 Adjunct Professor of Business Administration at Harvard Business School. Murray is the associate dean for innovation, and the Alvin J. Sitemap (1948) Professor of Entrepreneurship at the MIT Sloan School of Management, and faculty director of the Martin Trust Center for MIT Entrepreneurship. Wagner, who earned a master’s degree in aeronautics and astronautics at MIT as well as a PhD in bioastronautics from the Harvard/MIT Division of Health Sciences and Technology, is the business development manager at Blue Origin in Kent, Washington.

Andrew King, PhD ’94 and Karim R. Lakhani, SM ’99, PhD ’06 co-wrote the article, “Using Open Innovation to Identify the Best Ideas” (URL: http://sloanreview.mit.edu/x/55112). King, who earned a PhD from MIT Sloan, is a professor of business administration at Dartmouth’s Tuck School of Business. Lakhani is the Lumry Family Associate Professor of Business Administration at Harvard Business School. He earned a PhD from MIT Sloan.

Christina Raasch and Eric von Hippel are the authors of “Innovation Process Benefits: The Journey as Reward” (URL: http://sloanreview.mit.edu/x/55118). Raasch is a professor of technology management at Technische Universität München, TUM School of Management. In 2010 and 2012, she was a visiting researcher at MIT Sloan. von Hippel is the T. Wilson (1953) Professor in Management at the MIT Sloan School of Management.
A Key to Bringing Capitalism to China—Avoiding the Mistakes of the U.S.

But first, it is important to make the case for why China should move to a democracy.

Chinese leadership has signaled some willingness to introduce economic changes, but would the leadership consider giving democracy a try? Transitioning to a democracy sounds good on paper, but it is a hazardous process. It’s not as though Chinese leaders could copy a ready template. Many may argue that the U.S. model is such a template, but this is by no means a settled question.

But first, it is important to make the case for why China should move to a democracy.

True, China has made huge economic and social advances in the past few decades. However, it is equally true that its growth has not been efficient, and this has costly environmental consequences. On the social side, the growth has led to massive corruption and high income inequality.

A recent survey by Peking University showed a large gap in income between the country’s top earners and those at the bottom. In 2012, the households in the highest 5 percent income band earned nearly a quarter of the nation’s total income. Those in the lowest 5 percent accounted for only 0.1 percent of total income.

The accumulation of wealth among the elites has contributed to corruption. Graft, bribery, and cronyism are rampant. Indeed, the Chinese government itself has repeatedly said that corruption is the chief threat to the leadership’s legitimacy.

China’s growth is perilously unbalanced, as well. The country relies far too much on cheap labor and subsidized capital as opposed to technology and science-based innovations. While for years the Chinese leaders have talked about the imperative to change growth from extensive margins to intensive margins, it is easier said than done.

Technology-based growth drivers require a rules-based system, freedom to think and challenge authority, and a government with limited reach and power. In short: rule of law and political openness that are the hallmarks of democracy. But let’s not delude ourselves: Democracy is not the panacea, and the U.S. model, in particular, is far from perfect. This
country has, time and time again, failed to enact policies that protect citizens against gun violence, to tackle climate change, and to enact universal healthcare. If a mature democracy with high income and with a relatively educated electorate has failed in so many fronts, we should worry about how a beginning democracy would fare in the context of a developing country.

The U.S. system, while offering many strong attributes, also has some glaring weaknesses that future democracies should try hard not to replicate.

There are, however, some valuable lessons from U.S. democracy from which aspiring democracies should learn. Consider, for instance, the American voting system. Voting is, at least in theory, a vital demonstration of how Americans hold their leaders accountable. And yet, U.S. voter participation is pathetically low. In 2012—a presidential election year!—turnout was about 57.5 percent. What’s more, studies show that voters are extremely ignorant about both the political process and the policy positions of their candidates.

Special interests are another big problem. In the aftermath of Citizens United, a U.S. Supreme Court ruling that prohibits the government from restricting political expenditures by corporations and labor unions, elections are awash in cash. According to an analysis by MapLight.org, the cost of winning a seat in Congress averaged more than $10 million in the 2012 election cycle.

This money has a direct impact on how judgments are made. Political judgments by voters in the United States tend to be subjective and intuitive, rather than data driven. This is one of the main reasons that special-interest groups have so much sway, because they have a powerful impact on how those political judgments are shaped and formed. Another big problem is gerrymandering and the way political districts are drawn. Despite the fact that districts should be drawn to reflect “substantial equality of population”—per the U.S. Supreme Court, the majority parties in particular states establish boundaries along partisan lines. There is an inherent conflict of interest built into this system.

Future democracies must think creatively about how to widen participation and also limit the influence of money and special interests. There are a few things that future democracies could do differently. For instance, they could make voting compulsory. Voters would be required to study the issues, understand the facts, and learn about the candidates. Also, the voting period should be stretched out over a longer period of time to reduce the “transaction costs” of voting. The voting system in future democracies should be modernized, and some of the decisions should be taken out of politics altogether. For example, political districts could be drawn randomly by computer. Also, future democracies should strive to limit the power of money in their political system.

So far, there is no indication that China wants to be a democracy. But as the second-largest economy in the world, that transition will happen sooner rather than later. The U.S. system, while offering many strong attributes, also has some glaring weaknesses that future democracies should try hard not to replicate.

YASHENG HUANG is Associate Dean for International Programs and Action Learning and the International Program Professor in Chinese Economy and Business.
Little’s Law

**John Little, SB ’48, PhD ’55**

John Little is best known for his proof of the queuing formula, \( L = \lambda W \), commonly known as Little’s Law. The formula asserts that the average number of customers in the queuing system, \( L \), is equal to the rate at which customers arrive and enter the system, \( \lambda \), multiplied by the average time a customer spends in the system, \( W \). When applied to the practice of operations management, where output is the primary focus, the formula allows the manufacturing system to determine how to manage its operations to achieve the ideal output rate, influencing operations practice in everything from factories to hospital emergency rooms.

System Dynamics

**Jay Forrester, SM ’45**

Jay Forrester is the founder of System Dynamics, a way of mathematically modeling and understanding complex issues and problems over time. Originally developed in the 1950s to help corporate managers better understand industrial processes, new applications for system dynamics have been discovered over the years. It is currently used to model a wide variety of areas, including socioeconomic, ecological, managerial, and urban systems.

User-Generated Innovation

**Eric von Hippel, SM ’68**

In 1976, Eric von Hippel began exploring the concept of user innovation—the idea that end-users, rather than manufacturers, are responsible for a large amount of product innovation. Today, many manufacturers have reoriented themselves to seek out user innovations, rather than focus on perceived customer needs, in order to discover what their customers truly want.

The Billion Prices Project

**Roberto Rigobon, PhD ’97 (right) and Alberto Cavallo, MBA ’05**

The Billion Prices Project aggregates price information from a wide range of online retailers throughout the world to give real-time inflation predictions. Through the gathering of this data, the project aims to answer questions on what conditions lead to inflation. More important, the project seeks not only to show worldwide economic trends in real-time, but also to predict when and where financial crises may occur by examining data trends.
Bill Aulet, SM ’94

Disciplined Entrepreneurship
Getting Started

Three ways to start a new venture

When I listen to my students, I hear a diverse range of reasons as to why they are interested in entrepreneurship. Some students have worked in one industry for years and want a change. Some want to push their skills to the maximum and have the biggest impact on the world. Some want to be their own boss. Some hold patents and are interested in the different ways they can commercialize them. Some have an idea about how their own life could be improved, and they wonder if that idea is interesting to others.

All of these reasons can be synthesized into three distinct categories (see Table 0.1):

1. **Have an idea:** You have thought of something new that can change the world—or some small part of it—in a positive way, or something that can improve an existing process you’re familiar with and you want to implement it.

2. **Have a technology:** You have come up with a technological breakthrough and want to capitalize on it, or simply expedite its deployment to have a positive effect on society. Or, you have learned about a technological breakthrough and you see great potential for a business.

3. **Have a passion:** You are confident and you are comfortable pushing yourself to develop your skills in the most comprehensive way possible. You also might believe that being an entrepreneur is the way to have the biggest impact on the world. You simply might know that you want to work for yourself and control your own destiny, but you don’t have an idea or technology yet, so you’d like to learn about entrepreneurship while looking for a good idea, technology, and/or partner. (Read on to learn how to find a good idea or technology based on your passion.)

I am frequently told that an entrepreneur cannot start without knowing a “customer pain”—a problem that bothers someone enough that they would be willing to pay to alleviate the problem. But that approach can be discouraging to someone who is unfamiliar with entrepreneurship. Furthermore, it discounts the importance of starting a company in line with the
Table 0.1 / Idea versus Technology versus Interest
What does it sound like to have an idea versus a technology versus a passion? You should be able to sum up your idea, technology, or interest in one succinct sentence.

Idea:
“I want to start a company in Africa that will create a sustainable business model to improve life for the people there and empower them with jobs.”

Here, the idea is that a sustainable business model will reduce poverty in Africa more effectively than charitable contributions to the poor. This sentence is enough to move on to the next step of Market Segmentation, though as you will see, you will have to be much more specific before you can turn the idea into a business.

Technology:
“I have a robot that allows you to feel objects rendered by a computer.”

This statement radiates with potential. How could someone benefit from being able to have a three-dimensional object on their computer screen and still be able to feel it, in some way, in physical space? I co-founded a company, SensAble Technologies, around this very technology, and throughout the book, I share SensAble’s story.

Passion:
“I have a master’s in mechanical engineering, and I can quickly prototype most any technological gadget you want. ... Now I want to put my skills to use in the most impactful way possible, and be my own boss.”

This person has identified a personal comparative advantage, the ability to prototype gadgets quickly, which can help a business go through product iteration faster. The person may want to consider a hardware-based business, as it would line up well with the comparative advantage.

Once you have answered this question, you will have taken the first step toward discovering a customer pain—a pain that you are interested in alleviating because it is in line with what you are interested in and have expertise in.

How to go from “I have a passion” to “I have an idea or technology”
Many of my students who are interested in entrepreneurship do not yet have an idea or a technology; so if this is you, you are not alone. By first taking stock of your personal interests, strengths, and skills, you can more readily identify good opportunities. You can do this exercise either alone or with a group of potential co-founders.

Consider the following:
Knowledge: What was the focus of your education or career?
Capability: What are you most proficient at?
Connections: Who do you know that has expertise in different industries? Do you know other entrepreneurs?
Financial assets: Do you have access to significant financial capital, or will you be relying on a meager savings account to start out?
Name recognition: What are you or your partners well known for? Skills in engineering? Understanding fiber optics?
Past work experience: In previous jobs you’ve held, what inefficiencies or “pain points” existed?
Passion for a particular market: Does the idea of improving healthcare excite you? How about education? Energy? Transportation?
Commitment: Do you have the time and effort to devote to this endeavor? Are you ready to make a new venture your primary (or only) focus?

If you or your founding group have strong coding and project management skills, you may be more inclined to develop a web app. If you are a pro at rapid prototyping, you may want to consider creating a physical product of some sort. Or if your past work experience is in education or medicine, you may want to consider what you can create that would improve those areas.
Three ways to start a new venture

I have a technological breakthrough!

I have an idea!

I have a passion!

Often, you will find an idea or a technology that improves something for you personally, then realize that idea or technology has the potential to help many others. This phenomenon is called “user entrepreneurship”; the Kauffman Foundation has found that nearly half of all innovation-based startups that are at least five years old were founded by user entrepreneurs.¹

Finding a founding team: entrepreneurship is not a solo sport
In 15.390 New Enterprises, the foundational entrepreneurship class I teach with other faculty at MIT, students who go through the 24 Steps must form teams within two weeks, due to the time constraints of the academic semester. This process is not an optimal way to form teams, but is enough for the student teams to gain experience in team formation and for teams to implement (in an accelerated manner) the 24 Steps over the course of a semester. From the ideas in the class that turn into businesses, some teams stay intact; but far more often, teams undergo a healthy reconfiguration of their membership at the end of the semester to create a stronger, more unified team that is better suited to capture an opportunity on a longer-term basis. This is an important evolutionary process.

Your choice of co-founders is extremely important. The research at MIT suggests that businesses with multiple founders are more successful than those founded by an individual.²


BILL AULET is the managing director in the Martin Trust Center for MIT Entrepreneurship and a senior lecturer at the MIT Sloan School of Management. The Trust Center is responsible for entrepreneurship education across all five schools at MIT, starting in the classroom but extending well beyond to student clubs, conferences, competitions, networking events, awards, hackathons, student trips, and, most recently, accelerators. Aulet teaches at least three different entrepreneurship-focused classes per year in addition to his responsibilities of running the Martin Trust Center.

Disciplined Entrepreneurship: 24 Steps to a Successful Startup dispels the myth that entrepreneurship cannot be taught. It includes every step necessary to build an innovation-driven startup—the same data-driven approach used by MIT faculty and students who have started their own companies. For more information, visit http://disciplinedentrepreneurship.com/.

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Join us as we bring together alumni, industry leaders, and friends of MIT at a series of academic conferences focusing on the latest research and academic activity at MIT Sloan.

**MIT AND THE DIGITAL ECONOMY: THE SECOND MACHINE AGE**

Friday, April 4, 2014
The TimesCenter
242 West 41st Street
New York, NY

Digital technologies are transforming business, our economy, and our society. They are driving innovation and creating unprecedented wealth. At the same time, a gap is emerging as accelerating changes in technology overtake the ability of people and organizations to keep pace. Harnessing the exponential improvements in artificial intelligence, robotics, networks, analytics, and digitization is the grand challenge for our generation and for MIT in particular.

This event will highlight MIT’s role in both understanding and shaping our increasingly digital economy. Please join us for a celebration of innovation and technology and to learn more about the Institute’s response to this challenge through an exciting new initiative on the digital economy.

**MIT FINANCE FORUM**

Friday, May 16, 2014
Mandarin Oriental
776 Boylston Street
Boston, MA

MIT is often referred to as “home to the pioneers of modern finance,” a place where many breakthroughs in financial economics were conceptualized. With traditions deeply rooted in finance, today’s faculty remains committed to groundbreaking research with a focus on the future.

This event will feature talks by faculty on evolving financial markets and policy changes, and will bring a global perspective to the challenges facing the industry.

For more information on these events, and to register, please visit: http://mitsloan.mit.edu/alumni/events/
The Birth of Modern Finance

Many scholars and industry leaders agree—the birthplace of modern finance is MIT. The Institute lays claim to pioneers like Fischer Black, Stewart Myers, and John Cox, as well as Nobel Laureates Paul Samuelson, Robert Merton, Myron Scholes, and Franco Modigliani. Formed in the 1960s, long before many business schools recognized finance as a distinct field of study, the MIT Sloan Finance Group is responsible for research breakthroughs that helped shape finance theory and practice over the last 40 years—and continue to do so today.
The modern intellectual history of finance begins with Paul A. Samuelson, who started his lifelong career at MIT in 1940. The Department of Economics named him assistant professor when he was 25 years of age and a full professor at 32. In the 1960s, Samuelson became interested in finance and wrote several seminal papers on topics including asset allocation and the fallacy of time diversification, and, of course, on the pricing of warrants and options, which would become the start of something much bigger. In 1970, he was the first American to win the Nobel Prize in Economics. John Kenneth Galbraith wrote in 1977 that, “Generations of students have learned their economics from Paul Samuelson, the pre-eminent teacher of his time.” Economic historian Randall E. Parker calls him the “Father of Modern Economics,” and the New York Times considered him to be the “foremost academic economist of the 20th century.”

Samuelson’s legacy is certainly far-reaching. He attracted many talented collaborators and mentees to MIT, including Robert Solow, Paul Krugman, Franco Modigliani, and Joseph Stiglitz, all of whom went on to win Nobel Prizes. Following Samuelson’s lead, the two departments—Economics (in the School of Humanities, Arts, and Social Sciences) and Finance (in the School of Industrial Management)—forged a lasting bond that made each stronger. In 1952, when the School of Industrial Management moved into the newly acquired Sloan building at the east end of campus, the Department of Economics left the Hayden Library, where social sciences was located, and joined their management colleagues, a sign of their close relationship.

Samuelson’s contribution has been that, more than any other contemporary economist, he has contributed to raising the general analytical and methodological level in economic science. He has in fact simply rewritten considerable parts of economic theory.

—NOBEL PRIZE COMMITTEE

What Dean Penn Brooks wrote in his last Annual Report in 1959 is still true today:

The area of economics has particular significance for the field of management, and the strength of the School has always been magnified by our faculty’s close working arrangement with MIT’s distinguished Department of Economics and Social Science. The collaboration is not only in the design of the teaching programs, where members of that Department contribute substantially to our program, but also in the close personal research relationships that exist between members of the two groups.

One of Samuelson’s most significant contributions to the field of finance, however, was mentoring a rather unlikely PhD candidate in 1967—an applied mathematics student from Caltech who had no prior economics training and who was rejected from every other economics program to which he applied. That young maverick was Robert Merton. Yale, Harvard, Berkeley, and Stamford didn’t want him—the MIT Economics Department welcomed him with open arms.
Franco Modigliani (left) accepting the Nobel Prize in Economic Science.

Born in Rome in 1918, Franco Modigliani left Italy in 1939, just before World War II broke out, because of his Jewish descent and anti-Fascist views. A passionate man who never lost his heavy Italian accent, Modigliani often talked with his hands. He was known for what Stewart Myers once called “absent-minded generosity.” He joined the MIT faculty in 1962 after stints at Northwestern, Carnegie Institute of Technology, Harvard, and the University of Illinois. He was named Institute Professor in 1970. In 1985, MIT presented him with the James R. Killian, Jr. Faculty Achievement Award. The Nobel Prize came a few months later. “On the day he won the Nobel, we played doubles,” Samuelson told MIT News. “An intense tennis player, he never stopped moving. He was so intense, he once ran into a cement wall trying to get the ball.”

An elder statesman among economists, he was always surrounded by young students and researchers with whom he loved to engage on the major economic and social issues of the day. Modigliani passed away in Cambridge at 85 in 2003. “When he died he was the greatest living macroeconomist,” Samuelson told MIT News. “He revised Keynesian economics from its Model-T, Neanderthal, Great Depression model to its modern-day form.”

Then-Dean William Pounds advised Merton to skip the traditional finance courses (because he’d get bored quickly and leave) and enroll in Paul Samuelson’s mathematical economics course. Merton showed up the first day of registration, walked into Samuelson’s open door, and didn’t leave for three years. “The rest was history,” says Merton. “I lived in his office from the end of that class on.”

Samuelson once described Merton as “your average American boy next door, fond of baseball and taking autos apart.” Merton bought his first stock (GM) when he was 10 years old. He regularly balanced his mother’s checkbook and set up a “bank” with money from neighbors and family. At an early age, he read the stock tapes and began trading. Baseball was his first passion—the Brooklyn Dodgers—but at around age 11, that passion turned toward cars. On his bedroom wall, he put a large sheet of paper covered with more than 1,800 numbers. He crossed one out each day, counting down until he would be old enough for his driver’s license. At 15 he rebuilt his first car. It wasn’t long before he realized his real passion was applying math to economic problems.

What Francis Walker and Davis Dewey did for economics at the turn of the century, Paul Samuelson and Bob Merton did for the field of finance near the end of the century. At the time, they didn’t realize they were helping to create a new discipline—after all, finance was still part of economics in those days, not yet considered a serious academic subject in its own right. Plus, Merton had his sights set on becoming an economist. In fact, when he graduated in 1970 with a PhD in economics and applied for jobs in academia, Merton interviewed only with economics departments, no business schools. It was Franco Modigliani, with a joint appointment in economics and finance, who convinced Merton to stay at MIT and teach finance.

MODIGLIANI-MILLER THEOREMS

Around the same time that Samuelson was writing his dissertation, Modigliani, a young Italian economist, was developing a theory based on an examination of individual behavior—how people save for retirement. His theory, the life-cycle hypothesis (1953), would later provide important predictions for the economy as a whole, and win him a Nobel Prize in Economic Sciences in 1985.

Modigliani’s research with Merton Miller at Carnegie Institute of Technology (now Carnegie Mellon University) laid the groundwork for the field of corporate finance. No single work had prompted such widespread and revolutionary changes as the Modigliani-Miller (MM) Theorems. The influence of the MM (1958) propositions on capital structure and the (1961) theses on dividend policy pervades almost all aspects of financial economics.
to this day—opening the door on a new era in modern finance. The theorems introduced rigorous economic thinking to the anecdotal world of 1950s corporate finance. “Franco’s work is timeless,” said MIT economics professor James Poterba. “The issues he worked on are the big questions. They are as important today as when he wrote his papers.”

Modigliani also built, along with economist Albert Ando, a large-scale model of the U.S. economy to test the impact of monetary policy. “We learned enormous amounts about individual sectors of the economy,” said Poterba. “No part of the economy was safe from Franco’s microscope. It was tremendously influential.”

THE FOUNDING FATHERS OF FINANCE

With Modigliani in the lead, the Finance Group—Stewart Myers, Gerry Pogue, Myron Scholes, Bob Merton, and Fischer Black—coalesced into a small but influential collection of researchers. Finance departments at other schools were larger—such as those at Chicago and Wharton—but in terms of productivity, MIT’s during this period was equally, if not more, important. “It was a wonderful band of scholars,” recalls Myron Scholes. Assisting Modigliani and Merton Miller at the University of Chicago, Scholes found infectious their “joy of getting results, and asking the next questions.” Upon meeting Black his first summer at MIT, Scholes became fascinated with options, insurance, and distributions of portfolios.

Since Modigliani, then the Finance Group’s senior faculty member, was preoccupied with large macro projects, and Sidney Alexander, the unit head, was not a hands-on overseer, this new cohort of talented intellectuals was left to its own devices. What followed was a decades-long era of intense collaboration and creativity that transformed the academic field and the landscape of real-world finance.

“It was a rare and wonderful experience,” recalls Merton. “Our group was marked by a diversity of thought, a quality of mind, and a genuine affection for each other. We had passionate intellectual disagreements, but still had a great respect and affection for each other. We were blind to everything but talent, productivity, and skill. The research flowed so fast for us, and the students, there wasn’t enough time to do it all. That doesn’t happen everywhere.”

Stewart Myers

Fischer Black (left) and Myron Scholes, both c. 1970.
THE BLACK - SCHOLES FORMULA

\[
C(S, t) = N(d_1)S - N(d_2)Ke^{-r(T-t)}
\]

\[
d_1 = \frac{1}{\sigma \sqrt{T-t}} \left[ \ln \left( \frac{S}{K} \right) + \left( r + \frac{\sigma^2}{2} \right) (T-t) \right]
\]

\[
d_2 = \frac{1}{\sigma \sqrt{T-t}} \left[ \ln \left( \frac{S}{K} \right) + \left( r - \frac{\sigma^2}{2} \right) (T-t) \right]
\]

\[= d_1 - \sigma \sqrt{T-t}\]

OPTIONS PRICING

The 1970s was a decade steeped in financial strife. Interest rates ballooned into the double digits. Inflation was the highest it had been since the Civil War. An OPEC oil embargo caused gas prices to soar and shortages created long lines at the pumps, despite the rationing system that was hastily implemented. The stock market fell, unemployment was high, and with the end of Bretton Woods, foreign currency shifted from fixed to floating. The country was in crisis, and traditional solutions weren’t working. All this economic risk and uncertainty set the stage for tremendous innovation.

In 1970, Black and Scholes solved the problem of valuing options and derived their now-famous formula. At the same time, Merton was working on this problem, but took a different approach, using Itô calculus to model the randomness of financial markets. Conversations with Scholes helped him reframe his ideas. With the publication of his paper on “Rational Option Pricing,” Merton took finance into uncharted waters, developing new tools and models that changed the course of modern finance. Leaders in the field see it as the dawn of a new era; Merton attributes it to good timing. “When it comes to innovation, the most important factors are need, need, need,” he says. “If this work had been published in the 1960s, it would have sat on the shelf.”

Merton and Scholes won the Nobel Prize in Economic Sciences in 1997. Black would have joined them in the honor, if not for his death in 1995. The impact of their formula was staggering, but they did not devise it from scratch. They built their seminal theory on the shoulders of their senior colleagues, including Samuelson, and his earlier work on valuing warrants, and Paul Cootner, who edited in 1964 The Random Character of Stock Market Prices. The formula was groundbreaking, but it did not win the Nobel Prize. Black-Scholes was just one example of a replicating methodology; it provided a way to evaluate the risk and production cost of a new instrument. And because it is flexible and can be applied in thousands of situations, it has been a workhorse for more than 40 years.

A n article Bob Merton wrote in 1970 blew me away. It was the first year he was teaching at Sloan and he was working on a paper he would never publish. He’d been working on the options problem (along with other MIT greats like Paul Samuelson and Henry McKean, the world-class mathematician). He wasn’t able to solve the problem in 1970, but he was close. In fact, if you replaced one letter in his equation (beta with r) then you had it. (Later he did solve it in 1973, along with Black and Scholes.) Bob recognized that he hadn’t found the solution, but continued forward anyway. In his paper he went on to say, if he had found a solution he could go about solving all of these other problems, risky debt, deposit insurance, convertible bonds, etc., and he laid out their solutions, contingent on obtaining the solution to the options equation. Even though it was never published, it spawned hundreds of papers by Bob and his graduate students. My thesis evolved from a footnote in that paper.

As a graduate student I had a field day with this new paradigm. The equation, a partial differential equation, was actually a variant of the classic heat equation of thermodynamics (with Einstein as one of the original discoverers). Remarkably, no one had solved this equation mathematically. But Fischer Black, Myron Scholes, and Bob Merton made use of financial economics to transform the problem, which led to the ultimate solution. With this discovery, Chemical Engineering PhD students were congregating at the Dewey Library in an attempt to transform their problems into finance analogs in order to find closed-form solutions. While Finance PhD students were heading over to Baker Library in search of known chemical engineering solutions they could transform into finance analogs for ready-made papers. It made for a strange cross-sharing of ideas between heretofore disparate departments.

— Eric R. Rosenfeld, SB ’75, PhD ’80

Bob Merton (left) accepting the Nobel Prize in Economic Sciences in 1997.
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