From Skills to Jobs: Integrated Learning, Innovation, and Career Success in the 21st Century

Collaboration, Contributions:
Departments: Chemical Engineering, Mechanical Engineering, Energy and Mineral Engineering, Smeal Supply Chain; Campuses: University Park, Behrend, Lehigh Valley, Penn College, Berks; Institutes: Institutes for Energy and the Environment, Institute for Natural Gas Research
Build New Integrated Practices: Learning, Innovation, and Growth

Integration Bridge

K-12  ?  Higher Ed

Global Knowledge Portal

Stem Preparation

Existing Curriculum

Research

Career Discovery

Integrated Learning

Market to Discovery

Workplace Needs

Focus Here

Ref: 953
Focus Areas

Career Discovery

- Students learn about job / skills market
- Career Discovery – build personal grid
- Integrate all skills and experiences
- Workplace data from BurningGlass.com

Integrated Learning

- Learning modules – market problems
- Case studies from companies
- Integrate skills application to cases
- Student teams, sharing, simulations

Market to Discovery

- Bridge market needs to basic research
- “Virtual Assets” – bridge valley of death
- Sponsored projects – industry led and IP ownership / proprietary
- Entrepreneurship, start-up, equity options

Description

Engagement Examples

- Company validation of market skills, gaps
- Prioritization top skills: baseline, specialized
- Mentoring / feedback students grids, career maps
- Support content: “knowledge bricks”

- Support design of learning module case studies
- Content, examples to support case studies
- University, internship and market use of content
- Sharing across all Penn State campuses, disciplines

- Support for design of market based modules
- Conversion of market needs to research questions
- Build new start-up companies for sponsored work
- Entrepreneurship, leadership, professional skills
Career Discovery

Higher Ed

Career Discovery

Workplace

Student Skill Grid and Career Map

Career Discovery Sessions

Student Skill / Experience Grid

https://psu.instructure.com/courses/1960582

Market Opportunity

Industries, Jobs, Skills, Needs

Student Skills Grid and Projected Career Maps

Skills

Jobs

Companies

- Student Learning and Career Planning Connected to Market Opportunity
- Companies support to validate, prioritize key skills needs, identify gaps
- Strengthen connection between students and workplace
Career Discovery Sessions - Students

Background
Many signs point to a breakdown in the current U.S. labor market. Hiring companies cannot find people with the necessary skills, from truck driving to data mining. Workers at all levels, meanwhile, find it more and more difficult to climb a career ladder, or even to get onto the bottom rung. The rapid evolution in technology and business practices accelerates and intensifies the need for new approaches to career awareness, preparation, and retraining. In a series of industry planning events, graduate courses, and discussions with students, we have deployed a simple yet effective tool for beginning and maintaining the career planning discussion: a skills grid tool, with roles chronologically listed as rows and key skill/experience categories as columns. The student can readily see both existing strengths and patterns of success as well as gaps that can be proactively addressed. It is useful for initial career planning as well as long-term career management. We have found that students gain much from sharing their evolving grids with their peers and mentors. Further, one of us (MA) has used this approach in industry for >35 years and found the grid to be an excellent tool for career planning. During the past year, we have also been working with Burning Glass Technologies, a Boston-based big data/machine learning company that has built a substantial database of job postings, resumes, and government jobs data. Matt Sigelman, the company’s CEO, argues that rather than a jobs market it is more insightful to analyze how companies are looking for skills. We licensed Burning Glass data products to identify opportunity areas for Penn State campuses to engage local hiring companies: what skills are in short supply, how might the campuses respond at undergraduate, graduate and continuing education levels to help ease the shortage, how can companies more effectively recruit? We seek feedback from a wider audience at Penn State beginning with students and other interested groups at Penn State.

What:
• We are piloting new student group discussions from professional societies and university organizations to have evening event to discuss skills, jobs and careers.
• Prior to the session students will review online background content on skills, jobs and state of the market
• A one-page skills grid template is available and each student will draft his or her personal skills grid and share during the discussion session.
• The Career Discovery Module is at: https://psu.instructure.com/courses/1960582

Outcomes:
• Each student will present their skills grid and have a chance to learn from others in the group.
• Session feedback will be collected and will help improving sessions for greater student benefit.
• Students will learn more about the jobs market, skills required to secure a job.
• Future: we will engage employers to be part of the session discussion and feedback using ZOOM.
• Other ideas or suggestions for improvement will also be captured during the session.
Integrated Learning - Market Based Problems

Market Skills Needs
- Baseline
- Specialized
- “Data”

Integrated Learning
- Market Applications, Case Study Examples
- Key skills prioritized by markets

Market Applications
- Oil and Gas
- Chemicals and Materials
- Manufacturing
- …

New Learning Modules
- Case Studies, Simulations
- Live data examples
- Scenario Analysis
- …
- Numerous other Penn State examples exist

Higher Ed

Workplace
Integrated Learning

Background:
Technology has transformed HOW we can work and has enabled radically new business models such as Amazon in retail, Uber in transportation, and Airbnb in lodging. Despite the transformation already seen in major sectors, the changes have not (yet) transformed how universities conduct research and education. And how different market sectors integrate research with academic and government labs. We are developing integrated models of collaboration from basic research both forward to market and deeper into education that are enabled by technology. Integrated learning would be designed with common shared content. The concept of “how do I do …” application examples would be built to connect basic skills to application examples such as “how do I site a well, how do I tune a control loop, how do I assess customer needs …”. Students already look to YouTube for practical training in most any procedure. Udacity.com is an example of market-based learning catalyzed by tech companies. Having a rigorous process for designing, curating and serving shared content could be built through market partnerships between workplace and Universities. Shared content can be used in classrooms, for project-based learning examples as well as on the job for examples to use for problem solving. This requires rethinking the existing University business model which is best done as a workplace / University partnership to provide support. Penn State with 24 campuses and a strong alumni base in an excellent position to consider steps forward in partnership with key market sector companies.

What:
• Build new project-based learning modules emphasizing use of skills in market applications, build case studies in partnership with companies.
• Project modules will emphasize professional skills: leadership, communication, team-work, integration of business concepts with engineering and working with ambiguous questions to introduction judgment and decision making.
• Create content that is multidisciplinary and shared across all departments and campuses.
• Pilot projects are underway in Energy and Mineral Engineering (EMS), Chemical and Mechanical Engineering Departments.

Outcomes:
• Learn the concept of business value creation, basic business financial concepts and engineering analysis and decision making for financial performance.
• Exposure to market problems and technologies, learn about companies products and services through case student problems
• Build new skills and experiences in hands-on project based learning.
• Companies will be able to share markets, products and services to engage students for internships or recruiting.

Ref: 1041
Chemical Engineering Course Example - Spring 2018

**Cloud – Shared Content**

- YouTube / Udacity
- Khan academy
- Learncheme
- Lynda.com

**ChE 497 - Industrial Problem Solving (Future Badge, Nanodegree?)**

**Career Discovery**
- Skills Grid
- Career Map
- Class Scorecard

**Technical Finance**
- Income Statement
- Finance <-> Process

**Business Problems**
- Lemonade Stand
- HB Manufacturing
- 2,6 Plant Simulation

**Innovation**
- Lean Start Up Model
- Business Model Canvas
- Team Project

**Data, 6sigma, …**
- Technical cost modeling
- Shift, drift, variance

**Principles**
- Begin with the end in mind ($, career).
- Use existing online digital skill training for CHE, business, professional.
- Create an integrated experience with $ = f[customers, CHE, professional …].
You are a new process engineer in a plastics manufacturing plant. The business has been successful over the years but recent new products from competitors have resulted in the reduced selling price for your products. This has resulted in a slip in operating profit which has gotten attention of the senior leadership at headquarters.

The business product manager with many years experience is giving you a tour of the facility and describing how the business works. She seems fair and pretty astute about how things work and you are interested in the comments she makes about different parts of the organization. Sounds like there are a lot of opinions about what should be done. Being a remote location, some refer to the company R&D organization as a possible source for helping the business. One thing is clear, finding ways to reduce the cost of manufacturing your major product line is very important in the short term. She leaves you with some final advice “focus on the opportunities”.

You have been asked to make a presentation next week to the business team. You have been asked to share your first impressions of the business. Also, you have been asked for your recommendations on what should be done for the business manufacturing cost reduction plan. Also, since you recently joined from the company R&D group the business team would like recommendations on how R&D might be able to help. With the high spending for raw materials some speculate there must be a big R&D opportunity.

You need to prepare a presentation and prioritize a list of possible projects for improving the manufacturing cost. What is your plan?
Market to Discovery

**Penn State**
- Contract services with Penn State Facilities
- Contract Research
- Penn State potential equity stake (via 1855 Fund)
- Supplies students, Post-docs, faculty

**NewCo**
- Formed in Penn State Incubator
- Handles all agreements w/university(s) & companies (Bridge to university for Co’s)
- Ben Franklin provides pot. Seed funding plus entrepreneurial and business services support
- Hires students, faculty (on payroll and/or equity)
- Integrated Education connection for accelerated ramp-up

**External**
- Agreements with the start-up; get access to select university expertise
- Directs start-up projects
- Financial transactions with the start-up
- Provides Funding, equity stake
Market to Discovery

Background

Innovation has been a major engine of U.S. economic growth and job creation. Research universities have played a vital role in the creation of new knowledge and the preparation of students for the workforce. But the foundation of the education/innovation model of the past century is being disrupted. Technology is accelerating the rate of change and corresponding innovation cycle-times are decreasing. New business models are transforming established markets such as UBER in transportation, Airbnb in hospitality, and Amazon in retail, book publishing, and now cloud computing. The cloud, big data, AI, machine learning are examples of technology changing how problems can be solved. We are now in an integrated world where information across all domains is changing how we interact with, learn, share and apply knowledge. Today, more innovation with reduced development cycle-time is needed. Despite past successes, gaps exist between University basic research and market commercialization as a source of new innovation. Market pressures have forced companies to manage more closely the funding of research and development for new products and services. Companies often struggle to work with Universities as project development and cycle-times do not match their needs. Faculty are often disconnected from immediate market need, and lacking a clear funding stream (and priority for applied work), they tend to focus on longer-term basic research where public funds are typically available. Across many traditional industries there is a loss of knowledge from retirement of career employees. As the workforce becomes more dynamic, with long-tenure positions becoming much less common, intellectual capital management becomes a vital part of maintaining the knowledge base underlying the business model. With the rise of entrepreneurship, the lean start up model and new company formation as a means of taking new technology to market, especially in bio and technology sectors, we have an opportunity to build new bridges between market and research. Building a “start up” connection creates new innovation opportunities and investment for companies, learning opportunities for students and access to market needs through pass-through University services and research funding.

What:

• Create new “start-up” companies to bridge market need to research, be a source of technology commercialization
• Integrate concepts of entrepreneurship, business development and market commercialization
• Provide connection of many activities already in place: learn start-up, entrepreneurship, launch boxes, Ben Franklin innovation park …
• Connection integrated learning by domain areas to accelerate the development of new innovative companies and technologies

Outcomes:

• New opportunities for faculty and students to engage in market commercialization
• Students have job and research opportunities as part of education – skill and market ready
• University new revenue streams, license of IP to commercial exit for higher return, higher risk
• Ability for one or more companies to partner with start-ups to mix technology, innovative new ideas and build an equity position
Oil and Gas Virtual Asset – Anticipated Products and Services

Basic Research

Tech Service
- Pair students with data
- Perform custom analysis for company assets
- Laboratory measurements

Special Service
- Virtual Asset
  - BIG Data Analytics
  - Engaged scholarship
  - Workforce training
- Company data kept secure and private

Standard Offering
- Standard Analysis
  - Production characterization and forecasting
  - Well Characterization
  - Benchmarking: your company vs. other operators in play

Custom Service
- BIG Data Analytics: trends in play
- Decision support
- Probabilistic forecasting
- Efficacy of treatments

Ref: 901
Market to Discovery Example

Basic Research

- Public funding -> market needs
- Integrate multiple disciplines

Oil and Gas - "Virtual Asset"

Market Needs

- Market problems – complex, system level
- Multidisciplinary – technical, business and social

Market to Discovery

- Connect market need to research program needs – technical, business
- Align with entrepreneurship, start-up model
- New experience and learning opportunities for faculty
- Support and engagement of basic research

Marcellus – Production by Operator

Marcellus – Production Capability

Ref: 1024
Market Sector Integrated Example - Oil and Gas

Career Discovery
- Career Discovery Background
- Career Discovery - Personal Skills and Experience Grid
- Career Discovery - Personal Skills and Experience Grid
  - Skills from the Market
  - Market Skills Data
  - Professional Skills Data

Integrated Learning – Oil and Gas Capstone Design

Stakeholder Needs – Oil & Gas
- Oil and Gas Jobs
- Oil and Gas Skills
- Specific Company Skills / Jobs

Basic Research – Oil and Gas

Market to Discovery – “Virtual Asset”

Innovation Needs
- Market, Company
- Shared, Proprietary
- Economic, Environmental
- Brand, Sustainability
Global Knowledge Portal

Background:
Today, a greater level of innovation with reduced development cycle-time is needed. Reducing the cost of education is critical as student debt now exceeds $1.3T. Despite past successes, gaps exist between University basic research and market commercialization as a source of new innovation. Market pressures have forced companies to manage more closely the funding of research and development for new products and services. Companies often struggle to work with Universities as project development and cycle-times do not match their needs. Faculty are often disconnected from immediate market need, and lacking a clear funding stream (and priority for applied work), they tend to focus on longer-term basic research where funds are available. In many industries there is a loss of knowledge from retirement of career employees. As the workforce becomes more dynamic, with long-tenure positions becoming much less common, intellectual capital management becomes a vital part of maintaining the knowledge base underlying the business model. The pace of change has created a need for life-long learning. Continuous skills development is emerging with a growing list of online and problem-based training offerings. Technology enables major new collaboration models to be designed and implemented. Online training supports the concept of “how do I do …” application examples: students already look to YouTube for practical training in most any procedure. Partnerships of universities and businesses in different market sectors can provide excellent examples of how we can build a shared resource of application and functional knowledge. Companies could use the same framework for managing proprietary content and maintaining behind their firewall. Udacity.com is an example of market-based jobs and skills needs catalyzed by tech companies. This same model can extend to other major sectors and could form the basis for integrated knowledge networks. The online content can be used in classrooms, for project-based learning examples as well as on the job for examples to use for problem solving. Curation of existing content is a first step before generating new content. New knowledge networks could extended to integrate K-12 through to work helping to address early interest in STEM with a broad range of backgrounds.

What:
• Design new integrated collaboration models from University to Workplace, use Global Digital Platforms to enable global sharing with local application.
• Demonstrate a model of operation which consolidates and streamlines overhead tasks with reinvestment in value activities such as education and research.
• Build new integrated partnerships of companies, universities to design and build shared content
• Curate and build shared knowledge modules, globally shared, that can be used to support a range of learning activities from classroom to self instruction.

Outcomes:
• Access to most current content to support life-long career planning and the development of a qualified workforce for today’s economy.
• Broad shared knowledge that is globally accessible and used for classroom, internships, and life-long learning needs.

Ref: 1063
Shared Common Content, Local Delivery

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Global Knowledge Portal

Chemicals and Materials
Oil and Gas
Pharma
...

Applications

Knowledge Management

Workplace

Shared Content

Data, Analytics
Degree Skills
Business
Professional Skills

Shared Content

Skills

Existing Curriculum

Career Discovery

Integrated Learning

Integrated Internships?

Research

Market to Discovery

Knowledge Management

Local Delivery

Global Knowledge Portal

Ref: 1028
Concept Development

In Progress

- Build program model between Penn State / workplace to generate new funding and programs based on market feedback
- Focus Areas: Career discovery, integrated learning and “market to discovery”
- Pilot projects underway in each area
- PA Energy TeamPA, DCED PA Energy Horizons study, opportunity for PA, Penn State, Workplace partnership

Build Demonstration and Market Sponsors

Fall / Spring 2018

Focus Areas:
- Career Discovery Modules with students, societies, …
- 5 Campus, ChE, ME, EME skills market feedback using Burning Glass workplace analytics
- Partnerships integrated learning / market to research for energy programs in: Oil&Gas … “virtual asset”, Power, Distributed Energy
- Energy Outreach – “PA Energy Innovation Network”

Next:
- Use pilot programs as step 1 concept for new model
- Establish University/Company design partnership
- Identify 10 top company design partners, update, feedback – energy/other; opportunity for new professional degree, Masters, aligned with market need and Penn State differentiation
- Engage broader Penn State campuses, index offerings

Learning Summit

Spring 2019

- Shared concept of integrated University/Workplace
- Updates and shared lessons learned
- Breakout sessions on key development areas
- Core team – define scope, path and resources
- Build proposal for company and public agency engagement

Expanded Proposal

Summer / Fall 2019

- Proposal for next steps
- New partners – private, public and government
- Expanded funding opportunities

Needs:
- Leadership support – concept, design and communication
- Integrated plan – colleges, campuses, development
- Support from career planning, departments, alumni

Ref: 956
Learning Summit - Spring 2019

What:
• Form core team of design partners and university leadership and faculty
• Agenda – emerging market practices, sharing, learning and assessing new opportunities with Design Partners .. Career to life-long learning
• Engage Penn State campuses; local sessions with shared learning
• Summit Outcome – top priorities for existing and new program acceleration; mechanisms for funding, governing and leading; next steps for funding development

Needs:
• We seek design partners to help develop, design and launch new integrated practices
• Need engagement, feedback and support generating background information
• Regular updates, status and progress calls prior to the summit
Learning Summit

**Purpose:**
- Meeting to Share Education Trends, Needs and Current Best Practices
- Form Multiple Sponsor / Penn State (all Campuses) / Partner School(s) Core Team
- Pre-work - Inventory existing practices, gaps and needs, review and discuss
- Generate feedback and priorities for developing major program proposal

**Agenda:**
- Invited external speaker(2) leading transformation of education external to Penn State
- All - sharing of current best practices – each attendee
- Student feedback – lessons learned, needs and opportunities
- Sponsors – current practices, future needs and opportunities
- University – current practices, emerging technologies and examples
- Break-out Sessions
  - Content Organization, Priorities from sponsor organizations
  - Market sector discussions – oil & gas, power, distributed energy, turbo machinery
  - Business model, financial considerations, funding strategy
  - Leadership structure, operation, and prioritization
- Report-outs
- Summary – proposal, communication, next steps
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