FLORIDA POLYTECHNIC
University

Science, Technology, Engineering & Mathematics (STEM) Landscape: Trends and Models

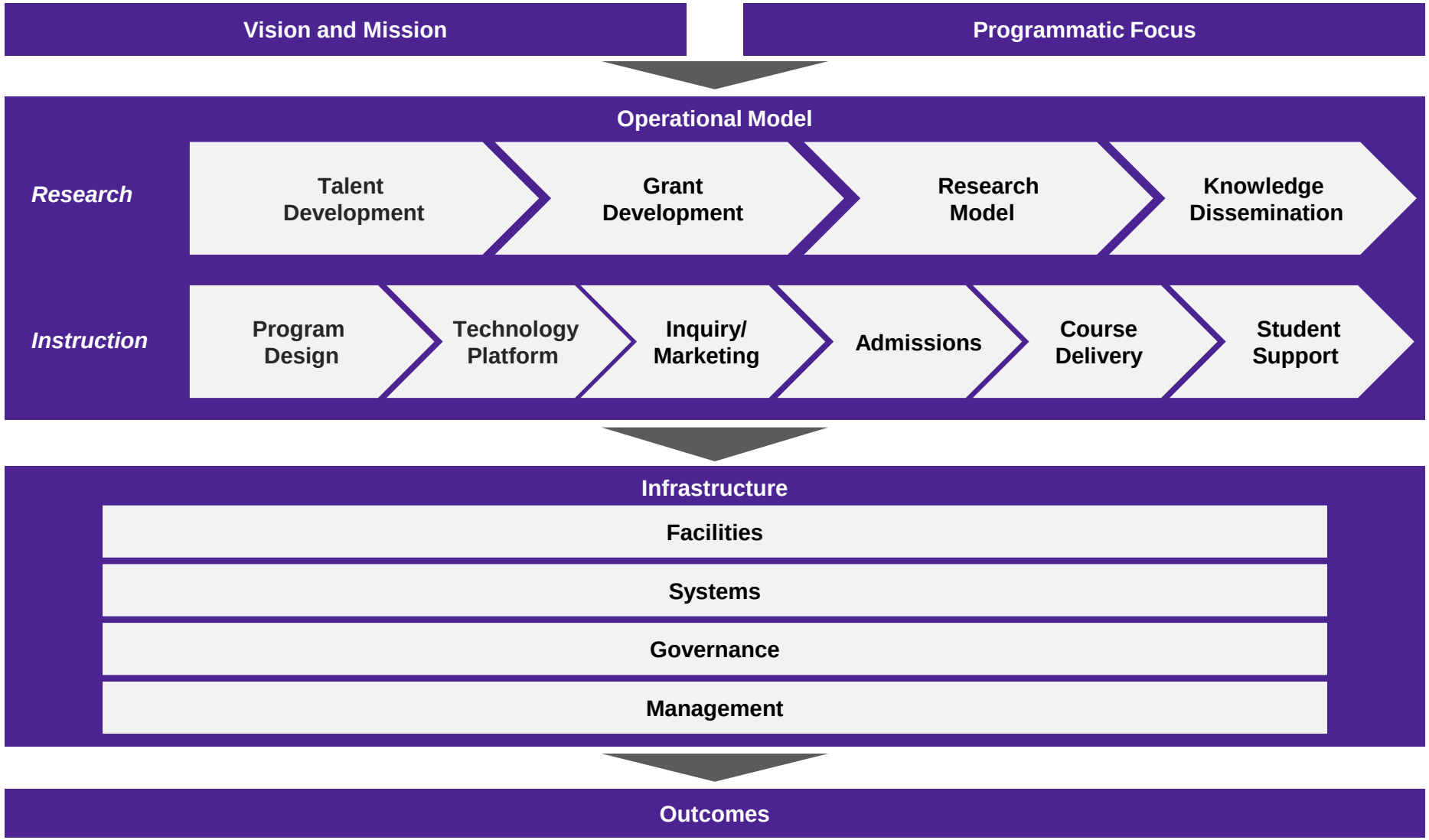
THE PARTHENON GROUP

February 5, 2013

Objectives for Today

- Provide a brief overview of the U.S. higher education landscape
- Describe current trends in the area of STEM, nationally and in Florida
- Provide an in-depth overview of STEM models, nationally and internationally (Mission and vision, key success factors, industry partnerships)
- Discuss role of online education and emerging online STEM offerings
- Discuss implications for Florida Polytechnic University

A university's strategic plan will integrate vision and programmatic focus with an operational model and supporting infrastructure



Agenda

Developing the Vision in Context

Programmatic Considerations

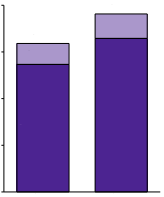
Operational Model Considerations

Implications for Florida Polytechnic University

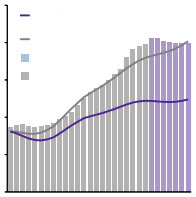
Higher Education Landscape

Enrollment has been relatively flat and is projected to slightly decline over the next few years

Fall Enrollment, U.S. Not-for-Profit Institutions, 2002-2011)



4-Year Not-for-Profit Contributions to Enrollment Model, 1990-2019



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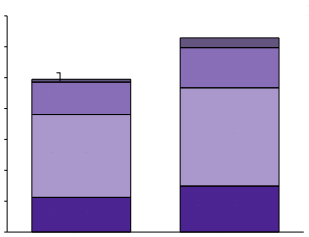
Source: IPEDS; Parthenon HED Enrollment Forecast

Higher Education Landscape

Growth in degree completions has been fueled mainly by Associate degrees and Doctorate degrees

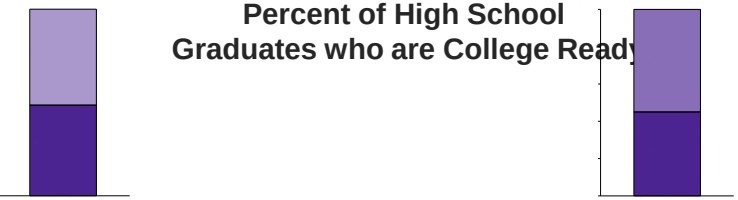


Degrees Awarded at U.S. Not-for-Profit Institutions, 2004-2011

Source: IPEDS

Higher Education Landscape

Half of high school graduates are not college ready, resulting in college drop-out rates of over 50%. Majority of students attend schools with low graduation rates



Percent of High School Graduates who are College Ready

Graduation Rate for Students Matriculating in 2003

Percent of Institutions with Given Graduation Rate

Nearly 1/2 of high school graduates are not ready for college

Over half of the students matriculating in 2003 have dropped out

Majority of students attend schools with graduation rates below 50%

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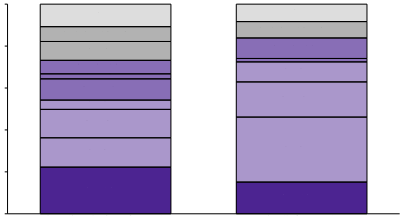
Source: NCES; Strong American Schools (Diploma to Nowhere, 2008); Adelman, 2006; Bettinger & Long, 2005

Higher Education Landscape

Nationally, tuition and public funds contribute approximately 55% of total institutional revenues. In Florida SUS, this is closer to 70%



Revenue by Source for U.S. and Florida SUS Not-for-Profit Institutions, 2011

Note: Other includes Sales and Services of Education Activities, Capital Appropriations, Contributions from Affiliated Entities, and Non- reoccurring revenue, such as the selling of assets
Source: IPEDS

Higher Education Landscape

The National Center for Education Statistics and the US Immigration and Customs Enforcement Agency categorize STEM degrees into six areas

U.S. Immigration and Customs Enforcement

STEM = Science, Technology, Engineering and Mathematics

ies NATIONAL CENTER FOR EDUCATION STATISTICS
Institute of Education Sciences

Computer and Information Sciences

Largest Majors

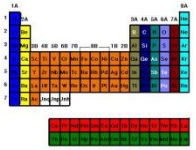
- Comp. & Info. Sciences
- Computer Science
- Comp Sys Networking & TeleCom

Engineering and Engineering Technologies

Largest Majors

- Mechanical Engineering
- Electrical, Electronics & Com. Eng.
- Civil Engineering

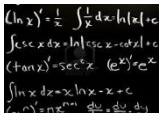
Physical Sciences



Largest Majors

- Chemistry
- Physics
- Geology/Earth Science

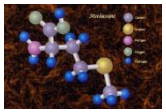
Mathematics and Statistics



Largest Majors

- Mathematics
- Statistics
- Applied Mathematics

Science Technologies



Largest Majors

- Biology Technician
- Chemical Technology
- Industrial Radiologic Technician

Biological and Biomedical Sciences

Largest Majors

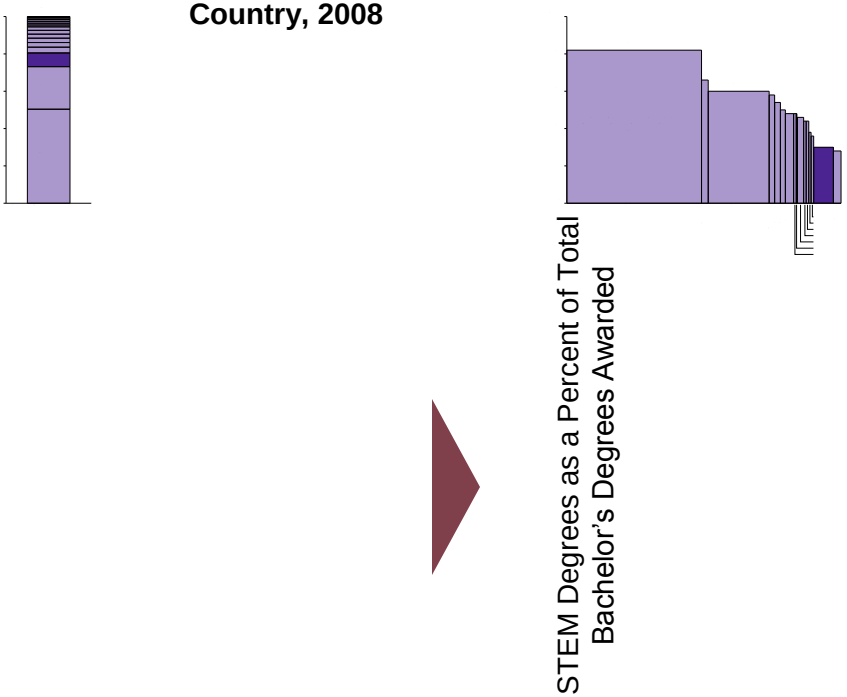
- Biology/Biological Science
- Biochemistry
- Biomedical Sciences

Source: NCES

Higher Education Landscape

The percent of STEM graduates in the US is among the lowest of the developed economies; China and India far out-produce the US

STEM Degrees Awarded by Country, 2008



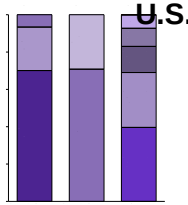
STEM Degrees as a Percent of Total Bachelor's Degrees Awarded, by County, 2008

Note: Data for China, India, and Brazil is from the Accenture Report on STEM "No Shortage of Talent"
Source: U.S. Congress Joint Economic Committee; Accenture Report on STEM "No Shortage of Talent"

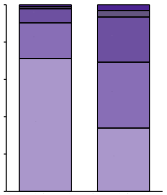
Higher Education Landscape

In 2011, 342K STEM degrees were awarded by 1.4K institutions in the U.S.

U.S. STEM Degree Students by Type of School, Degree Level, and Field 2011



Percent of Degrees Awarded at Given School That are STEM Degrees, 2011



Most STEM degrees are awarded at the bachelor level and in public institutions

While many institutions offer STEM degrees, specialized schools produce a larger proportion of degrees

Source: IPEDS

A university's strategic plan will integrate vision and programmatic focus with an operational model and supporting infrastructure

Vision and Mission

- **Why do we exist?** What is the problem or issue we are trying to address? What is our purpose as an organization?
- **What population or market will we serve?** Who is our target audience and what are their needs? How do we propose to address these needs? What are our geographic boundaries?
- **What will success look like?** How will our target audience benefit from our efforts? What is the ultimate result we hope to achieve?

Programmatic Focus

Operational Model

Infrastructure

Outcomes

Agenda

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Programmatic Considerations

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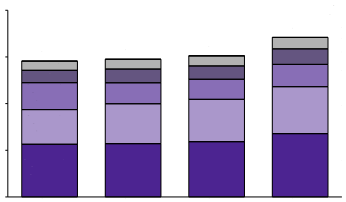
Implications for Florida Polytechnic University

STEM Programmatic Trends – U.S. Context

Of the six STEM areas, Engineering and Engineering Technologies is the largest field, but Biological and Biomedical Sciences has grown the fastest

U.S. STEM Degrees by Field, 2005-2011

Bachelor's Degrees and Above



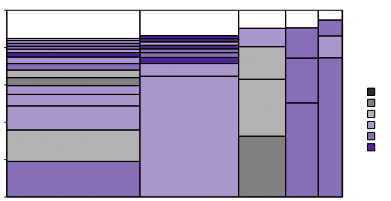
Source: IPEDS; US National Science Foundation

STEM Programmatic Trends – U.S. Context

Of the ~340K STEM degrees awarded nationally in 2011, a handful of large programs dominate a given STEM Field

U.S. STEM Degrees by Field and Degree, 2011

Bachelor's Degrees and Above



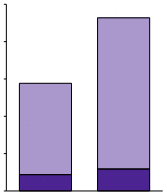
Annual Growth ('05-'11)

Source: IPEDS

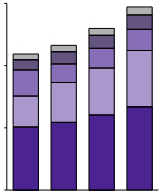
STEM Programmatic Trends – Florida Context

In Florida, STEM degrees have declined slightly as a percent of overall degrees awarded by Florida schools, but are still growing faster than the national average

Florida STEM Degrees * as Percent of Total Florida Degrees, 2005-2011



Florida STEM Degrees * by Field, 2005-2011



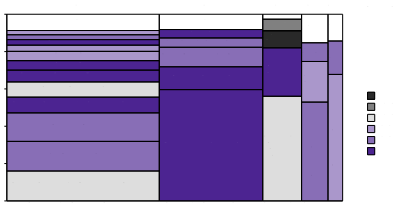
Note: * Bachelor's degrees and above
Source: IPEDS; US National Science Foundation

STEM Programmatic Trends – Florida Context

Compared to national averages, Florida has seen more extreme (over 10% annually) specific degree growth

Florida STEM Degrees by Field and Program, 2011

Bachelor's Degrees and Above



Annual Growth ('05-'11)

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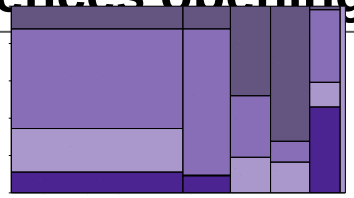
Source: IPEDS

STEM Programmatic Trends – Florida Context

BLS predicts 10.5K * STEM job openings in FL in 2020. Computer Sciences openings are skewed toward lower degree levels



Florida STEM Related Job Openings by Degree Level, 2020E

- **As Florida Polytechnic considers the programmatic focus of the institution, it will need to conduct a more detailed analysis of demand (national and regional job markets in STEM-related fields) and supply (what STEM-related programs are already being offered in Florida's colleges and universities)**
- **MGT America will be providing additional detail in this area**

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Note: * The number of job openings is based on current BLS methodology and likely underrepresents job openings due to replacements.

STEM Programmatic Trends – U.S. Context

The focus on "applied" and "learning through doing" is becoming more apparent in undergraduate STEM education

Trend 1:
Involving students in research earlier on

- "Involving students earlier on in research **makes the concepts they have to learn much more real,** and keeps students engaged and in the field"
- "To be done well, this needs to become part of the school's/department's curricular design, and **faculty need to be encouraged to write students into their grants"**

Trend 2:
Preparing students for industry (at all degree levels)

- "Institutions are starting to **hire more people from industry into academia to teach.** These people can infuse courses with their applied thinking and develop projects that teach students how to apply theoretical concepts"
- "Industry is looking for so much more than just the theoretical skills in engineering, etc. **They are looking for people with problem-solving, teamwork, and communications skills.** Projects co-sponsored by industry help build these skills"
- Students in our engineering program are required to take a project class every semester with a company sponsor. Classes get more complex as you move up. **Companies often tell us that we have solved their 2-year problem.** Our undergraduates are ready to work – have the right skills" (ASU-Poly)

Trend 3:
In view of the above, higher education is recognizing the importance of building relationships with business

- "**Seniors work on capstone projects that come from industry.** Industry pays for some materials and then serves as advisors. Industry partners often use these projects as a way to **identify/hire the most capable students**" (UW-Seattle)
- "Companies typically **pay $20-$25K per student project**. Larger companies often do it for **recruitment purposes,** smaller companies do it to **expand their own bandwidth**" (ASU-Poly)
- "**Funding from the state has dropped.** One of the ways to generate resources is to focus more on startups coming out of the research lab. This helped build the high tech industry in the area" (UW – Seattle)
- "**Co-ops** are also a good way to provide students with experiential learning and to match students and employers. These are different from internships in that they alternate work terms with school terms, and typically extend the length of degree (5 years vs. 4 years)"

Source: Parthenon interviews with experts in the field

A University's strategic plan will integrate Vision and Programmatic Focus with an Operational Model and supporting Infrastructure

Vision and Mission

- **Why do we exist?** What is the problem or issue we are trying to address? What is our purpose as an organization?
- **What population or market will we serve?** Who is our target audience and what are their needs? How do we propose to address these needs? What are our geographic boundaries?
- **What will success look like?** How will our target audience benefit from our efforts? What is the ultimate result we hope to achieve?

Programmatic Focus

- **Demand:** Where is the greatest labor market need, nationally, regionally, and locally? What programs/degrees are required to meet this need? What are funders and employers looking for?
- **Supply:** What is already being offered by other universities in Florida, and with what level of success? Where are the biggest gaps and opportunities?
- **Differentiation:** What is the best way to differentiate ourselves in the STEM landscape? How focused/broad should we be at the beginning?

Operational Model

Infrastructure

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Developing the Vision in Context

Programmatic Considerations

Operational Model Considerations

- **National and International STEM Models**
- **Research in STEM Fields**
- **Online Learning in STEM Institutions**

Implications for Florida Polytechnic University

STEM Models – Introduction

Globally, STEM-focused institutions fall into three broad groupings based on their mission and focus

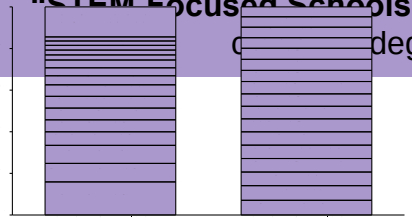
	1 Global Research Institution	2 Elite Undergraduate Institution	3 Industry-Engaged Institution
Primary Customer	**Faculty/Academia**	**Students**	**Employers and Economy**
Description	• Known for high research funding and high quality faculty • Receive high rankings on research dimensions • Typically focused on Doctoral degrees	• Very selective (high admission requirements) • Produce graduates who are hired into top firms • Typically focused on Bachelor's and Master's degrees	• Closely aligned to industry • Higher proportion of faculty come from industry • Emphasis on applied, hands-on learning and co-ops/apprenticeships for students

STEM Models – Methodology

We used the following criteria/metrics to identify STEM-focused institutions

Initial Filter: Degree of STEM Focus

"STEM Focused Schools": 50% or more of graduates c degrees in STEM



7% of all STEM degrees

"STEM Production Schools": More than 2,500 students complete STEM field degrees each year

15% of all STEM degrees

STEM Models – Methodology

We used the following criteria to determine the primary focus of STEM institutions

Initial Filter: Degree of STEM Focus

- "STEM-Focused Schools": 50% or more of graduates complete degrees in STEM
- "STEM Production Schools": Have more than 2,500 students complete STEM field degrees each year

	1 Global Research Institution	2 Elite Undergraduate Institution	3 Industry-Engaged Institution
Inputs	• **US:** Lombardi rankings (top 25) • **International**: Times Higher Education rankings (top 100 under 50)	• Median SAT scores (in the top 25 on the Lombardi measure) • US News & World Report rankings (in the top 25)	• Qualitative assessment of ties to industry (mission of institution, student experience, faculty background and focus)
National Examples	CALTECH • MIT, Stanford, Georgia Institute of Technology, University of Michigan	Olin College • Harvey Mudd, Carnegie Mellon, Rensselaer Polytechnic Institute	ASU's Polytechnic campus • Virginia Tech, Colorado School of Mines, Univ. of Maryland – Baltimore County
International Examples	POSTECH Pohang University of Science and Technology • ETH Zurich (Switzerland), Korea Advanced Institute of Science & Technology (Korea), Cranfield University (UK)	**IIT (India)** *Note: awards masters/doctorates as well* • Bandung Institute of Technology (Indonesia). Model not typically found in Western Europe	**TTI (Japan)** • Polytechnics Canada, Duale Hochschule Baden-Wurttem-berg (German), Aston Univ. & Derby/ Rolls Royce (UK)

Notes: **Lombardi rankings** are developed by the Center for Measuring University Performance at ASU and include 9 measures: total research dollars, federal research dollars, endowment, annual giving, national academy members, faculty awards, number of doctorates awarded, number of postdocs, and median SAT**. US News & World Report rankings** include the following measures: Acceptance rate, freshman retention rate, 6-year graduation rate, class size, SAT/ACT 25th-75th percentile. **Times Higher Education rankings** use 13 performance indicators grouped into five areas: Teaching (learning environment), Research (volume, income, and reputation), Citations (research influence), Industry Income (innovation), and International Outlook (staff, students, and research).

1 Global Research Institution: Caltech (US)

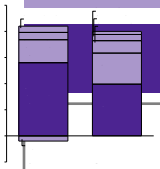
California Institute of Technology boasts extensive, robust options in research, earning it the rank of # 1 World University in Times Higher Education rankings

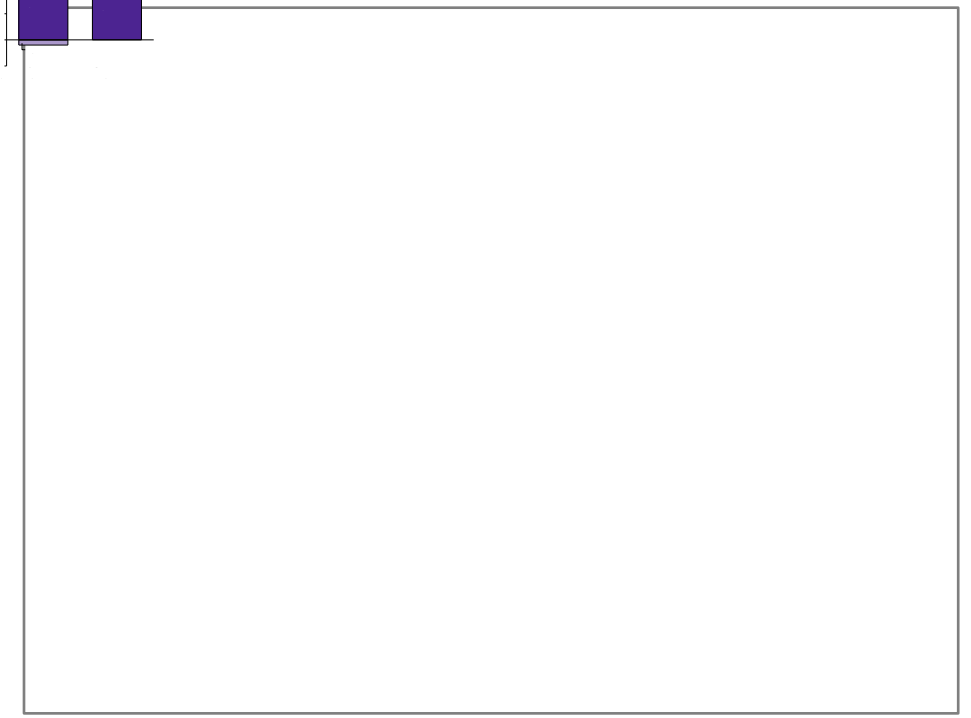
	California Institute of Technology
Location & Year Founded	• Founded in 1891 • Pasadena, CA
Ownership	• Private, Non-profit
Education Levels Awarded	• Bachelors, Masters, Doctoral • Post-master's certificate & combined-degree programs with 14 undergraduate liberal arts colleges
Enrollment (2011)	• 978 Undergraduates • 1,253 Graduates
Faculty	• 322 full time, 16 part time faculty • Student to faculty ratio: 3:1
Departments	• 48 Research Centers & Institutes • 26 Majors for Bachelors, 27 Masters Programs, 27 PhD Programs, 2 Doctor of Engineering Programs
Subject Focus	• 6 Academic Divisions: Biology, Chemistry & Chemical Engineering, Engineering & Applied Science, Geological & Planetary Sciences, Humanities & Social Sciences, Physics, Mathematics, & Astronomy
Endowment	• $1.6B (2011)
Accolades	• Times Higher Education #1 World University Ranking • US News #10 Best National University

Key Features

- **Breadth and depth of research:** Multitude of advanced theoretical research centers, including inter-disciplinary centers
- **Innovation:** More than 2,000 patents since 1980 through the Caltech Office of Technology Transfer
- **Student-focused approach**: Student to faculty ratio of 3:1
- **Elite individuals:** Many faculty and alumni are Nobel Prize winners and National Medal of Science recipients; highest SAT scores in the US.

Financials (FY 2011)





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Source: University Website, US News and World Reports, IPEDS; Center for Measuring University Performance

1 Global Research Institution: Other Examples in the US

Other leading institutions also adopt this model

	Massachusetts Institute of Technology	Stanford University	University of Michigan – Ann Arbor	Georgia Institute of Technology
Location & Year Founded	• 1861 • Boston, MA	• 1891 • Palo Alto, CA	• 1817 • Ann Arbor, MI	• 1885 • Atlanta, GA
Ownership	• Private	• Private	• Public	• Public
Degree Levels Awarded	• Bachelors, Masters, Doctoral	• Bachelors, Masters, Doctoral and Professional	• Bachelors, Masters, Doctoral	• Bachelors, Masters, Doctoral
Total Enrolment (2011)	• Undergrad: 4.3K • Graduate: 6.5K	• Undergrad: 6.8K • Graduate: 8.4K	• Undergrad: 27K • Graduate: 15.3K	• Undergrad: 14.5K • Graduate: 7K
Annual Revenue	• $4.2B (29% of revenue from research grants)	• $6.3B (17% of revenue from federal grants)	• $4.1B (32% of Expenses Spent on Research)	• $1.1B (55% of Expenses Spent on Research)
Subject Focus	• Science, Technology, Engineering, Mathematics	• Science, Technology, Engineering, Mathematics and Social Sciences	• Science, Technology, Engineering, Mathematics and Social Sciences	• Science, Technology, Engineering, Mathematics
Rankings	• Lombardi Rank: 1 • U.S. News Rank: 6 • Median SAT Score: 1465	• Lombardi Rank: 1 • U.S. News Rank: 6 • Median SAT Score: 1440	• Lombardi Rank: 3 • U.S. News Rank: 29 • Median SAT Score: 1300	• Lombardi Rank: 23 • U.S. News Rank: 36 • Median SAT Score: 1335
Comments	• Most (70 percent) of the research conducted on the MIT campus is supported by the US government • Focused on developing fields, Bioengineering, Sustainability, New Media, Financial Technology and Entrepreneurship	• Entrepreneurial Focus – Stanford Engineering faculty and graduates have founded an estimated 12,700 companies over the decades, including Google, Hewlett-Packard and Cisco Systems, that form the backbone of Silicon Valley	• 29% STEM Degrees • Engineering School's Center of Entrepreneurship recently hosted "Student Hacker Contest"	• In 2012, SmartMoney named Georgia Institute of Technology as 1st best salary returns on tuition • Fosters a number of start up companies through technology center

Source: University Websites, Times Higher Education; IPEDS

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Global Research Institution: Pohang Uni. of Science and Tech.

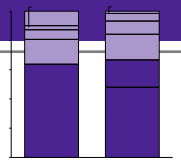
Only 28 years old, *Postech* is a very well-known example of a young, world-class research university with >60% of their income coming from research grants and contracts

	Pohang University of Science & Technology (Postech)
Location & Year Founded	• Founded in 1986 • Pohang, South Korea
Ownership	• Private (POSCO; one of world's largest steel-producer – independently run)
Education Levels Awarded	• Bachelors, Masters, Doctoral
Enrollment (2011)	• Undergraduate: 1,414 • Postgraduate: 1,870
Faculty	• Student : Faculty ratio = 4.3:1
Departments	• Undergraduate: 11 Departments (4 Science, 7 Engineering) • Graduate: 6 Departments, 7 Division, 5 Graduate Schools, 3 Specialised Graduate Schools • Research Units: 69 units
Subject Focus	• Science, Technology, Engineering, Mathematics
Endowment	• $2B (2011)
Accolades	• Times Higher Education #50 World University Ranking • Times Higher Education #1 World University Ranking Under 50

Key Features

- **State-of-the-art science research facilities:** Multiple research centers set up in conjunction with industry, private and public institutions
- **Strict faculty hiring and pay structure:** Implements strict tenure evaluation and performance-based pay based on research and student satisfaction
- **Student-focused approach**: highly personalized, hands-on, research-led experience for students; all students are given full scholarship and on-site accommodation

Financials (FY 2011)



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Source: University Website, Times Higher Education, Korean Herald

1 Global Research Institution: Other International Examples

Other leading technology HEI also adopts this model and have a particular focus on postgraduate & doctoral degrees

	ETH Zürich – Swiss Federal Institute of Technology Zürich	École Polytechnique Fédérale de Lausanne	Korea Advanced Institute of Science and Technology	Cranfield University
Location & Year Founded	• Founded in 1853 • Zurich, Switzerland	• Founded in 1968 • Lausanne, Switzerland	• Founded in 1971 • Daedeok Science Town, Korea	• Founded in 1946 • Cranfield, UK
Ownership	• Public	• Public	• Public	• Public
Degree Levels Awarded	• Bachelors, Masters, Doctoral • Continuing Ed (Certificates, MBA)	• Bachelors, Masters, Doctoral • Short courses for Cont. Education	• Bachelors, Masters, Doctoral	• Masters, Doctoral
Enrollment (2011)	• Bachelors: 8,439 • Masters: 4,563 • Doctoral: 3,699	• Bachelors: 2,892 • Masters: 1,855 • Doctoral: 3,355	• Bachelors: 3,452 • Masters: 2,197 • Doctoral: 2,357	• Masters: 2,700 • Doctoral: 700
Annual Budget	• $1.6B (~25% from third party private funding)	• $856M (~30% from third party private funding)	• $397 (33% for research activities; 32% from research grants)	• £166M (~30% from research grants/contracts)
Subject Focus	• Science, Engineering, Architecture, Management, Social Science	• Science, Technology, Engineering, Mathematics	• Science, Technology, Engineering, Mathematics	• Aerospace, Automotive, Bioscience, Energy, Environment, Management, Manufacturing, Security and Defence
Times Higher Education Rankings	• Ranking: – #12 in world – Overall – #8 in world – Eng. & Tech. • Citation Score: – 86.6 – Overall	• Ranking: – #46 in world – Overall – #2 in world – Under 50 – #14 in world – Eng. & Tech. • Citation Score: – 95.3 – Overall	• Ranking: – #94 in world – Overall – #5 in world – Under 50 – #44 in world – Eng. & Tech. • Citation Score: – 58.4 – Overall	• Ranking: – #11 in world – Staff : Student ratio – #1 in UK – Staff : Student ratio
Comments	• Top technology-centric university in the world outside the US • Sister university of École Polytechnique Fédérale de Lausanne	• Recently won 2 projects worth $1.2B each in an EU technology contest (Jan 2013)	• All lectures given in English • Allocates 7% of budget towards globalization activities	• Largest center in Europe for applied research, development and design • Industry partners include Airbus, Boeing, GlaxoSmithKline, Rolls-Royce, Shell and BP

Source: University Website, Times Higher Education

2 Elite Undergraduate Institution: Olin College (US)

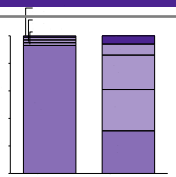
The Franklin W. Olin School of Engineering relies heavily on the endowment while offering a distinctive program for a select few students

	Franklin W. Olin School of Engineering
Location & Year Founded	• Chartered in 1997, first students in 2002 • Needham, Massachusetts
Ownership	• Private, Non-Profit
Degree Levels Awarded	• Bachelors Only
Enrollment (2011)	• 344 Undergraduates
Faculty	• 35 full time, 9 part time (no tenure) • Student to faculty ratio: 9:1
Departments	• 3 ABET-accredited degrees: General Engineering, Electrical and Electronics Engineering, Mechanical Engineering • No academic departments
Subject Focus	• Engineering only
Endowment	• $369M (2011)
Accolades	• *US News* #6 Best Undergraduate Engineering Programs, non-doctoral

Key Features

- **Small and Focused:** Small, undergraduate only student body
- **No Departments or Majors:** Every students is responsible for creating their own path in the course of study
- **No Tenure:** Faculty is focused on innovative teaching
- **Very Selective:** Very rigorous screening process; Opened with full scholarships for all students, now $20K/year

Financials (FY 2011)



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Source: University Website, Atkinson, Robert D. and Mayo, Merrilea, "Refueling the U.S. Innovation Economy: Fresh Approaches to Science, Technology, Engineering and Mathematics Education, IPEDS

2 Elite Undergraduate Institution: Other Examples in the US

Harvey Mudd is closest to the Olin model; Carnegie and RPI have a much stronger research component. The model is more rare – opportunity to differentiate

	Harvey-Mudd College	Carnegie Mellon University	Rensselaer Polytechnic Institute
	HARVEY MUDD COLLEGE	Carnegie Mellon University	Rensselaer
Location & Year Founded	• 1955 • Claremont, CA	• 1900 • Pittsburgh, PA	• 1824 • Troy, New York
Ownership	• Private	• Private	• Private
Degree Levels Awarded	• Bachelor of Science	• Bachelors, Masters, Doctoral	• Bachelors, Masters, Doctoral
Total Enrolment (2011)	• Undergrad: 0.7K	• Undergrad: 6.2K • Graduate: 6.3K	• Undergrad: 5.3K • Graduate: 2.1K
Annual Revenue	• $85.6M (Half of Revenue from Investment Returns)	• $1.2B (17% of Revenue from Federal Grants)	• $384M (17% of Revenue from Federal Grants)
Subject Focus	• Liberal Arts College of Science, Technology, Engineering, Mathematics	• Science, Technology, Engineering, Mathematics	• Science, Technology, Engineering, Mathematics
Rankings	• U.S. News Rank: 12 • Median SAT Score: 1490	• U.S. News Rank: 23 • Historically ranked 1 in Computer Science • Median SAT Score: 1395	• U.S. News Rank: 41 • Lombardi Rank: 35 • Median SAT Score: 1360
Comments	• Mission is to educate scientists, engineers, and mathematicians to be well-versed in the social sciences and humanities so that they better understand the impact of their work on society	• 55% STEM Degrees • Focused on innovation in education and research	• 74% STEM Degrees • Rensselaer Plan – Mission of leadership to increase global prominence by increasing spending on research and attracting additional graduate students

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Source: University Websites, Times Higher Education; IPEDS

2 Elite Undergraduate Institution: Indian Institute of Tech.

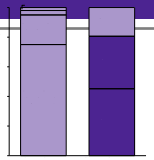
IIT schools in India are famous for the quality of students they attract and graduate at all levels (Bachelors, Masters, Doctoral)

	Indian Institute of Technology (IIT)
Location & Year Founded	• Founded in 1961 • 16 locations including Kanpur, Bombay and Mumbai (India)
Ownership	• Public
Description	• A collection of 16 autonomous public engineering institutes of higher education declared as 'Institutes of National Importance'
Degree Levels Awarded	• Bachelors, Masters, Doctoral
Enrollment (2012)	• ~40K across all IIT • Original IITs: ~5.5K per school (40-60% undergraduate) • Newer IITs: ~0.6K per school (60-80% undergraduate)
Subject Focus	• Science, Engineering, Technology, Mathematics, Humanities, Management
Times Higher Education	• Kharagpur: #226-250 in world - Overall • Bombay: #251-275 in world - Overall • Roorkee: #351-400 in world – Overall • Others are not ranked

Key Features

- **Branded Network:** 16 branches across India, all of same difficulty (share common entry exam)
- **Strong Placement Record:** Graduates go through assisted placement application process; high employment rate within banking and consultancy
- **Very Selective:** Very rigorous screening process; ~2% pass rate

Typical IIT* Structure



Note: *based on interview with IIT Bombay and IIT Kanpur. **reflects enrolment split of older IITs (newer IITs have % of Bachelor ~>60%)
Source: University Website, Times Higher Education, Parthenon Disguised Calls

3 Industry-Engaged Institution: ASU-Polytechnic (US)

Arizona State University Polytechnic Campus strives to provide students with an "applied, project-based, industry-engaged" learning experience

	Arizona State University-Polytechnic Campus (University of Arizona)
Location & Year Founded	• Founded in 1996 • Meza, Arizona
Ownership	• Public
Degree Levels Awarded	• Bachelors, Masters, Doctoral • Certificate, Post-master's certificate; 10 combined Bachelors/Masters programs
Enrollment (2011)	• Polytechnic Campus Total Students: 9,752 students • ASU Total Undergraduate: 50,484 students • ASU Total Graduate: 9,251 students
Faculty	• Polytechnic Campus: 226 faculty, 166 staff • ASU Total: 2,513 full time, 185 part time • Student to faculty ratio: 25:1
Departments (on the Polytechnic Campus)	• College of Technology and Innovation: 37 Majors • School of Letters & Sciences: 18 Majors • Mary Lou Fulton Teachers College: 11 Majors • W.P. Carey School of Business: 6 Majors • University College: 4 Majors • 8 Majors offered online
Subject Focus	• Aviation, Business, Education, Engineering, Math, Science and Technology, complemented by Arts, Humanities and Social Sciences
Endowment	• $515M (2011 ASU Total)
Accolades	• Ranking: – US News #4 Up-and-Coming Schools – US News #70 Top Public Universities – US News #44 Best Undergraduate Engineering Program (with doctorate)

Key Features

- **Differentiated learning experience for the student:** Students required to participate in an applied project every semester
- **Strong connections with industry;** Industry needs inform course and program design; customized degrees for employers' workforce, employer-sponsored student projects
- **Faculty:** Higher proportion from industry, adjuncts/contract. Different research focus (more applied)

Financials (FY 2011)

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Source: University Website, US News and World Reports, IPEDS

3 Industry-Engaged Institution: Other Examples in the US

There are a number of institutions focused on matching the skills of their graduates with the needs employers

	United States Naval Academy	Colorado School of Mines	Virginia Polytechnic Inst. and State University (Virginia Tech)	University of Maryland – Baltimore County
Location & Year Founded	• 1845 • Annapolis, MD	• 1874 • Golden, CO	• 1872 • Blacksburg, VA	• 1966 • Baltimore, MD
Ownership	• U.S.A.	• Public	• Public	• Public
Degree Levels Awarded	• Bachelor of Science Degree	• Bachelors, Masters, Doctoral	• Bachelors, Masters, Doctoral and Professional	• Bachelors, Masters, Doctoral and Graduate Certificate
Total Enrolment (2011)	• 4.5K Midshipmen	• Undergrad: 3.3K • Graduate: 1K	• Undergrad: 23.5K • Graduate: 7.5K	• Undergrad: 10.5K • Graduate: 2.5K
Annual Revenue	• Unknown	• $189M (35% of Expenses Spent on Research)	• $1B (37% of Expenses Spent on Research)	• $394M
Subject Focus	• Engineering & Weapons, Math + Science, and Social Sciences	• Engineering and applied science, and on the Earth's natural resources	• Devoted to technical arts and applied sciences	• Natural Sciences and Engineering
Times Higher Education	• U.S. News Rank: 14 • Median SAT Score: 1285	• U.S. News Rank: 77 • Ranked #1 in Business Week's Best Bargain Colleges (ROI) • Median SAT Score: 1260	• U.S. News Rank: 72 • Median SAT Score: 1210	• U.S. News Rank: 160 • Ranked No.1 on the USNWR's "Up-and-Coming Schools" • Median SAT Score: 1215
Comments	• 54% STEM Degrees • Applicants must receive a letter of recommendation from a member of Congress • Grads join navy upon graduation	• 87% STEM Degrees • One of a very few institutions in the world with broad expertise in resource exploration, extraction, production and utilization	• 34% STEM Degrees • "Invent the Future" Focus	• Engaged in partnerships with the U.S. Geological Survey and the U.S. Forestry Service • Recognized as a "Best Value" College

Source: University Websites, Times Higher Education; IPEDS

Industry-Engaged Institution: Japan Example

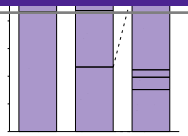
Toyota Technological Institute has climbed to #4 in Japan's University ranking with a strong focus on hands-on practical teaching

	Toyota Technological Institute (TTI)
Vision & Mission	• "Meet the demand of the global ecosystem, develop human resources with a willingness and ability to take advantage of development, equipment, systems and materials […] with particular importance within practical skills', 'internship in companies' and 'experimental practice' on campus" -- University President, Toyota Technological Institute
Location & Year Founded	• Founded in 1981 • Nagoya, Japan
Owner	• Private (independently run; under Toyota Motors Corporation)
Degree Levels Awarded	• Bachelors, Masters, Doctoral
Enrollment (2012)	• Bachelors: 387 • Masters: 86 • Doctoral: 11
Annual Budget (2012)	• ¥4.5B (~$50M) • 13% Profit; 23% from grants/business revenue
Departments	• Department of Engineering, Graduate School of Engineering
Subject Focus	• Engineering and Technology (closely related to Toyota's activities within the motors industry)
Hontoni Tsuyoi Daigaku* (2011)	• Rankings:#4 in Japan • Employment Rate: 98%
Employment Rate	• 98% (2011) compared to 82% average for the top 10 universities in Japan

Key Features

- **Prepare students for work in industry:** TTI programs incorporate a high level of industry understanding through high percentage of hours dedicated to labs/workshops and mandatory internship in the third year
- **Conducts specific research for industry:** TTI conducts ~40 industry research projects (joint and funded) per annum and issues on average five patents per year

Outcomes (Employment)



TTI Graduates by Destination, 2011/12

~70% are within electronics and automobile

Note: *equivalent to Times Higher Education in Japan
Source: University Website, Hontoni Tsuyoi Daigaku

Agenda

Developing the Vision in Context

Programmatic Considerations

Operational Model Considerations

- **National and International STEM Models**
- **Research in STEM Fields**
- **Online Learning in STEM Institutions**

Implications for Florida Polytechnic University

Research Trends

R&D funds can be directed toward either Basic or Applied research (though the distinction between the two has begun to blur)

Basic Research (Theoretical)

- **Goal**:
  - Basic research is driven by a scientist's curiosity or interest in a scientific question. There is no obvious commercial value to the discoveries that result from basic research
- **Examples:**
  - What are protons, neutrons, electrons composed of?
  - What is the specific genetic code of the fruit fly?

Applied Research

- **Goal**:
  - Applied research is designed to solve practical problems of the modern world, rather than to acquire knowledge for knowledge's sake
- **Examples:**
  - How can we improve agricultural crop production?
  - How can we treat or cure a specific disease?

Rules of Thumb

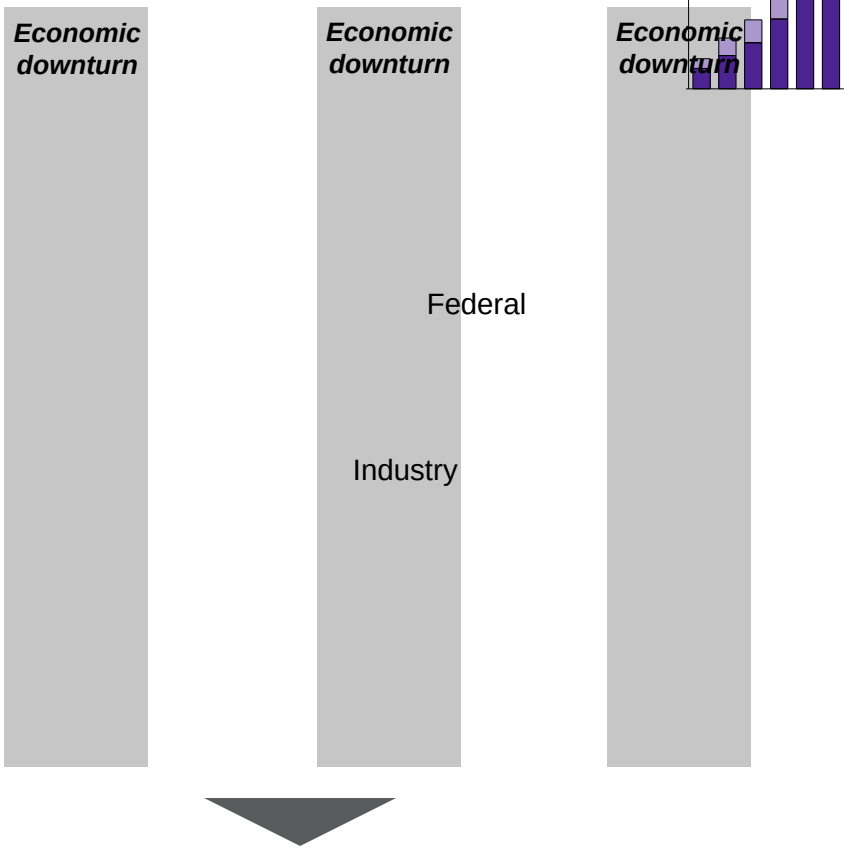
- If a practical use is only a few years away, then the work can be defined as strictly applied research
- If a practical use is still 20-50 years away, then the work is somewhat applied and somewhat basic in nature
- If a practical use cannot be envisioned in the foreseeable future, then the work can be described as purely basic research

Source: Congressional Research Service - http://www.fas.org/sgp/crs/misc/RL34454.pdf; Lawrence Berkeley National Laboratory; WebCASPAR

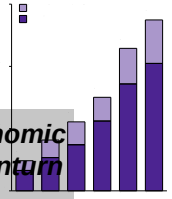
Research Trends

The largest source of R&D funding is the federal government. R&D expenditures have grown slightly slower in applied vs. basic research

Year-over-Year Change in Science & Engineering (S&E) R&D Funding, by Source of Funds, 1985/86 -2010/11



S&E R&D Expenditures at Universities and Colleges, 1985-2009



Industry R&D contributions tend to be cyclical (lower rates of increase during economic downturns), while federal contributions tend to offset this slowdown

In 2009, applied research was approx. 25% of all R&D

Source: U.S. National Science Foundation, Survey of Research and Development Expenditures at Universities and Colleges, annual.

Research Trends
Summary

- **R&D funding sources include the federal government, state government, institutional (university) funds, industry contributions, and foundations**
  - **The largest contributions come from the federal government.** Federal funding grew at approximately 7% per year from 1985 to 2011 excluding ARRA funds, and at 8% per year including ARRA funds
  - **Industry contributions, while cyclical, continued to increase** at 7% per year during 1985-2011. While growth slowed to 3.5% in 2000-2011, industry contributions continue to drive applied research

- While **applied research** grew at a slightly lower rate in 1985-2011 than basic research, it represents an **important part of overall R&D expenditures (~ 25%)**

- The **fields that experienced the most growth** in terms of funding were **Engineering** and **Life Sciences** (approx. 7% per year in 2000-2009 compared to 5-6% for other fields)
  - Within Engineering, Chemical Engineering funding grew the fastest in the last few years, followed by Bioengineering and Civil Engineering
  - Within Life Sciences, Biological Sciences funding grew the fastest in the last few years

Source: U.S. National Science Foundation, Survey of Research and Development Expenditures at Universities and Colleges, annual.

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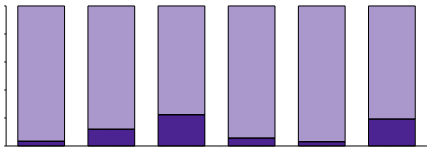
Implications for Florida Polytechnic University

Online Learning in STEM Institutions

Many programs are offered in an online or hybrid modality in STEM fields, although still at relatively low rates



U.S. Programs in STEM Fields, Bachelors and Master's Degrees

Examples of Online / Hybrid Programs

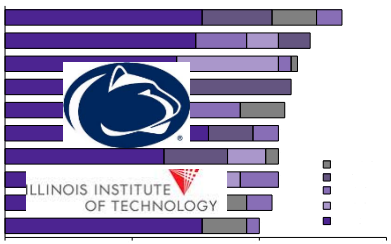
- Biochemistry, Biophysics and Molecular Biology
- Microbiological Sciences and Immunology
- Computer Systems Analysis
- Computer Technology Administration and Management
- Computer Engineering
- Chemical Engineering
- Civil Engineering
- Applied Mathematics
- Management Sciences and Quantitative Methods
- Chemistry
- Physics
- Geological and Earth Sciences
- Biology
- Medical Clinical Sciences

Source: Peterson's Database, IPEDS

Online Learning in STEM Institutions

Institutions with the largest number of online programs in STEM fields lead the way with 20+ engineering offerings each

Top 10 Schools with Online/Hybrid STEM Programs by STEM Field, 2011



UF UNIVERSITY of FLORIDA

THE UNIVERSITY OF ARIZONA

R·I·T

LEHIGH UNIVERSITY

JOHNS HOPKINS UNIVERSITY

COLUMBIA UNIVERSITY

ILLINOIS

Number of Online STEM Programs

Source: Peterson's Database, IPEDS

Online Learning in STEM Institutions

Each of the top 4 online STEM universities has approached their online STEM offerings with a slightly different model of delivery and focus

	Pennsylvania State University	Illinois Institute of Technology	University of Florida	University of Arizona
Program Name	• Penn. State One World Campus	• IIT Online	• Distance Learning UF	• ASU Online
STEM Programs by Field and Level	• Biology: 0 • Comp and Info Sci: 4 (A, C, B, M) • Eng. & Eng Tech: 31 (C, M) • Math & Statistics: 7 (C, M) • Physical Sciences: 11 (C, M)	• Biology: 5 (M, C) • Comp and Info Sci: 8 (C, M) • Eng. & Eng Tech: 30 (C, M) • Math & Statistics: 0 • Physical Sciences: 5 (C,M)	• Biology: 16 (C, M) • Comp and Info Sci: 2 (C, M) • Eng. & Eng Tech: 27 (C, M) • Math & Statistics: 1 (M) • Physical Sciences: 0	• Biology: 0 • Comp and Info Sci: 0 • Eng. & Eng Tech: 29 (B, M) • Math & Statistics: 0 • Physical Sciences: 16 (B, M)
Pricing	• Undergrad: $504 Per Credit (Overall Average) • Graduate: $930 Per Credit (Master's of Engineering)	• Undergrad: ~$430 Per Credit (Overall) • Graduate: ~$490 Per Credit	• $577 Per Credit (EDGE Master's program fee)	• Undergrad: $442 Per Credit (Overall Average) • Graduate: $463 Per Credit (Overall Average)
Comments	• 12K Online students across all programs • Experienced 5 straight years of double digit enrolment growth • USNWR: No. 2 for online graduate engineering programs • USNWR: No. 5 for online graduate computer information technology programs	• Primarily focused on graduate students • *"There are no IIT Online students at IIT. There are only IIT students who take their courses and programs online"*	• Engineering EDGE programs have same exact curriculum as on-campus degrees • Courses are videos of lectures and posted online the same day as actual lecture • Career Resource Center has specific program for distance learning graduates	• Utilizes QM student review process of courses to consistently improve the online experience • Expecting 30K full-time online students by 2020 and profit of $200M annually from online programs • Primarily focused on Master's program

A= Associate's Degree
B= Bachelor's Degree
M = Master's Degree
C = Certificate

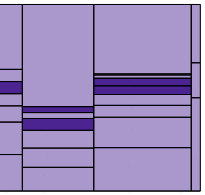
Biology = Biology and BioMedical Sciences
Comp and Info Sci = Computer and Information Sciences
Eng. & Eng Tech = Engineering and Engineering Technologies
Math & Statistics = Mathematics & Statistics
Physical Sciences = Physical Sciences

Source: University websites, Times Higher Education; school newspapers

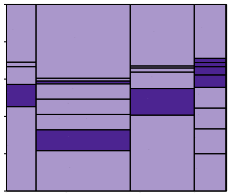
Online Learning in STEM Institutions

Florida Polytechnic should take into account current Florida Virtual Campus offerings in STEM fields as it considers adding courses and programs to the system

SUS Online Program Offerings



FCS Online Program Offerings



Note: Includes FL distance learning programs listed in the FLVC; see subsequent pages for “other” detail
Source: Florida Virtual Campus

Online Learning in STEM Institutions

There are a number of dimensions Florida Polytechnic should consider as it determines how online programs could fit into its portfolio of offerings

	STEM programs with highest/lowest online demand nationally	Models of online delivery nationally and in Florida	Leveraging the FLVC/ Current SUS Offerings
Key Questions For Consideration	• Are certain STEM programs inappropriate for the online modality? • Are there gaps in online STEM offerings that Florida Polytechnic would be most suited to fill?	• At what levels could Florida Polytechnic offer online programs (Bachelor's, Master's, Certificate)? • What students would be the focus of Florida Polytechnic's online programs (current face-to-face students or a different population)?	• How can Florida Polytechnic students take advantage of the current STEM offerings of other Florida institutions? • Which offerings can Florida Polytechnic add to the FLVC that would be demanded not only by its own students, but also those at other SUS/FCS institutions?

A University's strategic plan will integrate Vision and Programmatic Focus with an Operational Model and supporting Infrastructure

Vision and Mission

- **Why do we exist?** What is the problem or issue we are trying to address? What is our purpose as an organization?
- **What population or market will we serve?** Who is our target audience and what are their needs? How do we propose to address these needs? What are our geographic boundaries?
- **What will success look like?** How will our target audience benefit from our efforts? What is the ultimate result we hope to achieve?

Programmatic Focus

- **Demand:** Where is the greatest labor market need, nationally, regionally, and locally? What programs/degrees are required to meet this need? What are funders and employers looking for?
- **Supply:** What is already being offered by other universities in Florida, and with what level of success? Where are the biggest gaps and opportunities?
- **Differentiation:** What is the best way to differentiate ourselves in the STEM landscape? How focused/broad should we be at the beginning?

Operational Model

- **What type of students will we focus on?** E.g., will we recruit highly qualified students through full or partial scholarships? Will we target international students?
- **What type of research might we focus on?** Will we pursue government contracts? Which funding agencies/streams might be a good fit, given FPU's overall mission and programmatic focus?
- **How will we engage with employers?** Will we pursue private gifts/grants, including potential employee partnerships and contributions? Which industry associations might be good partners for FPU?
- **What type of faculty do we need to recruit, given stated mission?** What will it cost to recruit this type of faculty (salaries, research budgets, etc.)?
- **How will we deliver instruction to students? All onsite, hybrid, or also online?** What are the costs to develop and deliver online/hybrid courses? Can we leverage the Florida Virtual Campus?
- **How will we support our students and faculty?** What kind of supports do students need to persist and succeed in STEM? What do faculty need to teach effectively?

Infrastructure

Outcomes

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Infrastructure

- **Facilities and Equipment:** Some fields are more capital intensive than others – What infrastructure (classroom space, lab space, equipment) is needed, given programmatic choices?
- **Systems:** What kind of systems need to be in place to ensure a high-quality teaching and learning experience(e.g., seamless recruitment/admission systems, advising systems, academic intervention systems, employer partnership systems, etc.)? What technological solutions should be put in place to optimize the experience?
- **Government:** How will the university be governed? How will academic and management decisions be made?
- **Management:** What functional areas (academic and non-academic) need be created to support the work of the university, and how will they be managed and staffed?

Outcomes

Agenda

Developing the Vision in Context

Programmatic Considerations

Operational Model Considerations

Implications for Florida Polytechnic University

Implications for Florida Polytechnic University

How will we develop the strategic plan?

Vision and Mission

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Infrastructure

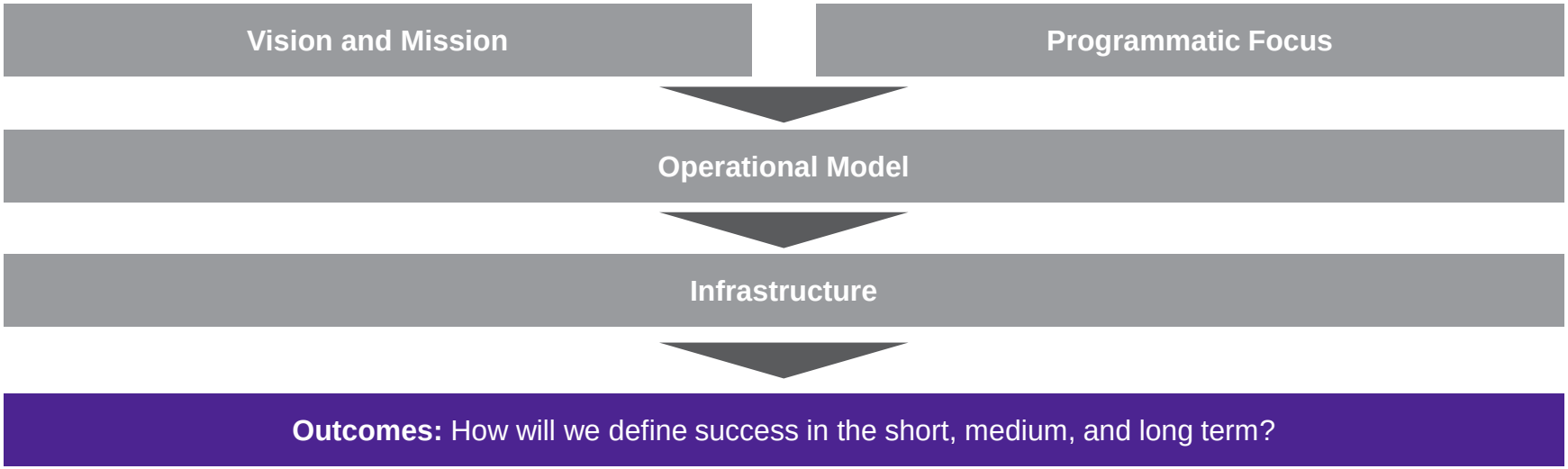
- **Facilities and Equipment:** Some fields are more capital intensive than others – What infrastructure (classroom space, lab space, equipment) is needed, given programmatic choices?
- **Systems:** What kind of systems need to be in place to ensure a high-quality teaching and learning experience(e.g., seamless recruitment/admission systems, advising systems, academic intervention systems, employer partnership systems, etc.)? What technological solutions should be put in place to optimize the experience?
- **Governance:** How will the university be governed? How will academic and management decisions be made?
- **Management:** What functional areas (academic and non-academic) need be created to support the work of the university, and how will they be managed and staffed?

Outcomes

Short Term	Medium Term	Long Term

Implications for Florida Polytechnic University

How will we define success?



What **student-related metrics** are most important to us?	What **research-related metrics** are most important to us?	What **industry-related metrics** are most important to us?
Examples: • **Short-term:** Student retention rates, percentage of students with project/co-op experiences • **Medium-term:** Completion rates, job placement rates, salaries of our graduates • **Long-term:** Advancement of graduates through industry ranks	Examples: • **Short to Medium Term:** Ability to attract funding for applied research • Industry Sponsored Research (ISR) rankings or number of patents (if select Industry-Engaged STEM Model) • Lombardi rankings, (if select Global Research STEM model)	Examples: • **Short-term:** Number of deep employer partnerships (funding, student sponsorships, etc.) • **Medium-term**: Employer satisfaction with the quality of our graduates • **Medium to long-term:** Ability to attract new employers to Florida because of our student talent

Appendix

1. **Additional Data**
2. Additional Details on Selected Institutions
3. Database of Analyzed Institutions

Research to Date

Primary Research (Interviews)

- **Lauren Banks Amos,** Research Analyst, American Institutes for Research (STEM subject matter expert, served as project director for NSF's Broadening Participation STEM project, and provided technical assistance to grantees of the NSF's Model Institutions for Excellence program)
- **Dr. Jim Borgford-Parnell,** Assistant Director, Center for Engineering Teaching and Learning at the University of Washington; Member of the AAU STEM Initiative Council
- **Dr. Mitzi Montoya,** Vice Provost of the Arizona State University Polytechnic Campus and Dean of the College of Technology & Innovation
- **Howard Moskowitz**, independent Technology/ Grant Consultant for the DOE and NSF
- **Dr. Kenneth R. Pence,** Associate Professor of the Practice of Engineering Management in the School of Engineering at Vanderbilt University

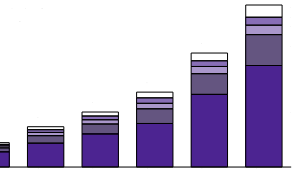
Secondary Research

- **STEM field definitions:** NCES and U.S. Immigration and Customs Enforcement
- **Higher education trends and STEM completions:** Integrated Postsecondary Education Data System (IPEDS), established as the core postsecondary education data collection program for the National Center for Education Statistics (NCES)
- **International trends:** Report by the U.S. Congress Joint Economic Committee "STEM Education: Preparing the Jobs of the Future," April 2012
- **U.S. R&D Funding:** National Science Foundation/ Division of Science Resources Statistics, Survey of Research and Development Expenditures at Universities and Colleges
- **U.S. STEM Trends:** University websites, literature search (articles), and a variety of reports, (including "Refueling the U.S. Innovation Economy: Fresh Approaches to Science, Technology, Engineering and Mathematics (STEM) Education", Atkinson, Robert D. and Mayo, Merrilea)
- **Rankings:** US News & World Report, Lombardi/Center for Measuring University Performance, Times Higher Education

STEM Landscape – U.S. Context

R&D research has increased by 8% annually since 1985, with industry contributions growing at a slightly lower rate than federal contributions

Science & Engineering (S&E) Sources of R&D Expenditures at Universities and Colleges, 1985-2011



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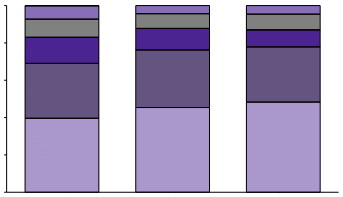
Source: National Science Foundation/Division of Science Resources Statistics, Survey of Research and Development Expenditures at Universities and Colleges: FY 2009

STEM Landscape – Florida Context

In Florida, the mix of STEM degrees is slightly different than nationally (higher percentage of engineering and bio degrees)

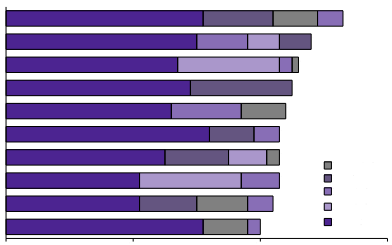


STEM Degrees by Field, 2011

Source: IPEDS; US National Science Foundation

Role of Online in STEM – National Context

While all of the schools with large online STEM programs offer engineering programs online, there is significant variety amongst the other fields of study



Top 10 Schools with Online/Hybrid STEM Programs by STEM Field, 2011

Number of Online STEM Programs

Source: Peterson's Database, IPEDS

Online Learning in STEM Institutions: Florida Virtual Campus

While Florida Polytechnic can build its own online offerings, it may also leverage the online offerings of other SUS institutions through the Florida Virtual Campus

Origins

- The Florida Virtual Campus was created out of the Florida Distance Learning Consortium, the Florida Center for Library Automation, the Florida Center for Advising and Academic Support and the College Center for Library Automation
- House Bill 5201 established the Florida Virtual Campus to "*provide access to online student and library support services and to serve as a statewide resource and clearinghouse for technology-based public postsecondary education distance learning courses and degree programs*"

Mandate

- HB 5201 requires the FLVC to provide the following services:
  - Develop and manage a library information portal and automated library management tools
  - Develop and manage an internet-based catalog of distance learning courses
  - Implement an online admissions application process for transient students
  - Develop and manage a computer-assisted student advising system
  - License and acquire electronic library resources
  - Promote and provide recommendations concerning the use and distribution of open-access textbooks
  - Provide help desk support to institutions and students and to identify and evaluate new technologies and instructional methods
  - Provide for the transfer of assets and liabilities of the Florida Distance Learning Consortium, the Florida Center for Library Automation, the College Center for Library Automation, 75 and FACTS.org to the Florida Virtual Campus

Revenue Implications

- **If a student enrolls in an online course with another College/University, the school offering the course receives the revenue for that course**

Inclusion

- Institutions charging a distance learning fee must list the course on the FLVC
- Institutions have discretion as to listing courses not charging a distance learning fee: some list all online courses and others only list courses with an associated distance learning fee

Usage

- From July 1, 2011 through June 30, 2012 the Distance Learning Catalog received 109,794 visitors, who viewed an average of 7.2 pages and spent 4.4 minutes on the site
- **32,283 courses were listed on the Distance Learning Catalog** from Fall 2011-Summer 2012, as well as 654 current degree programs (including certificate programs)

Source: Florida Senate (flsenate.gov); Florida Virtual Campus

Online Learning in STEM Institutions: Florida Virtual Campus

In 2011-12, 38 institutions listed courses on the Florida Virtual Campus

Florida College System

- Brevard Community College
- Broward College
- Chipola College
- College of Central Florida
- Daytona State College
- Edison State College
- Florida Gateway College (formerly Lake City)
- Florida Keys Community College
- Florida State College at Jacksonville
- Gulf Coast State College
- Hillsborough Community College
- Indian River State College
- Lake Sumter Community College
- Miami Dade College
- North Florida Community College
- Northwest Florida State College
- Palm Beach State College
- Pasco-Hernando Community College
- Pensacola State College
- Polk State College
- Santa Fe College
- Seminole State College
- South Florida State College
- St. Johns River State College
- St. Petersburg College
- Tallahassee Community College
- Valencia College

State University System of Florida

- Florida Atlantic University
- Florida Gulf Coast University
- Florida International University
- Florida State University
- University of Central Florida
- University of Florida
- University of North Florida
- University of South Florida
- University of West Florida

ICUF

- Lynn University
- Saint Leo University

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Source: Florida Virtual Campus

Appendix

1. Additional Data

2. Additional Details on Selected Institutions

Global Research models:

- Caltech (US)
- Postech (South Korea)

Elite Undergraduate models:

- Olin College (US)
- Indian Institute of Technology (India)
- Bandung Institute of Technology (Indonesia)

Industry-Engaged models:

- ASU-Polytechnic Campus (US)
- Polytechnics Canada (Canada)
- Duale Hochschule Baden-Wuerttemberg – Mannheim (Germany)
- Aston University (UK)
- Derby/Rolls Royce University Technical College (UK)
- Toyota Technological Institute (Japan)

3. Database of Analyzed Institutions

1 Global Research Institution (US): Caltech

Caltech's established programs include extensive, innovative research opportunities that lead to societal change, achieving its mission

Percent of Completions in STEM	Lombardi Rankings	Median SAT Score (2009)	*US News Ranking*
97%	Out of 9 National Measures: • 3 Rankings in the top 25 • 4 Rankings in the top 26-50	1515 (Ranked 1st)	• #10 National Universities • #3 Best Undergraduate Engineering Programs

Mission: The mission of the California Institute of Technology is to expand human knowledge and **benefit society** through research integrated with education. We investigate the **most challenging, fundamental problems** in science and technology in a singularly collegial, interdisciplinary atmosphere, while **educating outstanding students** to become creative members of society.

The Best and The Brightest

- 31 Caltech faculty and alumni have won **32 Nobel Prizes**
- **Students**: Highest SATs in the US
- **Faculty**
  - 15 California Scientist of the Year
  - 71 Members of the National Academy of Sciences
  - 33 Members of the National Academy of Engineering
- **Alumni**: 56 National Medal of Science recipients

Solving the Most Challenging, Fundamental Problems

- **48 Research Centers and Institutes**:
  - The Kavli Nanoscience Institute
  - Southern California Seismic Network
  - Space Radiation Laboratory
  - Partnership with the Jet Propulsion Laboratory
- "**High-Risk" Research**: Caltech promotes high-risk, high-reward research

Creatively Benefitting Society

- **Cross-disciplinary** research centers:
  - **Energy Science** focusing on clean power
  - **Medical Science** using nanoengineering to create molecular medicines and drug-delivery devices
  - **Earth and the Environment** developing systems to manage and respond to natural hazards

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Source: University Website, Times Higher Education, IPEDS; Center for Measuring University Performance

1 Global Research Institution (US): Caltech

Caltech creates a small school environment within the resources and opportunities of the elite research institution, leading to top outcomes

Curriculum and Program Design

Actively Seeking Improvement:

- Although Caltech already ranks #1 in the world, they are **building a new center to support "excellence and innovation in learning and teaching"**
- **Innovation in Education Fund:** Encourages new course offerings within the required core subjects to engage and challenge students
- Caltech partners with **Coursera** to offer MOOCs

Significant Research:

- **Summer Undergraduate Research Fellowships (SURF)**
- **Joint programs with several local medical centers,** including early acceptance to med school
- **80%** of undergraduates participate in **research**

Student Experience

Small Community Feel

- **3:1** Student to faculty ratio
- **Freshman Seminars**: In-depth, lab, field, or classroom experiences
- **Faculty Advisors:** Small-group open-ended guidance from professors on school and life

Small School experience with Big School Resources:

- Although Caltech clearly states its STEM focus, it still provides robust student-life activities
  - Division III sports
  - Full Performing & Visual Arts
  - Over 120 student clubs

Expansive Opportunities

- **12 regional partnerships** ranging from Children's Hospital Los Angeles to the Jet Propulsion Lab

Outcomes

Success at Caltech:

- 98% Average freshman retention rate
- 87% 6-year graduation rate (56% Nationally)

Success after Caltech:

- 55% of Caltech undergrads enter graduate school immediately after graduation (36% in engineering)

Success beyond Caltech:

- More than **2,000 patents since 1980** through the Caltech Office of Technology Transfer

*"Caltech is one of the world's leading science and engineering research institutions due to a proven strategy of **attracting top-caliber scientists and scholars** and providing an **environment in which they can thrive**"* -Caltech Prospectus

Source: University Website, IPEDS; Center for Measuring University Performance, *US News and World Reports*

1 Global Research Institution (International):Postech (S. Korea)

Postech focus on research is apparent across all stakeholders including its collaboration with industry for research and investment to hire Nobel Laureates as faculty

Vision: Postech was built to fulfil **Korea's need to be self-reliant in science and technology** in order to launch itself into the **global high-tech arena**. POSTECH's strive for excellence centers on ensuring its students the highest **academic standards in the scientific community**, focusing on **effective research**, and fostering the **tripartite** relationship of Academe, Research, and **Industry**

Faculty

- Very strict tenure evaluation and hiring process with incentive-based pay structure for the professors (dependent on their research results and student satisfaction level)
- Research is focused on Robotics, Nanomaterial, Biotechnology, Industrial, Energy, Mechatronics and Aerospace
- Invested $44M to hire Nobel Prize and Field Medal Laureates as faculty members (2011)

Students

- Higher admission standards than Yonsei Univ. and SNU (which are traditionally the toughest schools to get into in Korea)
- All students receive full scholarships and on-site accommodation
- Student: Faculty ratio= 4.3 (Postech prides in maintaining low ratio to ensure mentor-apprentice relationship esp. within research)
- Postech has overseas offices in Vietnam, China and India to recruit top students from abroad

Industry Partners

- Primarily partner with industry players to develop research facilities and activities
- Industry partner includes POSCO, Hyundai, LG and Exxon mobile
- E.g. Hyundai Motors sponsored the establishment of Postech's Automotive Mechatronics Center (AMC). One of its major roles is to conduct research in mechatronics to develop intelligent vehicles and Intelligent Transportation Systems

Outcomes

- THE Ranked #1 in the world for universities under 50 (years)
- THE Ranked #50 in the world
- #Citations per professor= 6.3; #Papers published per professor = 7.8 (2011)

- Hosts Korea's only synchrotron radiation facility, Korea's largest biotechnology research center, and Korea's only intelligent robot research center

- $~200M in research grants and contracts won per annum (>60% of their total income)
- POSTECH topped Korea's list of research expenses with 796.7M won (~$700K) on average per professor

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Source: University Website, Times Higher Education, Korean Herald, The Chronicle

1 Global Research Institution (International):Postech (S. Korea)

POSTECH
POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Initially, Postech's focus was on quality of local staff and students. It is now seeking a global presence

Focus on hiring and retaining top talent

Focus shift to globalization strategy

1986 — 2000 — 2004 — 2008 — 2012

1986

- 9 departments were established with 249 students and 60 faculty member
- Founded by POSCO, one of world's largest steel production company with government support

2004:

- Implemented radical changes within its hiring and pay structures: implement performance-based system based on the results of their research projects and student satisfaction level

Opened 23 new academic departments/school

(~1.05 department p.a.)

2009:

- Concludes a 10-year contract with Exxon Mobil for joint research and development projects (first Asian university partner with Exxon Mobil)
- Allocates large budget into the three-year campus globalization plan

2010:

- Declared its campus 'bi-lingual' to make it more attractive to foreign students and academics
- Implement stricter tenure evaluation within its faculties

2011:

- Listed in Times Higher Education World Rank 28

2012-present:

- Building fourth-gen. accelerator lab (one of 4 universities to have this worldwide)

Source: University Website, Times Higher Education, Korean Herald, The Chronicle

1 Global Research Institution (International):Postech (S. Korea)

Postech ensures its quality remains high with strong partnership with both public and private sectors as well as rigorous student admission process

Postech partners with various private and public institutions in research development

- Partnerships are often conducted with public and private institutions (including industry) in establishing new research centres/laboratories
  - **Public partnerships**: Korea Science and Engineering Foundation (KOSEF), Ministry of Education, Science and Technology (MEST), Ministry of Knowledge Economy, Institute for Information Technology Advancement (IITA), Korea Foundation for International Cooperation of Science & Technology, Ministry of National Defence and provincial governments
  - **Private partnerships**: Max Planck Society (Germany), POSCO, Hyundai Motors, LG, Exxon Mobile, other various industry players
    - Times Higher Education *Industry Income* score: 100 out of 100 (2010 – 2012)
- **Educational partnerships:** 92 universities in 24 countries including Caltech (US), Imperial College (UK), RWTH Aachen (Germany), Ecole Polytechnique (France) and IIT Delhi (India)

Postech seeks to recruit the best students worldwide, offering full-scholarship to those admitted

- *"[Postech] boasts 2,700 of the country's brightest students and a growing reputation for science and engineering[…] Their admission standards are higher than Yonsei University or Seoul National University, which are South Korea's best universities"*

  - Head of Division Education Policy, University of HK
- Recently opened overseas offices in Vietnam, China and India as part of a bid to recruit the best science students from abroad
- Grants full-tuition scholarships and accommodations to all students
- Largest fellowship for graduate students in Korea

Source: University Website, The Chronicle, Korea Herald

2 Elite Undergraduate Institution (US): Olin College

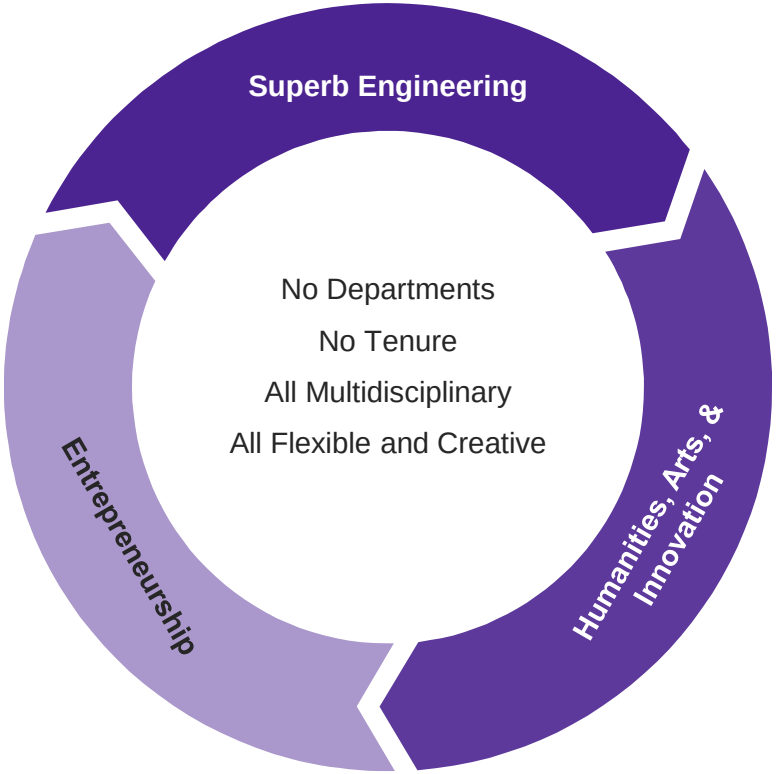
Olin incorporates entrepreneurship and innovation into the fabric of the program, leaving behind traditional program elements such as tenure

Percent of Completions in STEM	100%	25-75th percentile SAT	1360-1520

Mission: Olin College prepares students to become **exemplary engineering innovators** who recognize needs, **design solutions**, and engage in creative enterprises for the **good of the world**.

Teach by Example: Olin's programming is designed around the principles it seeks to instill in it's students:

- **Original designs:** There are no majors, so every students is responsible for *creating their own path* in the course of study
- **Collaborative thought processes:** *Professors co-teach courses* in the same way that they expect *students to collaborate on projects*
- **Creative problem solving:** Students actively engage through *hands-on learning to solve problems* posed by businesses



*"The case of Olin suggests that such **institutional innovation**, as opposed to simple tinkering around the edges so common to most discussions of STEM reform at the undergraduate and graduate level, will need be needed **to move STEM education in the United States to the next level**."*

- Atkinson and Mayo, "Refueling the U.S. Innovation Economy"

Source: University Website, Atkinson, Robert D. and Mayo, Merrilea, "Refueling the U.S. Innovation Economy: Fresh Approaches to Science, Technology, Engineering and Mathematics (STEM) Education, IPEDS

2 Elite Undergraduate Institution (US): Olin College

The rigorous and personalized recruiting mechanism fills the small campus with creative individuals who collaborate towards innovation

Matching Students

Two-Way Process:

- Olin actively identifies and recruits target students, then **invites them to campus**
- Students attend "Candidates' Weekend – meet faculty and students, participate in a design project, interview, and do team exercises, all **evaluated for admissions**

Mutually Beneficial Matches:

- Every admitted student receives a **four-year, half-tuition scholarship** valued at approximately $80,000 over four years
  - Until 2009, this was a full scholarship for every student
- Innovative **faculty have autonomy** to creatively adapt engineering education

Explicit Innovation

New Curriculum:

- Based on **reforms from the NSF**, including emphasis on **business, teamwork, and communications skills**
- Multidisciplinary integration of subjects, hands-on learning, team-oriented projects, competency-based assessment, and feedback-driven improvement

SCOPE (Senior Consulting Program for Engineering): a significant year-long **engineering project for an actual client**

- A corporate partner provides a **challenging engineering problem** that has **significance to the sponsor**
- **World-class student engineering team**, faculty advisor, and dedicated, professionally-equipped work space

Outcomes

Success at Olin:

- 90% 6-year graduation rate (56% Nationally)
- 68% have research internships

Success after Olin:

- 80% of graduates go into engineering
  - 25% of those graduates are entrepreneurs
  - 10% of graduates work at their own enterprises
- **Corporate Partners Program** enables companies to gain a presence on campus by financially supporting students

Success beyond Olin:

- New **pilot program** with University of Illinois at Urbana-Champagne (UIUC) to adapt Olin techniques to the large research institution

*"We think as long **as you learn how to be creative with engineering**, whatever you do with your engineering degree will undoubtedly contribute to the world. At Olin, **we educate engineers differently**."* – Olin Prospectus

Source: University Website, Atkinson, Robert D. and Mayo, Merrilea, "Refueling the U.S. Innovation Economy: Fresh Approaches to Science, Technology, Engineering and Mathematics (STEM) Education, IPEDS

2 Elite Undergraduate Institution (International): IIT (India)

Indian Institute of Technology

Vision: The IIT network was built by the government in attempt to train high quality workforces across the country in the field of technology to enable India to compete in the global stage. Mission is to engage in cutting-edge research, identify areas of specialization based on real industry needs, undertake collaborative projects with industry, and **develop human capital**, intellectually capable and imaginatively gifted leaders

Faculty

- All professors are of PhD level or above
- Perceived to be of somewhat lower quality than the student body (not "world class")
- *"The faculty in the IIT is not world class. It is the students in IITs who are world class. So the IITs are excellent because of the quality of students not because of quality of research or faculty"* - Indian Environment Ministry
- Poor student to teacher ratio in some of the IIT (e.g. 18:1 in IIT Roorkee)

Students

- High quality students due to rigorous entry requirement, with a pass rate of ~2%
- Have to pay tuition fee, but what they pay only covers ~40% actual cost; the remainder are subsidized
- Great employment prospects, has a 'Placement Office' where students apply for a employment via the school instead of independent applications

Industry Partners

- Strong involvement with industry through recruitment/placement partnerships
- Recruiters include BCG, Deutsche Bank, Goldman Sachs, IBM, ITC, Sony, Google, Schlumberger, Morgan Stanley, Roll-Royce Microsoft, and Wal-Mart
- Also partners with industry to establish research in specific topics (Design and Innovation Centre with Ricoh to assess innovative new design and technology for their products); research grants/contracts makes ~20% of total revenue

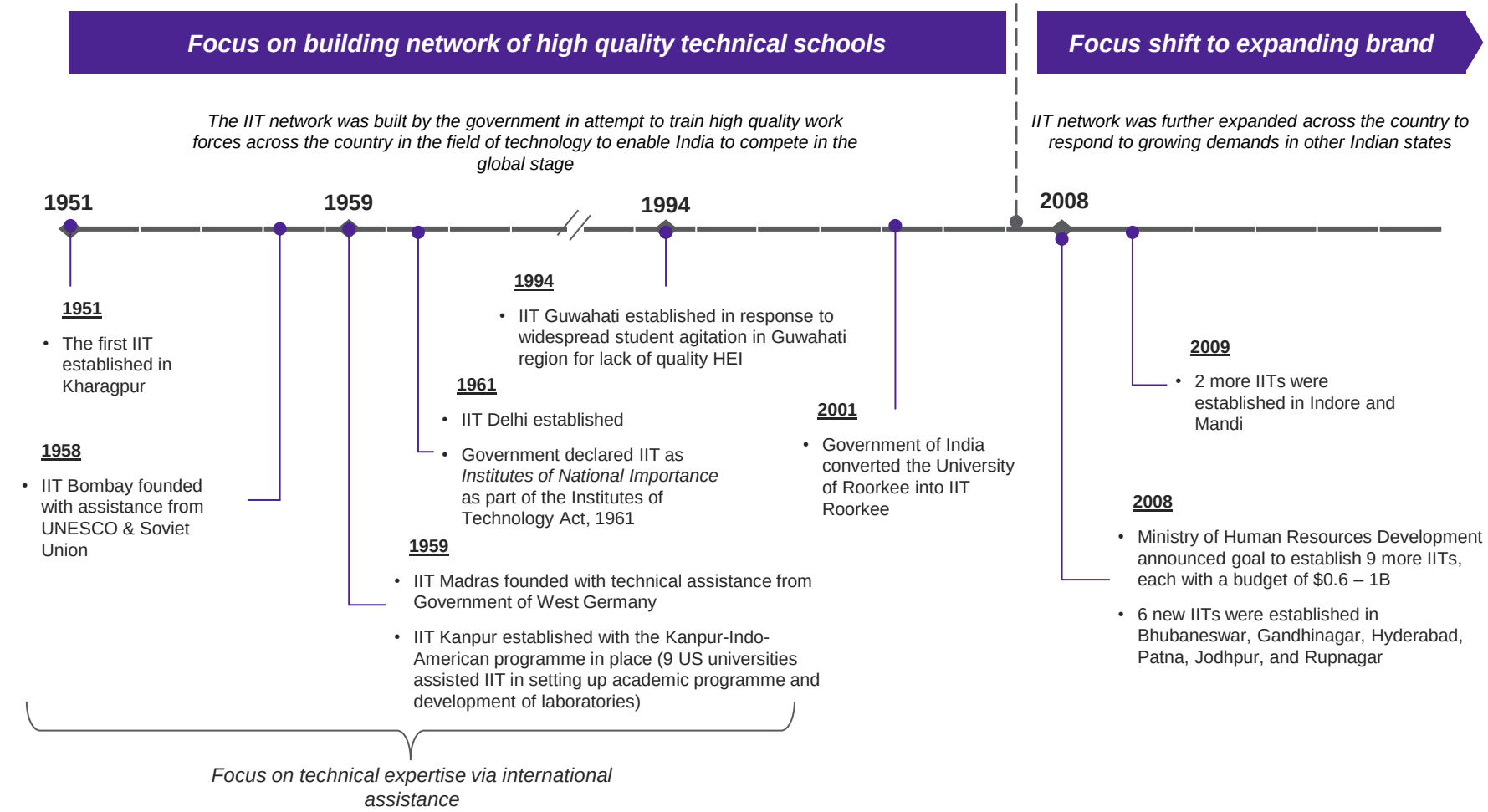
Outcomes

- The only 3 institutes in India ranked in QS World University Ranking (Delhi-212, Bombay-227, Kanpur-278)
- Graduates employment rate ~90%
- High (and increasing) demand for IIT graduates in global blue-chip companies across all sectors
- Government declared IIT as *Institutes of National Importance* as part of the Institutes of Technology Act, 1961
- Government expanded into establishing 8 new IITs to broaden geographical reach and cater demand

Source: University Website, Times Higher Education, Secondary Sources

2 Elite Undergraduate Institution (International): IIT (India)

IIT has extended its brand across the country over the years via new openings and conversions



Source: University Website, Times Higher Education, Secondary Sources

2 Elite Undergraduate Institution (International): IIT (India)

IIT has tougher entrance requirements than any other STEM institution, and this elite reputation has led to high demand for placement into IIT

IITs has an extremely rigorous entry procedure to ensure quality students

- Admission to undergraduate degrees are conducted through IIT Joint Entrance Examination (JEE): ~500K candidates take the exam every year competing for 10K places across the IITs
- *"Starting 2013,* [IIT] *will use the country's common engineering-university entrance exam to filter which students get to take the JEE . We just have too many candidates otherwise "*

  - Executive Administrator, IIT Bombay
- Postgraduate & Doctoral places are more restricted and must go through various written examinations and personal interview

Graduates are increasingly opting for top professional service positions while industry demand remains strong

- *"~90% of graduates seek direct employment, while the other 10%, which is declining, plan to gain higher education typically at IIT or an overseas institution […] 40% of those seeking employment tend to enter core engineering jobs, while the rest go to finance, consultancy and even start-ups"*

  - Executive Administrator, IIT Bombay
- *"Top placement firms in the IITs are consulting, IT, banking and insurance. The number of B.Tech students opting for higher studies in engineering and research also seems to have declined"*

  - The Hindu, July 2012
- *"Placement at the IIT seem to have been insulated from the global economic slowdown. Companies like Facebook, Samsung and Google are offering 5-10% higher salaries than last year […] blue-chip recruiters include Boston Consulting Group, Deutsche Bank, Goldman Sachs, IBM and Google"*

  - Times of India, December 2012

The growth in IITs have been spurred by both demand from candidates as well as industry needs

- In 2008, Indian Ministry of HR Development announced the government plan to establish more IITs across the country, including setting up 8 new IITs and converting another existing university into an IIT by 2013
- "*The government decision to open new IITs is partly to give access to other states that didn't have an IIT previously. Demand for a place in IIT has been booming for years. We used to get 150,000 application a few years ago, now we have 500,000"*

  - Executive Administrator, IIT Bombay
- *"The demand for setting up [more IITs] has also come from Indian business and industry groups, as well as from multinationals, which plan to set up or expand their business in India"*

  - Merinews, India, May 2008

Source: University Website, Indian Institute of Technology Kanpur, Disguised Calls, The Hindu, Times of India

2 Elite Undergraduate Institution: Bandung Institute of Tech. (Indonesia)

The Bandung Institute of Technology also focuses on producing quality graduates through tough entry requirements

	Bandung Institute of Technology (ITB)
Location & Year Founded	• Founded in 1959 • Bandung, Indonesia
Ownership	• Public
History & Vision	• Originally established by the Dutch colony as a Technische Hogeschool to meet the needs of technical resources in Indonesia. Post-independence, ITB became part of University of Indonesia's Faculty of Engineering, and later gained independence
Degree Levels Awarded	• Bachelor, Masters, Doctoral
Enrollment (2011)	• Bachelor: 13,671 • Masters: 5,024 • Doctoral: 745
Revenue (2011)	• Rp. 870B (~$90M); ~60% private funding
Admission Rate	• 4% (2008) - most selective University in Indonesia
Employment Rate	• >90%* (2011)
Subject Focus	• 12 departments (incl. Science, Technology, Engineering, Mathematics, Design, Architecture, Pharmacy, Management)
THE Ranking (2012)	• Not ranked by THE • #1 in Indonesia (4iCu)
Comments	• University with most notable alumni within the worlds of business and politics (including the first president and the current richest person in Indonesia)

NOTE: This model is present in countries such as India and Indonesia, where there are an abundance of people wanting to pursue Higher Education, but there is a lack of established institutions dedicated to research. The model is not typically found in the West, where there are sufficient research-based places for school-leavers wanting to pursue STEM subjects

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Note: * Excludes graduates continuing studies in Higher Education.
Source: University Website, Secondary Research

3 Industry-Engaged Institution (US): ASU-Polytechnic

Arizona State University's Polytechnic Campus weaves the needs of industry into the institution through curriculum design and applied research

Percent of Completions in STEM	Lombardi Rankings	Median SAT Score (2009)	*US News Ranking*
15% of all ASU Completions	• Top 25 American Research Universities	1080 (Ranked 515th)	• #139 National Universities • #4 Up-and-Coming

Arizona State University Mission: To establish ASU as the model for a New American University, measured not by who we exclude, but rather by **who we include and how they succeed**; pursuing **research and discovery that benefits the public good**; assuming major **responsibility for the economic, social, and cultural vitality** and health and well-being of the community.

ASU-Polytechnic Vision: To create a unique **niche** institution that provides a **differentiated learning experience for students** by involving them in applied, project-based instruction, and **serves the needs of local employers** by engaging them in curriculum design, project sponsorship, and customized instruction for their existing workforce

Inclusive success:
Slightly lower GPA and testing requirements at Polytechnic

Research and Discovery:
19 High Tech Facilities and Project-based assessments

Economic, social, and cultural responsibility:
Custom degrees for companies (Intel) and industry partnerships

New American University

1. Leverage Our Place
2. Transform Society
3. **Value Entrepreneurship**
4. **Conduct Use-Inspired Research**
5. Enable Student Success
6. Fuse Intellectual Disciplines
7. Be Socially Embedded
8. Engage Globally

Practitioner Professors:
Focus on innovative engineering teaching over research

iProjects:
Flexible format for experiential and authentic learning (internships, lab-based research)

Corporate Partners:
80% of projects come from local partners, including state projects

Source: University Website, Parthenon Interviews January 2013, IPEDS, Center for Measuring University Performance

3 Industry-Engaged Institution (US): ASU-Polytechnic

From research expenditures to admissions requirements, ASU-Polytechnic's industry-based vision influences each element of their campus

Applied Research Focus

Funding:

- 2/3 tuition base, 1/3 other (of that, 2/3 is research)
- Different source of funding: 2/3 of the research funding comes from **USAID development grants** because the research is directly applicable to energy development
- Research expenditures of **$10M**/yr **compared to $70M**/yr at the traditional ASU engineering sites

Faculty:

- **Extensive industry experience** (more than typical) in both full professors and adjuncts
- **Higher teaching load** (5 courses) – less research, more teaching
- **Specific faculty profile**: Polytechnic hires for professors who want their impact to be teaching undergraduates – they are excited about innovating engineering education

Innovative Approach

- 80:20 undergraduates to graduates
- **Admissions requirements** – GPA requirement of 3.0 vs. 3.2 (for rest of ASU) to broaden access
- Streamlined programming to allow individual flexibility and efficiency (combined 54 programs into 17)
- **Employer partnerships with iProjects**:
  - Students participate in realistic, corporate-driven design projects every semester
- **Outcomes-based learning**: Students must demonstrate their knowledge by designing projects that "don't melt or blow up," not theories on paper
- **Custom Degrees**: ASU-Polytechnic collaborates with corporations to design programs to advance their own workers from associates to bachelors (INTEL)

Outcomes

Success at ASU-Polytechnic:

- ASU has an 82% freshman retention rate in a system of more than 50,000 students
- ASU: 57% 6-year graduation rate
- **Programs in high-need fields**: Polytechnic ***responds to workforce needs*** and builds courses, then programs (Environmental Sustainability)

Success after ASU-Polytechnic:

- ***95% job placement within 6 months*** after graduation
  - Focused placement with corporate partners instead of a general career services approach
- "Employers tell us **we save them two-years** because we teach our students communication, collaboration, and creative thinking" - ASU Vice Provost

Source: University Website, Parthenon Interviews January 2013

POLYTECHNICSCANADA

3 Industry-Engaged Institution: Polytechnics Canada

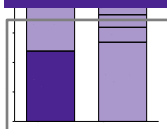
British Columbia Institute of Technology

	Polytechnics Canada (BCIT)	
Location & Year Founded	• Established in 2003, BCIT Opened in 1963 • Alliance of ten schools across Canada	
Ownership	• All institutions are public	
Degree Levels Awarded (All schools)	• 86 Bachelor's degrees, 13 Articulated Bachelor's degrees (applying associates credits to earn a bachelors degree) • Non-bachelors: 710 Diploma programs, 490 Certificate programs, 175 Apprenticeship programs	
Total Enrollment	**All Schools:** • 179,608 full-time students • 53,370 part-time students • 33,816 apprenticeship students • 59,596 graduates per year	**BCIT:** • Approximately 18,000 full-time students. • Approximately 28,000 part-time students
Faculty Members (BCIT)	• More than 1,700 full-time faculty and staff • More than 500 part-time faculty and staff	
Departments (BCIT)	• Applied & Natural Sciences, Business & Media, Computing & IT, Engineering, Health Sciences, Trades & Apprenticeship	
Subject Focus	• Technology, Applied Sciences, Business, Commerce, Engineering	
Endowment	• BCIT = $17.3M	
Applied Research	• In 2010/11 alone, Polytechnics Canada schools engaged over 4,900 students in 560 research projects and developed 307 prototypes. These research projects are part of the program course requirements and not co-op or internship opportunities outside of the formal learning experience.	

Key Features

- **Mission :** Serve the success of learners and employers through direct connection to workforce demands
- **Explicit focus on applied research** with projects integrated into the curriculum, not as external partnerships
- **Degree levels:** Offer both bachelors as well as associate degrees and certificates

BCIT Financials, FY 2012 (Can. Dollars)



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Source: University Website, BCIT Foundations Report, Polytechnics Canada Website

3 Industry-Engaged Institution: Polytechnics Canada

British Columbia Institute of Technology

Mission: The mission of BCIT is to serve the success of learners and employers by:

- Providing **high quality technical and professional education** and training that supports our graduates as **practitioners** and as citizens
- **Advancing the state-of-practice**

Multiple Levels of Degrees

- **Certificates, diplomas and degrees:** entry-to-practice credentials for careers
- **Career development** coordinated programs and courses
- Include **industry services**, advanced studies and continuing education

Experiential and Contextual Teaching and Learning

- Focus on **interdisciplinary approach**
- Classroom and curriculum designed to model the work environment
- Currently **developing an E-Learning Strategy**

Applied Research

- Faculty and students engage in research activities to **solve business and industry problems** to increase competitive strength
- Grant-funded and Industry-sponsored
- Example Research Areas:
  - Biotechnology
  - Green Roof Technology
  - Renewable Energy
  - Smart Grid/Intelligent Micro Grid
  - Sustainable and Environmental Initiatives

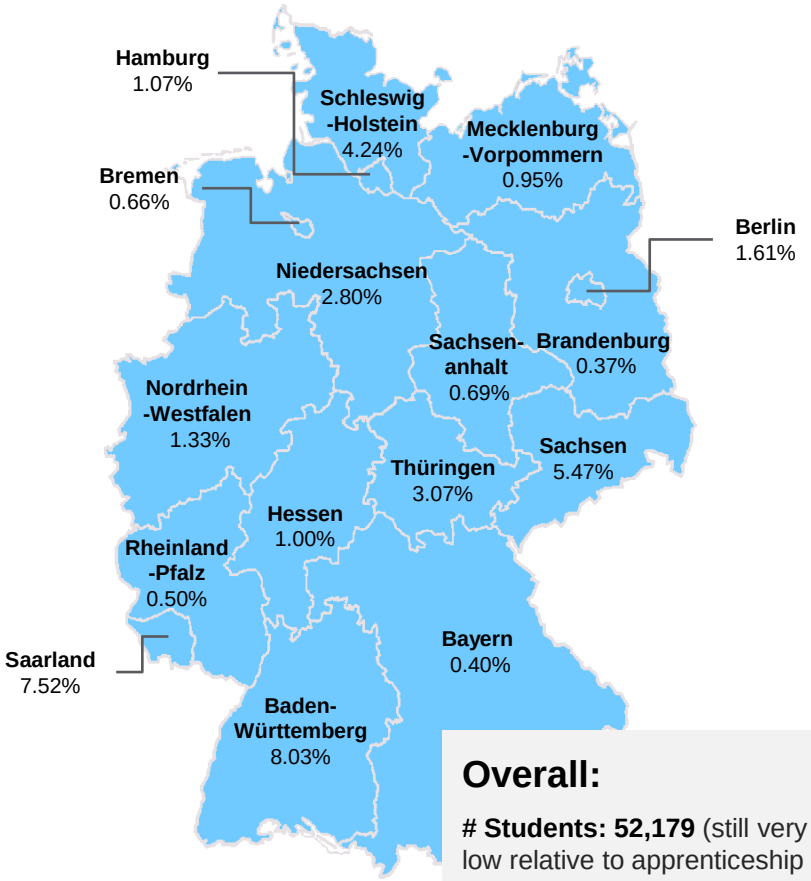
Source: University Website, Polytechnics Canada Website

3 Industry-Engaged Institution: The German Model

In Germany, vocational education has evolved to combine the traditional apprenticeship route with academically rigorous qualification for vocational subjects

- Dual programs emerged in Baden-Württemburg almost 30 years ago to provide a more academically rigorous and meaningful qualification for vocational subjects. It started with Daimler-Benz and other large companies and was taken up by the SME/Mittelstand in the Bundesländer. Now dual studies programmes has backing from across the corporate sector in Germany
- The **drivers of programme growth** are:
  - The ongoing skills shortage:
    - The German government has targeted a number of areas of skills shortage
  - The desire by employers to:
    - Have more qualified employees, combined with their inability to teach the more academic content
    - 'Try before you buy' with new employees, as with the old apprenticeship model
    - Ensure the employees will have the right skill sets
  - Students' need for programmes with high employability
- The **student value proposition** of Dual-System degree is:
  - A recognized B.A. degree qualification
  - Typical high employment rate, e.g. 85% of Dualen Hochschule Baden-Wuerttemberg graduates stay with their company after graduation
  - A programme seen as more valuable to students and employers than the traditional apprentice system due to the added academic element

% Students enrolled in HE in Dual Studies Across Bundesländer, Germany, 2009-10



Overall:

 # Students: 52,179 (still very low relative to apprenticeship figures in Germany , of ~1.5M in 2009/10)

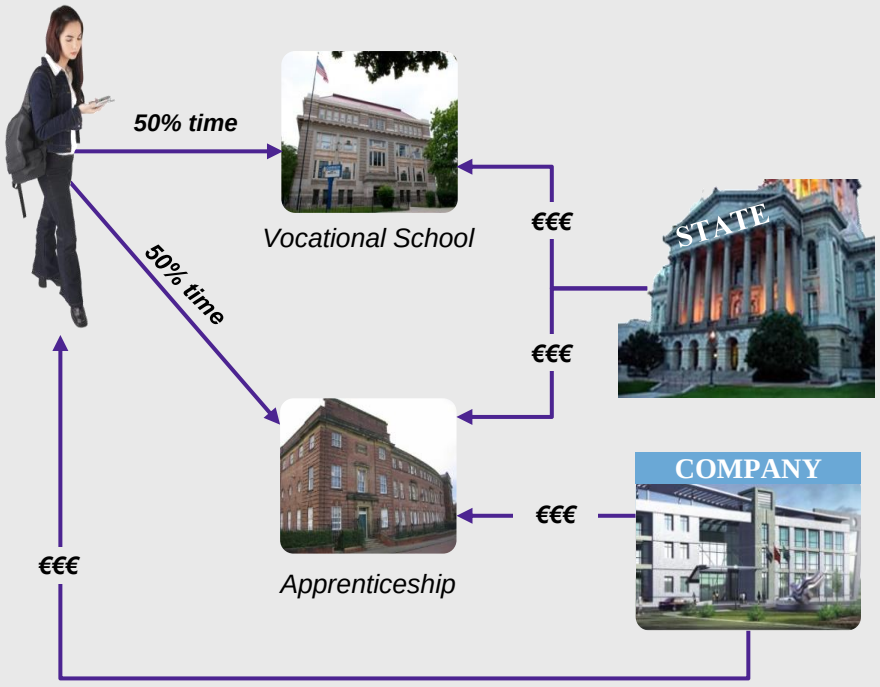
% of HE: 2.46%

Note: Percentage reflects number of students in dual studies out of all students in higher education by Land
Source: Germany Federal Statistical Office

3 Industry-Engaged Institution: The German Model

Dual-education enables students to graduate with occupation-specific skills and knowledge for targeted employment

Typical German *Duales-Ausbildungssystem* Overview *



Commentary

The dual system is designed to ensure students are gaining precise skills and theory for specific occupations through the roles of apprenticeship

- Students typically train in a company for 3 -5 days a week, while they attend a vocational school the remainder of the time
- Students learn both general lessons (e.g. German) and trade-specific theory at the schools

This system is implemented across multiple education levels and is also prominent in several European countries

- The dual-system is commonly found at the secondary and post-secondary, non tertiary level, but is gaining popularity within the tertiary level as well for Bachelors and Masters degrees
- Countries such as Austria, Switzerland, Denmark, Sweden, Netherlands and France are also common practitioners of this system
- The UK is starting to adopt this system via its new opening of University Technical College (UTC), targeted to students aged 14-19

Note: * Given for students attending public vocational schools. Private schools tuition fee are typically funded by parents/ private loans
Source: Ministry of National Education, Germany, Eurydice, Parthenon Interviews

3 Industry-Engaged Institution: DHBW (Germany)

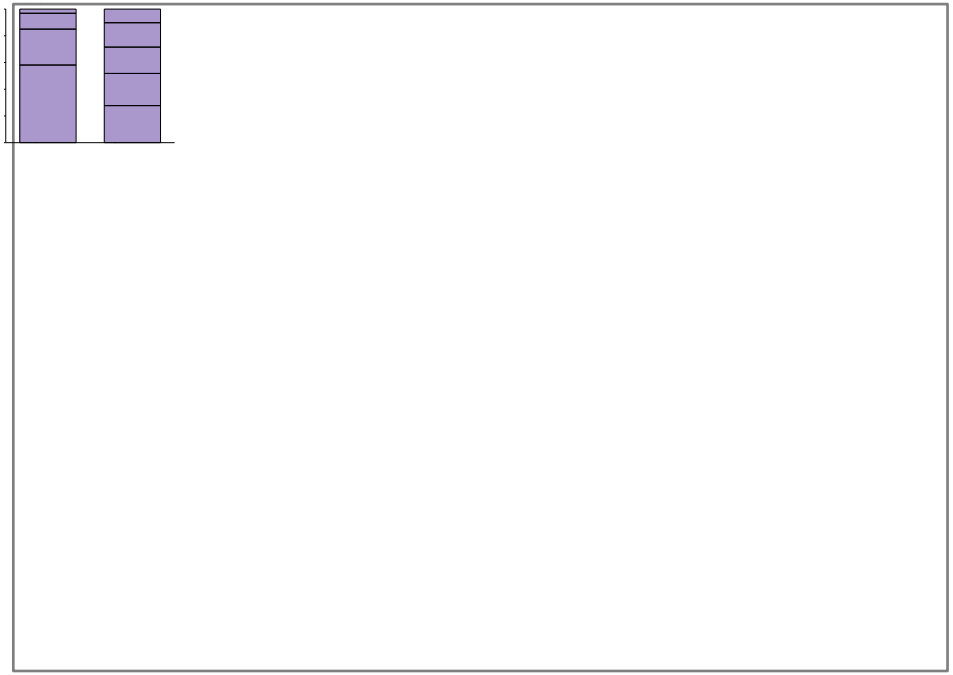
Success for an institution like DHBW typically depend on its quality of industry partner to ensure high employment rate post graduation

	Duale Hochschule Baden-Wuerttemberg – Mannheim
Location & Year Founded	• Founded in 1974 • Mannheim, Germany
Ownership	• Public, part of the DHBW collection of schools (8 across the country)
Education Levels Awarded	• Bachelor, Master
Total Enrolment (2012)	• 5,704 (total)
Annual Budget	• ~€25M (2010)
Subject Focus	• Business, Technology, Engineering
Est. Employment Rate	• 80-90%
Industry Partner	• ~2,000 German businesses, social and public institutions
Comments	• Admission is conditioned on the student obtaining an apprenticeship prior to enrolling

Key Features

- **Combined work-study model:** Students alternate every 3 months between formal learning in school and practical learning in companies or other institutions
- **Strong connections with industry;** Industry needs inform course and program design
- **Employability:** Students are contracted by the apprentice-company and have better employment path post-graduation

Financials* (FY 2011)



Note: *given for DHBW all (includes all 8 sites)
Source: University Website, Times Higher Education

Industry-Engaged Institution: DHBW (Germany)

Its specialist teaching, work experience and dynamic programme offering has placed DHBW in the German University Ranking

Vision: offers an attractive study model, which is based on the actual conditions and requirements of the labour market and businesses: This success story for the last 40 years is based on the **close connection between theory and practice,** between scientific studies at the university and professional experience in the partner company

Faculty

- Apart from general-study full time professors, specialist areas are taught by lecturers from Universities and Universities of Applied Sciences (*Fachhochschule*) as well as by qualified professionals
- Not research intensive; but have recently started receiving research funds from the state
- Teachings tailored to industry need and developed jointly with industry players in the fields of business, engineering and social work

Students

- Admission is conditioned on the student obtaining an apprenticeship prior to enrolling
- Students alternate every 3 months between science-based teaching (in the institution) and practical learning in companies or other institutions
- Within the school, students are taught in small groups

Industry Partners

- ~2K industry partners for the apprenticeship aspect within the dual-programme , including large blue-chip companies, Small and Medium Enterprises (SMEs), and other public and private institutions
- Close integration with its industry partner both in student recruitment as well as course development

Outcomes

- Part of Duale Hochschule Baden-Wuerttemberg: 12 locations across Baden-Wuerttemberg with total industry partners ~9K
- Only vocational college to be ranked in the German university ranking (others are University or Fachhochschule)
- Graduates employment rate 80-90%

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Source: University Website, Times Higher Education

3 Industry-Engaged Institution: United Kingdom Examples

A similar 'work & study' model has been successfully replicated in UK institutions across multiple education level

	Aston University	Derby/Rolls Royce University Technical College
Vision & Mission	• Its mission is to be the UK's leading University for business, enterprise and the professions. By 2020, Aston will be a top research led international University renowned for developing future leaders of business and the professions	• Technical academy for 14-19 year-olds, funded by Government in the amount of £40M. Partnership between a university, community college, and industry. Has identified priority industry including aerospace, automotive, defence, marine and rail
Model	• Gives students the opportunity to take a "sandwich" course (an industry placement) as part of a degree. Typically, students are in schools in Years 1 and 2, then have an industry placement in Year 3 and return to school for Year 4 • Works with public and private sector to develop tailored professional Cont. Ed. and Foundation Degree programmes	• A technical college directed to the upper secondary sector. "Placement" in industry is incorporated through practical subjects and projects (the curriculum combines practical and academic studies via formal lessons and work experience) • The curriculum is designed with local and national employers
Location & Year Founded	• Founded in 1895 • Birmingham, United Kingdom	• 2014 (planned opening) • Derby, United Kingdom
Ownership	• Public	• Public; collaboration of University of Derby, Derby College and Rolls Royce
Education Levels Awarded	• Bachelors, Masters, Doctoral	• General Certificate of Secondary Education, Diploma, Certificates (planned) • Target age: 14-19
Total Enrolment (2011)	• Undergraduate: 7.906 • Postgraduate (Taught & Research): 2,445	• 180 (planned)
Annual Budget	• £112M (~50% from academic teaching fees and support grants)	• n/a
Subject Focus	• Science (incl. Medicine), Engineering, Languages, Humanities, Business	• Science, Engineering
Est. Employment Rate	• 92% (2009) – Top 5 in the UK	• n/a
Industry Partner	• National Grid, E.On, Goodrich, PTC and RFA to establish Aston University Engineering Academy (a UTC) in 2012 • Various placement-partner	• Rolls Royce (so far)

Source: University Website, Times Higher Education, Secondary Research

3 Industry-Engaged Institution: Japan Example

TTI, on the other hand, collaborate with industry players in both research and student placement

Vision: TTI has a mission to meet the demand of the global ecosystem, to develop human resources with a willingness and ability to take advantage of development, equipment, systems and materials […] with particular importance within practical skills', 'internship in companies' and 'experimental practice on campus

Faculty

- 42 full-time faculty member, 25 of which are professors (others associate and assistant professors), all of which are involved in research
- Majority of the lecturers are specialist; (e.g. within *Creation Machine* or *Semi Conductor)* – there are no "Professor of Engineering"
- Faculty members receive ~10 external awards for their research and teaching (e.g. the SRC Paper Award 2009)

Students

- Mostly bachelor; some students came direct from employment (Working Adult students)
- High level of tech/practical-oriented classes; have modules on Toyota's production lines, etc. , and state-of-the-art facilities
- Students go through compulsory placement in their penultimate year

Industry Partners

- Partners for industry placement as part of their bachelors degree
- Partners include Sony, Daihatsu and Mitsubishi (and of course, all Toyota's divisions and subsidiaries)
- Also partners with private companies to do conduct ~40 specific research projects per annum); most of which are through **Funded Research** (instead of **Joint Research**)

Outcomes

- Opened a Toyota Tech. Institute with the University of Chicago in Chicago. Awards doctoral level degrees only
- Employment rate ~98% (highest in Japan)
- #4 Best University in Japan
- Registers ~5 patents per annum (both Japan and Internationally) – e.g. electron beam generator

Source: University Website, Hontoni Tsuyoi Daigaku, Secondary Research

Appendix

1. Additional Data
2. Additional Details on Selected Institutions
3. **Database of Analyzed Institutions**

   United States: 137 institutions
   International: 29 institutions