BHEF BUSINESS-HIGHER EDUCATION FORUM®

Winter Member Meeting

February 21 - 22, 2013

The Ritz-Carlton
Washington, D.C.

AGENDA

Thursday, February 21, 2013

The Ritz-Carlton, Washington, D.C.

3:30 - 5:00 p.m.	**Opening Program: How Emerging Fields are Reshaping Workforce Needs** *Plaza Ballroom, Ballroom Level*
5:00 - 6:00 p.m.	**Special Session: Sequestration** *Plaza Ballroom, Ballroom Level*
6:00 - 7:00 p.m.	**Chairman's Opening Reception** *Salon IIIA, Ballroom Level*
7:00 – 9:00 p.m.	**Chairman's Opening Dinner** *Salon IIIB, Ballroom Level*

AGENDA

Friday, February 22, 2013

The Ritz-Carlton, Washington, D.C.

7:30 – 8:30 A.M.	**Breakfast** *Plaza Ballroom, Ballroom Level*
8:30 – 9:00 A.M.	**Briefing: BHEF Strategy on Scaling for Impact** *Plaza Ballroom, Ballroom Level*
9:00 – 10:45 A.M.	**Plenary Session I: Gaining Insights from Cohort I Regional Projects and Scaling for National Impact** *Salon III, Ballroom Level*
10:45 – 11:00 A.M.	**Break**
11:00 A.M.– 12:00 P.M.	**Plenary Session I (continued)**
12:00 – 2:00 P.M.	**Luncheon Discussion: The Business Case for Developing 21st Century Workplace Competencies** *Plaza Ballroom, Ballroom Level*
2:00 – 3:30 P.M.	**Plenary Session II: How Higher Education is Adopting Disruptive Technologies to Improve Outcomes and Lower Cost in Undergraduate Education** *Salon III, Ballroom Level*
3:30 – 4:00 P.M.	**Closing Discussion: Operationalizing BHEF's Scaling Strategy** *Salon III, Ballroom Level*
4:00 P.M.	**Closing Reception** *Plaza Ballroom, Plaza Level*

OVERVIEW

Welcome to the Business-Higher Education Forum's (BHEF) Winter 2013 Member Meeting, a two-day engagement that will bring together thought leaders from across the nation. Members and guests will address the workforce challenges confronting our government and companies, which are rooted in a significant shortage of highly educated and skilled employees, especially in emerging fields critical to innovation. The conversation will explore how new undergraduate programs are needed to effectively prepare students with both the expert content knowledge and 21st century workplace competencies needed by business and government to maintain competitiveness and ensure national security.

BHEF's intensive project development and system dynamics modeling over the past year have produced powerful insights that have positioned us as a national leader to guide this effort. Together we will use them as a foundation for discussion of how such efforts can drive a comprehensive scaling strategy for national impact. These insights resulted in the shaping of an overarching project structure that bridges BHEF's two long-standing initiatives, *STEM* and *College Readiness, Access, and Success.*

The resulting *National Higher Education and Workforce Project* is exploring how business and government agencies can utilize their significant resources to expand the capacity for colleges and universities to increase the persistence of undergraduates, particularly women and underrepresented minorities. Within this effort, regional projects promote a new model of strategic business engagement in higher education that moves from a *transactional* to a *strategic* engagement model, creating a multidimensional feedback loop to effect deep, sustainable change in higher education undergraduate outcomes that connects to high-demand jobs.

This meeting is structured around four sessions designed to mobilize BHEF's unique membership to address the workforce challenges facing our country. Additionally, we will include a special session following the opening program about the effects of sequestration on the economy, the workforce, and higher education.

Opening Program: How Emerging Fields are Reshaping Workforce Needs

In a recent edition of the Harvard Business Review, the influential expert Scott Anthony describes a "fourth era" innovation model in which global companies tap their own human and financial capital to innovate, in sharp contrast to the VC-backed start-up model. His article highlights

BHEF member IBM and its Smarter Planet/Smarter Cities initiative, with a strong underpinning of data science and analytics. This emerging field is transforming innovation models, strategy, and operations in both business and in government. However, a recent McKinsey report, *Big Data: The Next Frontier for Innovation*, indicates that U.S. demand for employees with data science and analytics training will outstrip supply by nearly 200,000 data scientists and 1.5 million "analytics-enabled" managers.

The opening program will explore the demand for talent in data science and analytics and articulate a case for business and higher education to work together to confront significant anticipated workforce challenges. Thought leaders from a variety of sectors will discuss how their companies, sectors, and government agencies are affected by an inadequate supply of highly-skilled professionals—both data scientists and analytics-enabled workers—and explain how regional projects serve as platforms for a fundamentally new model of strategic business engagement with higher education can drive innovation and increase the competitiveness of U.S. companies.

Plenary Session I: Gaining Insights from Cohort I Regional Projects and Scaling for National Impact

Increasingly, innovation and competitiveness require new types of employees skilled (at either the expert or "enabled" levels) in a range of fields that are critical to national and regional competitiveness. In response to these workforce needs, BHEF implements a model of strategic business engagement in higher education that aligns five corporate levers—c-suite leadership, philanthropy efforts, employee engagement, core competencies, and funded research— to develop innovative regional higher education and workforce solutions. In June 2012 BHEF launched its first cohort of twelve regional collaborations through the *National Higher Education and Workforce Project*.

Through the lens of three major sectors that are the foci of regional BHEF projects—cybersecurity, water science, and energy/ sustainability—in this session participants will build on key insights gained from the development of the first cohort of projects and discuss how business can move from a *transactional* relationship to a *strategic* partnership with higher education, articulating its needs and then using its capabilities to expand higher education's capacity to increase student interest and persistence in high-demand fields, thus effectively responding to emerging workforce challenges.

With a second cohort of projects set to launch in 2013, BHEF will examine approaches to scaling the projects more widely into the business and higher education communities and connecting them through networks based on the sectors they are addressing and interventions they are deploying.

Luncheon Discussion: The Business Case for Developing 21st Century Workplace Competencies

Businesses must increasingly become "learning organizations" with employees able to develop new skills for the new jobs that innovation creates, while maintaining current skills to enhance

productivity. Workers, therefore, must possess content knowledge as well as core workplace competencies, such as critical thinking, analytical reasoning, and ability to work in multicultural teams, to spur productivity and innovation. The premium on such competencies reflects the increasing complexity of the problems that business is required to solve today, and the pace and agility at which it is challenged to respond to them. This reality also underscores the imperative to incorporate 21st century workplace competencies as an essential design principle of the regional projects co-developed by BHEF business and academic members.

Conversations between the business and education communities about the misalignment of recent graduated' abilities with workforce demand have often been lacking in specificity and concreteness, hindering the move from conceptual to practical needed to build the necessary workforce. As the Hewlett Foundation's national business partner addressing the need to equip students with 21st century workplace competencies as well as content knowledge, BHEF staff has collaborated with members to document the role that 21st century workplace competencies play in employee hiring and promotion and the impact of competency shortages on companies' costs and competitiveness. This lunch conversation will explore the implications from this research, building the business case for intervention strategies that integrate the 21st century workplace competencies.

Plenary Session II: How Higher Education is Adopting Disruptive Technologies to Improve Outcomes and Lower Cost in Undergraduate Education

BHEF's system dynamics modeling for the Office of Naval Research efforts has produced findings and insights into programs and policies that promote education and workforce alignment. Specifically, the simulations have demonstrated that new models of engagement with business and universities in which students receive multiple interventions, some relatively low-cost, in freshman and sophomore years can maximize persistence and yield higher ROI than investments in later years. In addition, scaling disruptive technologies, including intelligent learning tools, can increase student learning and persistence for large numbers of students.

Plenary II's learning session will expose participants to recent advances in online learning and their potential to enhance education offerings, improve learning and student outcomes, and potentially lower cost. Discussions will address the challenges individual institutions and systems of higher education face in developing and deploying these tools and redesigning classes using a "blended learning environment", and how the American Council on Education (ACE) has taken steps to determine, through its own research and evaluation, whether some Massive Open Online Courses (MOOCs) should be offered for credit. Participants will share insights from the University System of Maryland (USM) efforts to incorporate disruptive technologies as a design principle to its regional workforce initiatives. USM is partnering with the Bill & Melinda Gates Foundation and Ithaka S+R on a project to measure how well online learning platforms are working in a blended learning environment. The partnership will seek to accelerate the use of new learning technologies across higher education.

Plenary Session I

Gaining Insights from Cohort I Regional Projects and Scaling for National Impact

Overview

The U.S. faces a series of national security and competitiveness challenges rooted in a significant workforce shortage of highly educated and skilled employees, particularly in key emerging transdisciplinary fields such as data science and analytics, cybersecurity, water, energy and materials sciences, and engineering. Increasingly, innovation and competitiveness require new types of employees with either expert or "enabled" competencies in emerging fields. To address these needs, BHEF's regional higher education and workforce projects are creating new models of strategic engagement among industry, government, and higher education that explore the role industry and government agencies can play in utilizing their significant resources to expand the capacity for colleges and universities to engage and increase the persistence of undergraduates, particularly women and underrepresented minorities, in these fields.

In support of these projects, BHEF has deployed:

- A platform of evidence-based strategic planning, which includes tools such as STEM student migration analysis, BHEF's U.S. STEM Education Model, and the deployment of research-based interventions;
- A fundamentally new model of strategic business engagement with higher education, aligning the key levers of business for maximum impact; and
- A scaling strategy leveraging BHEF's projects, networks, university systems, and national industry and academic association partners.

Taken together, these components of BHEF's strategy can have systemic impacts on key education and workforce objectives, including the President's college completion and STEM workforce goals.

Through the lens of three major sectors that are the foci of regional BHEF projects—cybersecurity, water science, and energy/sustainability—this session will build on key insights gained from the development of the first cohort of regional workforce and higher education projects and discuss how industry can move from a transactional relationship to a strategic partnership with higher

education, articulating its needs and then using its capabilities to expand higher education's capacity to increase student interest and persistence in high demand fields and, thus, effectively respond to emerging workforce challenges. With approximately 20 projects coming online in 2012-2013, BHEF is now examining approaches to scaling the projects more widely into the business and higher education communities and connecting them through networks based on the sectors they are addressing and interventions they are deploying. BHEF is also seeking ways to identify promising approaches, content, and products developed through the projects that could be pushed out for broad adoption using such tools such as massive open on-line courses (MOOCs).

Regional Project Design Principles

BHEF's current regional projects have employed a set of design principles to ensure that the goals of the overall *Higher Education and Workforce Project*—increasing student persistence, particularly that of women and underrepresented minorities, toward bachelor's degree attainment and aligning undergraduate education to regional workforce needs—will be met:

- Increasing the persistence and building the workplace competencies of students in the first two years of the undergraduate experience;
- Integrating evidence-based practices for increasing student persistence using such tools as high-impact interventions (e.g., student research), student migration analysis, and computer modeling to simulate the impact of interventions over time and at scale; and
- Understanding regional workforce needs and developing undergraduate projects engaging local business and industry to address them in specific sectors.

BHEF's Model of Strategic Business Engagement in Higher Education

In implementing these design principles, BHEF employs a new model of Strategic Business Engagement in Higher Education which aligns key corporate "levers" to move from the traditional *transactional* engagement to a *strategic* business engagement that maximizes impact. While each lever can have impact independently, aligning them in business' engagements with higher education can have powerful synergistic effects. These levers include:

- **C-Suite** executives use their personal leadership to (1) shape internal and external messaging to raise community awareness of 21st century workforce demands; (2) build a critical mass of peers focused on undergraduate education in support of workforce goals; and (3) guide corporate policy development to ensure the corporation's actions align with its strategic education and workforce goals.
- **Philanthropy Efforts** serve as vital catalysts for positive, lasting, and high-impact change in higher education if invested strategically. Examples include support for creating new undergraduate models, early college high schools, virtual course tools that integrate innovative classroom instruction techniques, and operating support as organizations bring new, evidence-based practice to scale.

- **Employee Engagement** deploys the hundreds or thousands of employees within an organization to support strategic education goals. These individuals represent human capital that can be mobilized to act both inside and outside the corporation, providing grassroots support for a company's investments in education and becoming major advocates for the work.
- **Core Competencies and Expertise** include intellectual capital and unique subject matter expertise that business can utilize to strengthen the education-to-workforce pipeline, collaborating with higher education to create new courses, programs, and student learning experiences.
- **Funded Research** at university labs can serve as platforms for early research experiences for freshmen and sophomores, which have been shown to increase student persistence.

Regional Project Cohort I

BHEF and its members have made significant progress in advancing the twelve Cohort I regional projects launched in June 2012 (See Exhibit I) and forming networks to share resources and insights among them. The Northrop Grumman-supported Advanced Cybersecurity Experience for Students (ACES) at the University of Maryland College Park (UMCP) will admit its first class of 40-50 students in fall 2013. In October 2012, Northrop Grumman announced its support of a comparable program, called the Cyber Scholars Program, at the University of Maryland Baltimore County (UMBC).

In March 2013, the Battelle Memorial Institute will host an event at its headquarters in Columbus, Ohio to announce a series of STEM initiatives, including the BHEF regional projects at Case Western Reserve University and Ohio State University.

Through the submission of a large multi-year proposal to the National Science Foundation, BHEF is leading the development of the Undergraduate STEM Interventions with Industry consortium to advance knowledge in a largely unexplored area of four-year undergraduate STEM education: developing evidence-based models on how to implement strategic, effective, and sustainable engagement by private industry with higher education to increase the persistence of STEM students, particularly women and underrepresented minorities. The proposal identified the transfer of students from two-year to four-year institutions as a key juncture that, if addressed, could significantly increase both diversity as well as overall STEM degree attainment at the baccalaureate level. Of the initial twelve Cohort I projects, five elected to be included in the proposal including: City University of New York and IBM; Miami-Dade College and Next Era Energy; University of Massachusetts and the Massachusetts Competitive Partnership; University of Wisconsin and the Milwaukee Water Council; and Washington University in St. Louis and Boeing.

Scaling Strategy

In an effort to disseminate the learning, insights, and outputs from the regional projects, and bring the projects to scale, BHEF is pursuing scaling strategies at the project, network, university system, and national levels. In planning Cohort II, BHEF is working with members and other partners in developing eight to ten new projects for launch in June 2013. In Missouri, for example, BHEF members Novus International and University of Missouri System have begun planning

the development of the STEM Heartland Project to build a future workforce in the agricultural sciences. They are set to have their kick-off meeting in March 2013 in St. Louis. Discussions are underway for additional regions and sectoral foci including: Downstate New York and smart grid energy; Washington State and computer science; California and food and water sciences; Houston and energy; Colorado and chemistry; and West Virginia and energy.

At the network level, in December 2012, the Sloan Foundation hosted the first convening of the BHEF National Undergraduate Cybersecurity Network, and brought together BHEF members and others from companies (Battelle Memorial Institute, Next Era Energy, Northrop Grumman, Parsons, and Raytheon), higher education (Bowie State University, Cal Poly, Miami-Dade College, San Jose State University, Towson University, UMBC, and UMCP), and government agencies (National Institute of Standards and Technology, National Security Agency, White House Office of Science and Technology Policy) to discuss cyber workforce needs and shape a strategy for addressing them through engagement among the three sectors.

BHEF also is developing a network of effective practice, which is the focus of BHEF's recent proposal to the National Science Foundation, that will join five regional projects in a network to share lessons on designing, implementing, and evaluating high-impact industry-driven interventions focused on increasing the persistence of students transferring from two- to four-year STEM programs.

At the university system level, supported by a major grant from the Alfred P. Sloan Foundation, announced last fall, BHEF is scaling cybersecurity programs to two additional USM campuses, Towson and Bowie State, and is establishing the University System of Maryland (USM) Undergraduate Cybersecurity Network.

A number of other regional projects are being led by, or engage deeply with, university systems, which provide a strong platform for scaling innovation throughout the university system and beyond. The University of Wisconsin System, with its Milwaukee campus in the lead, will tap the resources of its various campuses in water science to develop new courses, research experiences, and mentoring opportunities for undergraduates in partnership with the Milwaukee Water Council. The CUNY system will mobilize several of its two- and four-year institutions to engage with IBM in bridging programs, course redesign, research internships, and capstone projects to increase the transfer and completion of students from two- to four-year programs in data analytics and sustainability in the built environment.

Finally, the National STEM Undergraduate Partnership, launched in June 2012, opens the opportunity for BHEF regional projects to network with other regions and share learning outcomes by connecting with key academic associations, industry associations, professional societies, and federal agencies. In November 2012 the Partnership was highlighted in the President's Cross-Agency Priority Goals as a primary partner on STEM higher education in achieving the President Obama's goal to graduate 1M new STEM students.

Exhibit 1: BHEF Cohort I Regional Higher Education and Workforce Projects

Cybersecurity and Information Technology

- **Case Western Reserve University** and **Eaton Company:** increasing the persistence and transfer of community college students in information technology.
- **CalPoly San Luis Obispo, Northrop Grumman Corporation,** and **Raytheon Corporation:** building a new undergraduate cybersecurity center.
- **Miami Dade College** and **Next Era Energy:** developing a new bachelor's degree program for students with associate's degrees in information technology and cybersecurity.
- **San José State University** and **Bay Area Council:** creating a Silicon Valley Center for Cybersecurity focused on cyber hygiene for computer science students.
- **University System of Maryland** and **Northrop Grumman Corporation:** launching the University of Maryland College Park Advanced Cybersecurity Experience for Students (ACES), an undergraduate cybersecurity living/learning honors program, and the University of Maryland Baltimore County Cyber Scholars Program.

Data Science and Analytics

- **The City University of New York (CUNY)** and **IBM:** building pathways for CUNY undergraduates and community college students in energy sustainability and large-data analytics.
- **The Ohio State University** and **Battelle Memorial Institute:** developing new undergraduate courses in large scale data analytics and data science.

Engineering and Computer Science

- **Washington University in St. Louis and The Boeing Company:** increasing the transfer of students from St. Louis community colleges and the University of Missouri St. Louis into bachelor's engineering programs.

Water Sciences

- **The University of Wisconsin System** and the **Milwaukee Water Council:** expanding opportunities in water science for undergraduates across the System, and recruiting and retaining students from community colleges into four year programs.

Life Sciences

- **The University of Massachusetts** and **Massachusetts Competitive Partnership:** mobilizing the Massachusetts community college system to increase the success rate of students transferring into four year programs in the life sciences, engineering, and information technology fields.

Higher Education-Workforce Alignment around High-Demand Clusters

- **Drake University** and **Principal Financial Group:** strengthening the education-workforce pipeline in high-demand fields such as bio-sciences, financial services, and health professionals.
- Louisville's **Business Leaders for Education (BLE):** addressing the skills misalignment to strengthen the education-workforce pipeline in high-demand fields such as advanced manufacturing; food and beverage manufacturing and innovation; value-added logistics and distribution; lifelong wellness and aging care.

Luncheon Discussion

BHEF BUSINESS-HIGHER EDUCATION FORUM®

The Business Case for Developing 21st Century Workplace Competencies

Overview

U.S. employers increasingly value employees who possess both content knowledge and fluency in core workplace competencies, such as critical thinking, analytical reasoning, expert written and oral communications, and the ability to work on multi-cultural teams. These 21st century workplace competencies are essential to productivity and innovation and the premium placed on individuals with these skills reflect the increasing complexity of the problems that business is required to solve today, and the pace and agility at which it is challenged to respond to them. IBM has been an advocate for this type of "T-shaped" professional who possesses both the deep content knowledge and the breadth of competencies that span across disciplines. Yet employers frequently cite deficiencies in 21st century workplace competencies in the current and upcoming workforce, and are legitimately concerned about the significant costs of employee training and turnover. These trends have major implications for U.S. economic competitiveness, security, equity, and civic engagement.

Conversations between the business and education communities about the misalignment between recent graduates' abilities and workforce demand too frequently stay in the conceptual realm, rather than the practical. Indeed, business and higher education have not been sufficiently engaged with each other to fully communicate the nature of 21st century competencies and, in turn, to build workable strategies to bridge the misalignment. Careful articulation of the competencies that business needs, and on-going collaboration between the two stakeholder groups, will enable higher education institutions to better adapt curriculum and co-curricular experiences to build 21st century competencies in students.

BHEF is the William and Flora Hewlett Foundation's national business partner addressing the need for 21st century workplace competencies as well as content knowledge, the combination of which Hewlett defines as "deeper learning." In this capacity, BHEF collaborated with members and their chief talent and training officers to document the role that 21st century workplace competencies play in hiring, training, and promoting employees, as well as those tools that businesses use to measure these abilities. These "deep dives" revealed the gaps that exist between companies' needs and competencies possessed by new hires, and the impact of these gaps on companies' costs and

competitiveness. Insights from these conversations will be the building blocks for an industry-led strategy to communicate business needs to those spearheading education reform efforts and incorporate 21st century workplace competencies into regional projects co-developed by BHEF business and academic members.

Insights from Industry

After interviews with more than one dozen chief talent and training officers at corporations in sectors including health care, aerospace and defense, and finance, several key insights came into sharper focus.

Rapid technological changes of the innovation economy require that recent college graduates enter the workforce with the wide combination of high-order skills and competencies that go beyond content knowledge and include such capabilities as critical thinking, problem solving, analytical reasoning, communication, and teamwork.

- Whereas once degrees in specific fields were sufficient for professional success, the increasingly competitive international workplace now requires employees to possess a variety of additional competencies beyond core academic expertise.
- Oral and written communications skills among new graduates need to be better honed to increase effectiveness in the workplace.

Leaner organizations, resulting from the recession and shifting demographics, are taking on a more integrated market model across the company. For example, companies move employees across divisions to give them a cross-functional work experience that deepens the company's bench strength and fills gaps in the workforce. These organizational shifts require a more flexible employee with the kinds of 21st-century skills that to enable them to play multiple roles and shift rapidly among tasks and working environments.

- Corporations are leaner today, using fewer staff to accomplish the same amount of work—or more.
- Graduates generally have the *content knowledge* to perform effectively in the workforce but too often lack the crucial *workplace competencies*.

Companies are increasingly screening applicants and current employees for particular competencies, using off-the-shelf tools and customized assessments, and investing less in internal training programs to increase those competencies. Asking education institutions to place greater emphasis on developing those competencies at the K-16 levels will realize considerable cost savings and, concomitantly, strengthen students' competitiveness in the job market.

- Companies are investing ever more resources to develop a better understanding of the workforce competencies they need.
- Companies increasingly adopt rigorous and aligned assessments in hiring, employee review, retention, and promotion.

Developing the necessary 21st-century workforce competencies will require closer collaboration between the corporations recruiting employees and the institutions educating them.

- Barriers to collaboration between business and K-16 education include a proprietary view of competency models, a focus on technical skills at the expense of training for core competencies, and an assumption that a college degree is a proxy for these competencies.
- Universities that seek to help students develop these competencies must serve the needs of particular institutions and regions and not use a generic, blanket approach.

Business-led interventions help mend the broken signaling mechanism between business and higher education needed to meet 21st century workforce goals.

- Fellowship opportunities for faculty to work alongside practitioners and co-curricular experiences for students as they work toward a degree often lead to better alignment between companies and universities.
- Academic programs in high-demand fields can establish advisory boards with strong industry representation that ensure necessary content knowledge and core competencies are integrated into curriculum.

BHEF's National Workforce and Higher Education Project: 21st Century Workplace Competencies as a Critical Design Principle

BHEF's *National Higher Education and Workforce Project* is a network of a dozen regional business-higher education partnerships focusing on high-demand workforce needs and improving higher education outcomes. As part of this work, BHEF is promoting development of a suite of workplace competencies that business considers essential to the 21st century workforce in addition to core content knowledge. Each of the regional sites within the *National Higher Education and Workforce Project* are conforming to common design principles (including a focus on the first two years of undergraduate education, integrating evidence-based practice, and addressing regional workforce needs). BHEF is committed to building a community of effective practice that builds both the academic content knowledge and the 21st century workplace competencies (together called "deeper learning") required today, and the next phase of the *National Higher Education and Workforce Project* will incorporate intervention strategies specifically designed to integrate 21st century workplace competencies.

T-shaped Professionals

The concept of a "T-shaped" professional refers to an individual with a deep knowledge of his or her discipline (the vertical leg of the T), but also the breadth of knowledge that allows the individual to see how one disciple interacts with others (the horizontal arm of the T). The T-shaped professional stands in contrast to the I-shaped person, an individual who specializes in one field and whose skills may come to be devalued following changes in technology or market conditions.

IBM has long advocated for the creation of more T-shaped professionals and has, since 2004, worked in partnership with higher education, government, and industry to promote the discipline of Service Science, Management and Engineering (SSME). Through SSME, IBM hopes to increase the number of students studying science, technology, engineering and math, more commonly known as the STEM fields. The T-shaped individual, as created through SSME, is both a collaborative innovator and an adaptive innovator, prized for the depth of their problem-solving skills in one field and the breadth of their communication skills in many others.

Donofrio, N., Spohrer, J., & Zadeh, H. (2010). *Research-Driven Medical Education and Practice: A Case for T-Shaped Professionals*. Retrieved from http://www.ceri.msu.edu/wp-content/uploads/2010/06/A-Case-for-T-Shaped-Professionals-20090907-Hossein.pdf.

Plenary Session II

How Higher Education is Adopting Disruptive Technologies to Improve Outcomes and Lower Cost in Undergraduate Education

The Evidence Base for Technology-Based Learning Tools: Findings and Insights from BHEF's Modeling

BHEF's system dynamics modeling for the Office of Naval Research has produced findings and insights into programs and policies that promote education and workforce alignment. Specifically, the simulations have demonstrated that new models of engagement between business and universities in which students receive multiple interventions, some relatively low-cost, in freshman and sophomore years can maximize persistence and yield higher ROI than investments in later years. In addition, scaling disruptive technologies, including intelligent learning tools, can increase student learning and persistence for large numbers of students. These disruptive technologies also offer scaling opportunities, and have the potential to significantly lower educational costs per student.

Online Learning Background

Online learning emerged in the 1990s as an alternative delivery model for education and training. Not-for-profit institutions, including Old Dominion University and the University of Maryland University College, as well as a wide range of for-profit institutions, provided online learning as a way to meet a growing demand for virtual delivery of certificate and degree programs. Additionally, online learning tools have been used to redesign "gateway" classes in order to increase student learning and improve student outcomes. Virginia Polytechnic Institution redesigned introductory calculus in the late 1990s and created its "Math Emporium" (see sidebar).

Virginia Polytechnic's Math Emporium

Virginia Tech's Math Emporium opened in 1997 in response to growing class sizes and shrinking resources. It employs what was then a groundbreaking Web-based teaching and testing system; the course redesign was sponsored by the Pew Charitable Trusts and has become a model for using technology to teach large-scale introductory university courses. Located off campus in a shopping mall, the Math Emporium occupies 60,000 square feet of space and serves more than 8,500 math students, all of whom must satisfy the university's quantitative and symbolic reasoning component and almost all of whom do so by enrolling in a mathematics course.

The Math Emporium is open 24/7 and offers seven self-paced, online, introductory math courses, one-on-one coaching from professors and graduate and undergraduate students, orientation sessions, independent study areas, student lounges, opportunities for collaborative learning, and over 500 Apple computers to facilitate the online learning component. Math staff members are available 60 hours per week to assist students.

An April 2012 *Washington Post* story reported that more VA Tech students today pass math courses than they did in 1997 and that per-student expenses have been cut by one-third by using the Math Emporium model.

However, scholars who analyzed the manner in which the internet introduced a series of disruptive business models have concluded that education has largely avoided "disruptive innovation." Clayton Christenson, of the Harvard Business School, has written extensively on disruptive innovation, by which he means those innovations at the bottom of the market that eventually displace the more established products or companies at the top of the market. He applies this same concept to education, specifically online education, which has certain delivery advantages over traditional education, including the lack of campus infrastructure, summer vacation, research activities and athletics, among other expenses.

But traditional brick and mortar universities are in a good position to exploit their own not insignificant resources (such as existing computer systems and faculty expertise) by providing blended instruction, which studies by the U.S. Department of Education have shown to be more effective than either a purely online or traditional classroom model. By blending online instruction (which is lower in cost) with classroom-based instruction, institutions are serving more students than previously possible under their old model. They are doing so with minimal outlay of new resources (notwithstanding the cost of developing the online learning tools) while simultaneously keeping costs down for students, improving both access and affordability.

The Onset of Online Learning at MIT and Carnegie Mellon

The Massachusetts Institute of Technology (MIT) first established its **OpenCourseWare** (OCW) project in 2001, posting the content from 50 courses online the following year. By 2007, MIT had posted almost its entire curriculum of 1,800 courses, representing 33 academic disciplines, and by 2012, it was posting 2,150 courses and boasted 125 million visits to its website.

Today, the OpenCourseWare Consortium includes more than 250 universities and associated organizations around the world. Its mission: "To advance formal and informal learning through the worldwide sharing and use of free, open, high-quality education materials organized as courses." To date, members of the consortium have published content from more than 13,000 classes in 20 languages. The OpenCoureWare project is not a teaching or class mechanism like EdX, which will be covered later in the section on MOOCs. (See http://www.ocwconsortium.org/ for more on the Consortium.)

Carnegie Mellon University's **Open Learning Initiative** (OLI) was established in 2002 with funding from the William and Flora Hewlett Foundation. Offering 17 free, introductory courses, the initiative seeks to use technology to make education more accessible and effective. Course content is not a regurgitation of that which is taught in the actual classroom, but rather is a redesign created specifically for web-based delivery. Faculty members ("content experts," as OLI refers to them) spend significant time reworking classes with the help of course designers.

Students must master skills and concepts, passing quizzes before moving on; faculty are able to monitor the class and individual students through a dashboard that shows them how students are doing. OLI collects data from students in real time, which allows the designers to tweak courses based on student learning cues and feedback as the session is ongoing. While classes are free for students, they are expensive for the university, given the time commitment required by faculty and others involved in course creation and maintenance.

The Emergence of MOOCs and Consortia

More recently, Massive Open Online Courses (MOOCs) have quickly emerged as a possible game changer in the delivery of higher education. They are truly what Clayton Christensen would call a disruptive innovation. In 2012 alone, more than two million students signed up for a MOOC. Consortia such as EdX, Coursera, Udacity, and Udemy are offering online courses taught by top-notch faculty to students anywhere in the world with an internet connection, free of charge. As many as 100,000 students have signed up for some individual MOOCs, although the completion rate hovers at around five or ten percent. Those who do complete a course typically receive some sort of certification but they do not receive credit.

That, however, may be changing. In November 2012, the American Council on Education (ACE) announced that it would be working with Coursera and EdX to determine, through its own research and evaluation, whether some MOOCs should be offered for credit. And in January 2013, Arizona State University, the University of Cincinnati, and the University of Arkansas System, among others, announced that they would offer a free introductory course online, through a program called MOOC2Degree, with the hope that those who complete and pass the course will subsequently go on to complete a degree.

Not all in higher education are convinced of the value of MOOCs and questions about their use within university classes abound. How should institutions assess the prior learning of students who have completed a MOOC and are now signing up for "traditional" courses? By what means will they determine how to assign credits for completed coursework and from which MOOCs? How does the advent of MOOCs affect the established business model and the bottom line? Can institutions afford the required adaptive learning platforms? What teaching methodology is best suited to this emerging format? And perhaps most importantly, how will MOOCs help individual institutions meet their particular missions?

Opportunity: Adoption of "Learning Analytics"

In an article last year in *Educause Review*, Kevin Guthrie, president of ITHAKA, a nonprofit that uses digital technologies to preserve the scholarly record and advance sustainable research and teaching, discussed Interactive Learning Online (ILO). He defines ILO as sophisticated adaptive systems that draw on usage data from students to deliver customized instruction tailored to a specific student. These systems, he believes, can increase faculty productivity while lowering instructional costs, all without sacrificing academic quality. The analysis of data is key to understanding how students perform, whether they succeed, and why some do not. It also allows instructors to engage in real-time assessment and to engage more directly with students who are underperforming. Data of this kind have not previously been available to educators, researchers and policy makers, and their value in improving learning outcomes cannot be overstated. New data analytics tools make data at the "click-level" available for research on learning and for improving the effectiveness of the learning tools.

University System of Maryland Partners with Ithaka S+R to Explore Innovation in Higher Education

As universities explore the potential of online education and other new technologies to improve student learning and graduation rates while lowering costs, the University System of Maryland (USM) is partnering with Ithaka S+R on a project to measure how well online learning platforms are working. Ithaka S+R, the recipient of a $1.4 million grant from the Gates Foundation, is a nationally known higher education research and consulting group. The partnership will seek to accelerate the use of new learning technologies across higher education. The USM will serve as a test bed for online or hybrid courses (those that blend face-to-face instruction with online instruction) in a range of subjects at campuses throughout the System. These new teaching technologies can deliver tangible cost savings, from engaging faculty in the most efficient manner to ensuring more students are able to graduate and complete their degree in less time.

The main focus of USM's partnership with Ithaka S+R will be a series of tests of online learning methods. Approximately 5-7 tests will be conducted during the 2013 spring, summer and fall terms. They will mostly be side-by-side evaluations of learning outcomes, comparing traditionally taught sections with hybrid or online-only sections in courses offered for credit. Students of traditionally taught sections and hybrid sections using Coursera and possibly other massive online open courses, or MOOCs, will take common final exams. This methodology will allow the partnership to assess the effectiveness of the different course delivery models. Students also will take surveys at the end of a term to give feedback about their experience in the courses.

Among its 11 campuses, USM includes the full range of institutional types that comprise American higher education. This breadth of institutions includes historically black universities, research universities, and the University of Maryland University College-the nation's largest non-profit online university. Given the System's strong record of experimenting with new teaching and learning technologies, the USM provides an ideal testing platform for how an individual campus can adopt advances in online learning. Furthermore, the USM was the first university system in the nation to embrace the use of technology and innovative educational techniques to redesign entire courses, resulting in better learning outcomes and lower costs.

The Ithaka/Gates project will not only examine the effectiveness of MOOCs. Included in the funded experiment will be online, blended, and highly interactive instructional models from Carnegie Mellon's OLI (On-Line-Learning) project, as well. In addition, we have applied for additional funding to test Pearson's LearningLab products.

Text provided by the University System of Maryland

Jim Clements

President
West Virginia University

Jim Clements is West Virginia University's 23rd president. WVU is the flagship university of West Virginia, with an internationally diverse student body of more than 33,000 undergraduate and graduate students across approximately 200 degree programs in the University's 13 constituent colleges, two divisional colleges, and multiple healthcare sites.

Dr. Clements chairs the boards of the West Virginia United Health System, the WVU Hospitals, and the WVU Research Corporation. In total, WVU and its affiliates represent a $2.3 billion enterprise and employ more than 18,000 people. WVU and its affiliates are currently in the midst of more than $600 million of capital improvements.

Regionally, he is a board member of the National Energy Technology Laboratory Regional University Alliance. He chairs the Implementation Committee of the Power of 32, a visioning initiative across 32 counties in Maryland, Ohio, Pennsylvania, and West Virginia. In the state, he recently co-chaired the West Virginia Higher Education Policy Commission's Diversity Initiative Council, and co-chaired the West Virginia Higher Education Policy Commission's College Completion Task Force. In addition, he serves on the board of the West Virginia Business Roundtable.

On a national level, he is active with national higher education organizations such as the Association of Public Land-Grant Universities (APLU) and the American Council on Education (ACE). He is currently co-chair of the APLU Energy Forum and is the chair of the ACE Commission on Leadership. Dr. Clements was the only university president selected to join a 15-member Innovation Advisory Board to the U.S. Department of Commerce. He was also nominated and participated in the 81st Joint Civilian Orientation Conference through the U.S. Department of Defense.

Before coming to WVU, Dr. Clements served as provost and vice president for academic affairs at Towson University, the second-largest public university in Maryland. Prior to becoming provost, he served as Towson University's vice president for economic and community outreach, and as the Robert W. Deutsch Distinguished Professor and chair of the Department of Computer and Information Sciences.

Dr. Clements earned a B.S. in computer science and an M.S. and Ph.D. in operations analysis from the University of Maryland Baltimore County (UMBC), as well as an M.S. in computer science from Johns Hopkins University. The fourth edition of his project management textbook was published in four languages and used in multiple countries; the fifth edition was released in spring 2012.

At WVU, Dr. Clements is a tenured professor in the Statler College of Engineering and Mineral Resources' Lane Department of Computer Science and Electrical Engineering.

He is married to Beth Clements, and they have four children – Tyler, twin daughters Hannah and Maggie, and Grace.

David Coleman

President
College Board

David Coleman is the ninth president of the College Board, a mission-driven, not-for-profit organization that connects students to college success and opportunity. Founded in 1900, the College Board is today made up of more than 6,000 educational institutions, including schools, school districts, colleges and universities.

Coleman grew up in a family of educators and has followed them into the field. He went to public school in New York City before enrolling at Yale University. At Yale, he taught reading to secondary school students from low-income families in New Haven and started Branch, an innovative community service program that worked with students at an inner-city New Haven high school. Based on the success of Branch, Coleman received a Rhodes Scholarship, which he used to study English literature at Oxford and classical educational philosophy at Cambridge. He returned to work at McKinsey & Company for five years, where he led much of the firm's pro bono work in education.

Together with a team of educators, Coleman then founded the Grow Network, an organization committed to making assessment results truly useful for teachers, parents and students. The Grow Network delivered breakthrough quality reports for parents and teachers as well as individualized learning guides for students. Based on the success of Grow, McGraw-Hill acquired the organization in 2005.

Coleman left McGraw-Hill in 2007 and co-founded Student Achievement Partners, a nonprofit that assembles educators and researchers to design actions based on evidence to improve student outcomes. Student Achievement Partners played a leading role in developing the Common Core State Standards in math and literacy, a process that drew on the input of teachers, states, higher education, business leaders and researchers from across the country. As a founding partner, Coleman led Student Achievement Partners' work with teachers and policymakers to achieve the promise of the Common Core State Standards. He left Student Achievement Partners in the fall of 2012 to become president of the College Board.

Coleman has been recognized as one of Time magazine's "11 Education Activists for 2011" and was recently named one of the NewSchools Venture Fund Change Agents of the Year for 2012.

Richard K. Miller

President
Olin College

Richard K. Miller was appointed the President and first employee of the Franklin W. Olin College of Engineering in 1999, where he also holds an appointment as Professor of Mechanical Engineering. He served as Dean of the College of Engineering at the University of Iowa from 1992-1999, and spent the previous 17 years on the engineering faculties at the University of Southern California (where he held the position of Associate Dean for Academic Affairs) and the University of California, Santa Barbara.

Dr. Miller's research interests are in structural dynamics and nonlinear mechanics with application to earthquake engineering and spacecraft structural design. He is the author or co-author of about 100 reviewed journal articles and other technical publications. His research interests are in nonlinear dynamic phenomena such as vibroimpact of adjacent structures during earthquakes, elastic wave propagation in frictionally bonded solids, stability and deformation in wrinkling membranes, active control of large civil structures, and dynamic identification of hysteretic structures. His work in spacecraft structures includes the design of large precision deployable truss antenna structures, the design of large inflatable reflectors, and the accurate analysis of the large deformation of articulated trusses during deployment. He has been a consultant to several companies including The Aerospace Corporation, NASA's Jet Propulsion Laboratory, Hughes Aircraft Company (now Raytheon Company), and Astro Aerospace Corporation (now Northrop Grumman Corporation), where he made contributions to the Heliogyro, Solares, Mast Flight Experiment, Milstar, Mobile Transporter, and other projects.

Dr. Miller has won five teaching awards at two universities, received the Legacy award from the College of Engineering at the University of Iowa, and was recognized in 2006 by the Mass High Tech journal as an All-Star for his work in leading the establishment of Olin College. He is a member of the Board of Directors of Stanley Consultants, Inc., and serves on the Board of Trustees of Babson and Olin Colleges. He has also served as the chair of the National Science Foundation's Engineering Advisory Committee and on several advisory committees for the National Academy of Engineering, Harvard University, and other institutions. In addition, he has served as a consultant to the World Bank in the establishment of new academic institutions. He is a member of AIAA, ASME, ASCE, ASEE, Tau Beta Pi, Phi Kappa Phi, and Sigma Xi. A native Californian, Dr. Miller earned his B.S. degree in Aerospace Engineering in 1971 from the University of California, Davis, where he received the 2002 Distinguished Engineering Alumnus Award. In 1972, he earned his M.S. degree in Mechanical Engineering from the Massachusetts Institute of Technology. In 1976, he earned his Ph.D. in Applied Mechanics from the California Institute of Technology.

Diana Natalicio

President
The University of Texas at El Paso

Diana Natalicio was named president of UTEP in 1988. During her long and distinguished career with the University, Dr. Natalicio has served as vice president for academic affairs, dean of liberal arts, chair of the modern languages department and professor of linguistics. Her sustained commitment to provide all residents of the Paso del Norte region access to outstanding higher-education opportunities has helped make UTEP a national success story.

During Dr. Natalicio's tenure as president, UTEP's enrollment has grown from 14,971 to more than 22,700 students, who reflect the demographics of the Paso del Norte region from which 90% of them come. More than 77% are Mexican American, and another 6% commute to the campus from Ciudad Juárez, Mexico. UTEP's annual budget has increased from $65 million to more than $400 million, since 1988. UTEP is designated as a research/doctoral university, recognized nationally for both the excellence and breadth of its academic and research programs. UTEP's annual research expenditures have grown from $6 million to more than $76 million per year, and doctoral programs from one to 19 during this same period. To accommodate steady growth in enrollment, academic programs and research, over the past five years the university has managed nearly $300 million in new and renovated facilities expansion projects in science, engineering, health sciences and other student quality-of-life related infrastructure.

Dr. Natalicio serves on the board of trustees of the Rockefeller Foundation and on the board of directors of the American Council on Education and the Association of Public and Land Grant Universities. She has served on the board of governors of the U.S.-Mexico Foundation for Science, the NASA Advisory Committee (NAC), the boards of Trinity Industries, National Action Council for Minorities in Engineering, Sandia Corporation and Internet2, and was appointed by President George H.W. Bush as a member of the Advisory Commission on Educational Excellence for Hispanic Americans. Initially appointed to the National Science Board by President Bill Clinton in 1994, she served two six-year terms as a Board member and three two-year terms as the NSB's vice chair.

Dr. Natalicio was recognized in 2011 by the President of Mexico with the Orden Mexicana del Aguila Azteca, the highest honor bestowed on foreign nationals. She received the Harold W. McGraw, Jr. Prize in Education in 1997, was inducted into the Texas Women's Hall of Fame in 1999, was honored with the Distinguished Alumnus Award at The University of Texas at Austin in 2006 and is the recipient of honorary doctoral degrees from Georgetown University, Smith College and the Universidad Autonoma de Nuevo Leon.

A graduate of St. Louis University, Dr. Natalicio earned a master's degree in Portuguese and a doctorate in linguistics from The University of Texas at Austin.

Mary Jane Saunders

President
Florida Atlantic University

Mary Jane Saunders began serving as the President of Florida Atlantic University on June 7, 2010. She is the sixth president in the half-century of FAU, a comprehensive public university with sites located throughout its six-county service region in Southeast Florida. As chief executive officer, Dr. Saunders oversees an institution that is currently serving 30,000 students at the bachelor's, master's, and doctoral and postdoctoral levels. With more than 3,000 employees, including 1,200 dedicated faculty members, and an annual operating budget in excess of $600 million, FAU ranks as one of the largest employers in South Florida. The University has an annual economic impact of $6.3 billion.

Under President Saunders' leadership, FAU is rapidly emerging as a major center of research, scholarship, creative services, community engagement and economic development. Important advances made during her first two years in office include the launching of the Charles E. Schmidt College of Medicine, the building of FAU Stadium and the opening of the Innovation Village housing campus on the Boca Raton campus. She is leading an initiative to strengthen the University's ties with business and industry in South Florida, fostering a climate of synergy that delivers direct benefits to the University's private sector partners and supports regional economic development.

In recognition of the increasingly important role that the University is playing in the economic arena, the Greater Boca Raton Chamber of Commerce named FAU the 2012 Business of the Year and the South Florida Business Journal included President Saunders on its list of the Most Influential Business Women of 2012.

President Saunders serves on the boards of a wide variety of community organizations. She is a founding member and an executive committee member of Life Sciences South Florida, a public/private consortium that supports the development of an industry cluster in South Florida encompassing the life sciences, biotechnology, pharmaceuticals, diagnostics and information technology. She is a member of the Executive Committee of MedUTech, a Boca Raton-based organization with similar goals. Additionally, she is a trustee and elected Board Member of the Greater Boca Raton Chamber of Commerce, an elected board member of the Business Development Board of Palm Beach County, and chair of the Broward County Educational Consortium Policy Council. She is also a board member and membership chair of the Florida Association of Colleges and Universities and an alumna of Class VII of the Florida Executive Leadership Program presented by Leadership Florida.