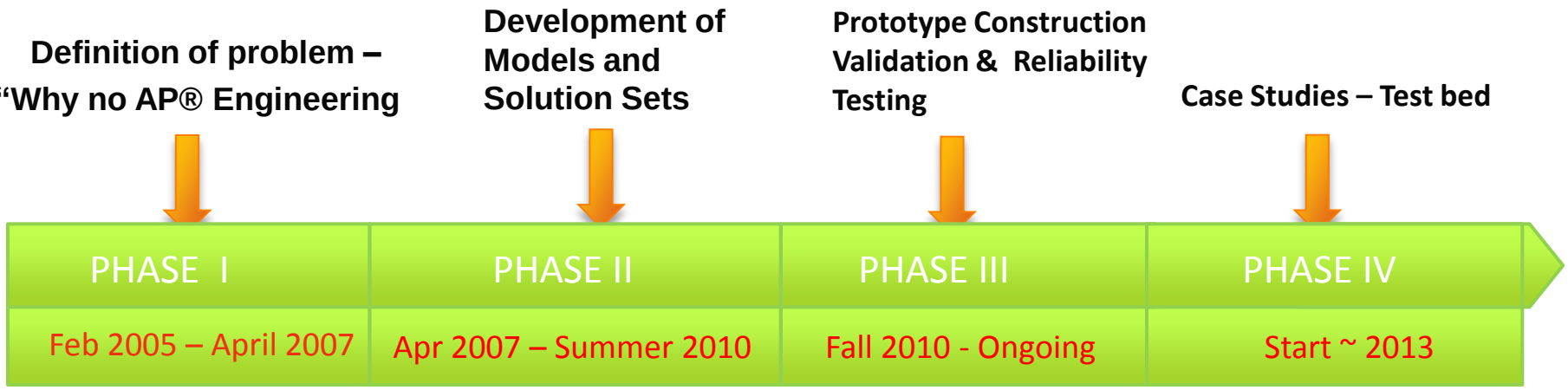
# The Development and Implementation of a Potential AP for Engineering Design Using a Rubric-Based e-portfolio

James Groves, Ph.D., University of Virginia
Rosemary Reshetar, Ed.D., The College Board
Mark Schroll, M.A., Innovation Portal
Leigh R. Abts, Ph.D., University Maryland

# Phases and Timelines
# EDPPSR *e*-portfolio and Case Studies




- Focus Groups
- Expert Interviews
- Review of Syllabi
- Workshop
- Pilot study of Course Model

- Workshops
- Focus Groups
- Expert Interviews
- Formation of Collaborators
- Model Development for Rubric and
- e-portfolio

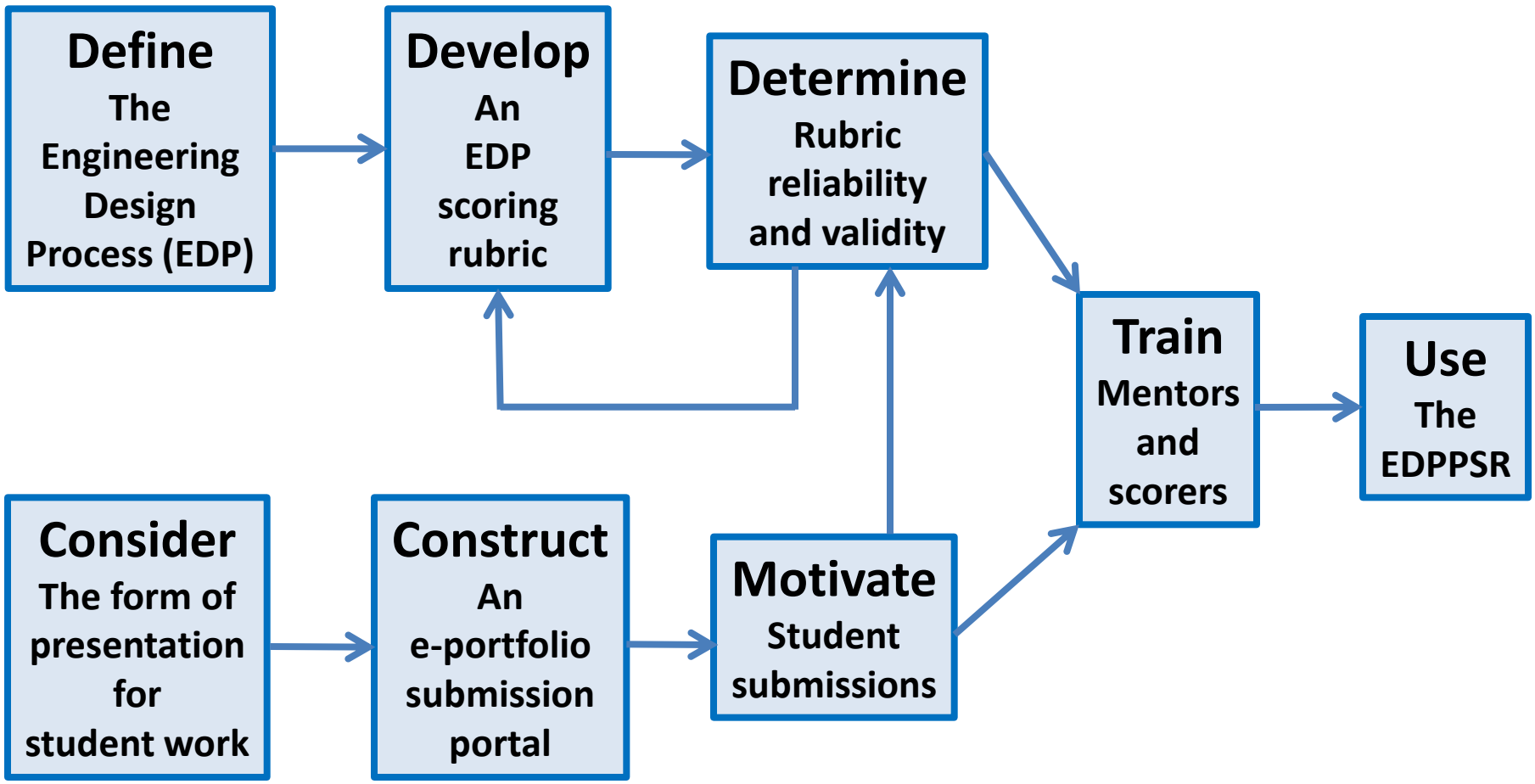
- Rubric for Design Process (EDPPSR)
- Inter-rater scoring
- Innovation Portal™
- Database development
- Psychometric Tool Development

- AP® Engineering Design
- Dual-credit
- Scholarships
- Competitions
- ABET Tool Kit
- Admissions Indicators

# Questions to Consider

- How can this rubric be applied?
- How might it impact the teaching and learning of Engineering Design?
- What is the greatest barrier to rubric use in secondary school programs (grades 9 – 12)?
- What is the best avenue for informing faculty about the rubric?
- If students matriculate with AP Engineering Design credit:
  - How might your program benefit/ change / be changed by enrolling such students?
  - How might your program apply the credit?
- When might your faculty want to learn more about this rubric and *e*-portfolio?

# Construction of an Engineering Design Process Portfolio Scoring Rubric (EDPPSR)



# The Motivation for Engineering

- **AP® –** Parents and school systems view AP® as a pathway to college placement and acceptance.
- **Weighted GPA –** Honors, gifted and talented, and AP impact the weighted average.
- **Inclusion –** Level the ‘playing field’ and increase diversity.
- **Align Project-based Activities –** Recognize student achievements in both formal and informal education settings.
- **Student learning trajectories –** Research and document for: design process, problem-solving, team work, and creativity.

# The Research Reviewed

- **Existing standards and accreditation** for secondary and undergraduate Introductory *Engineering / Design courses and programs*
- **Existing preparatory pathways** including current AP®, International Baccalaureate and Dual-enrollment models.
- **Comparative analysis** of existing *Introduction to Engineering* and / or Design courses.
- **Bridging** of formal classroom courses to informal activities such as FIRST Robotics.
- **Preparation of teachers** in engineering and design content and assessment.
- **Assessments** that include rubrics and an electronic portfolio – perhaps **modeled after AP® Studio Art.**

# Common Syllabi Elements

- **Design process**
- Problem solving
- Creative thinking
- Teaming
- Technical and engineering communications
- Ethics
- Basic computer tools
- Time management
- Project management
- Modeling
- Apply mathematics and science knowledge
- What it means to be an engineer
- Role in society

# Synopsis of findings relative to design

- **Design** incorporates many of the Syllabi elements.
- **No single framework existed that could:**
  - **capture the design process** fully or well,
  - **Or benchmark each element** of the process to a commonly accepted set of referenced artifacts.
- Design is a **stepwise, artifact driven framework** typically practiced over time and is an iterative process.
- **Many informal and formal** opportunities to practice design.
- The Design Process is **not unique to Engineering – Architecture, Fashion, etc.**
- In essence, the learning and practice of design is an **apprenticeship process.**

# The Relevance of the Portfolio

- Currently, **a student's transcript is the most widely applied and utilized model** for representing a student's learning and practice of the design process.
- However, **the transcript provides a series of one-dimensional, snapshots** or Grade Point Average – GPA.
- The assessment process most often used to generate the grade is a **multiple-choice test,** which for the past century, been central to the **definition of competency.**
- Given the **potential richness and complexity of evidence to demonstrate proficiency in the design process, the portfolio-based assessment** offers a promising alternative.

# Toward AP Adoption

## ➢ Basic College Board Criteria

1. **Recognition and acceptance** by the post-secondary constituents. Willingness of large numbers of US higher education institutions to grant credit and exemption from an existing undergraduate course.
2. **Availability of professional development** and related curriculum and instructional resources for teachers.
3. A sustainable **financial model.**

# About AP Courses & Exams

- **In 2011-2012 there are 34 Courses and Exams**
  - 3 Studio Art Subjects with Portfolio Assessments
  - 31 Subjects with 3 Hour Summative Exams
- **AP reported scores 1 through 5**

  5: Extremely well qualified (A)

  4: Well qualified (A-, B+, and B )

  3: Qualified (B-, C+, and C)

  2: Possibly qualified

  1: No recommendation
- **Cutpoints established** using college comparability studies and panel based standard setting.
- Need **Performance Level Descriptions** to clarify meaning

# Launching an AP Subject

- Involves data gathering with Higher Ed and K-12
- Funding to support course development
- Exam development and piloting
- Teacher professional development
- Feasibility and business case analysis
- Colleges and universities agree to award credit/placement for successful exam scores
- Sufficient interest in the course and that schools have the ability and willingness to offer it

# Evidence Centered Course & Exam Design Model

- Develop **curricular framework** based on claims of what students should know and be able to do and evidence that would demonstrate competency
- Develop **performance level descriptors** to describe what students in each category know and are able to do based on their test performance
- Develop **measurement tasks** to solicit evidence
- Create an **assessment framework**

**Iterative process with ongoing validation**

# Evidence of Validity

- The curriculum and exam reflect engineering design courses and the assessment reliably and validly measures intended content. This might include:
- Content experts agree on importance of what's included in course
- Large scale curriculum study of first-year engineering courses

# Evidence of Validity

- Strong positive correlations between assessment scores and grades in college engineering courses
- Students who take engineering course report feeling prepared for subsequent courses
- Empirical studies show that students who earn a high score on the exam perform well when placed directly into subsequent courses (longer-range goal)

# Portfolio Assessments

- AP Studio Art courses have high-level content requirements but they do not have an in-depth curricular framework
- While this allows maximum flexibility and independence for teachers and students, we found that it would be beneficial for new faculty to have a curricular framework and supporting materials to use if desired
- Two optimal paths for creating a successful portfolio
  - Structured course in subject
  - Portfolio of work created based on independent project(s)

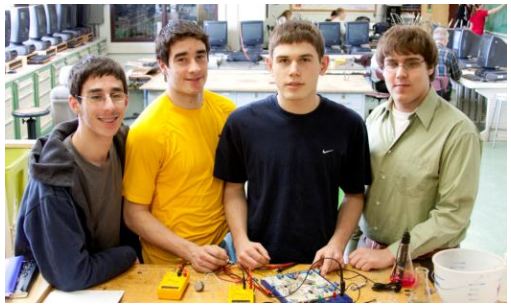
- How might you envision your college students contributing to our teaching materials and resources for the K-12 engineering community?

# Developing an accessible e-portfolio resource


www.innovationportal.org

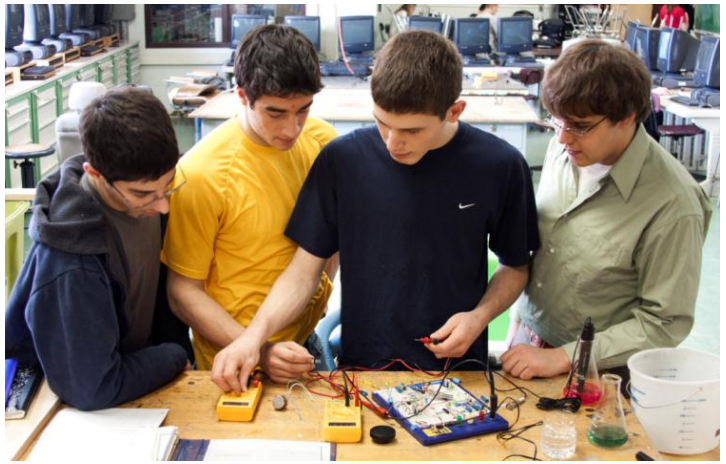
# What makes the Innovation Portal special?

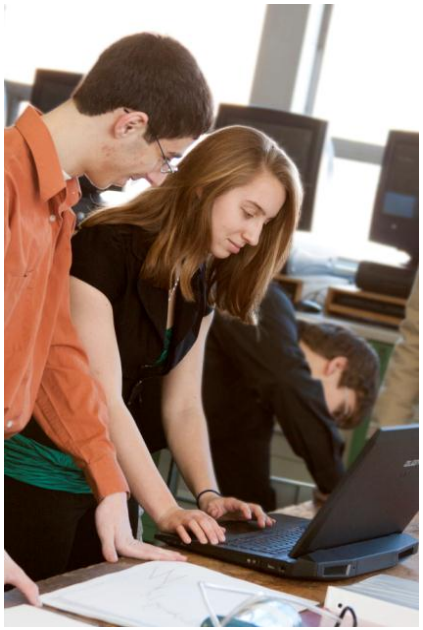
- Non-profit developed, higher education guided
  - Motivated by teachers
  - Available for anyone to use
  - Developed and maintained by PLTW
  - Repository + resource
  - Higher ed guidance on development
- Student centered
  - Students “own” their password protected accounts and data
  - Students control access and IP (teachers, scholarship committees, competition judges, AP reviewers)
- EDPPSR template for entire site

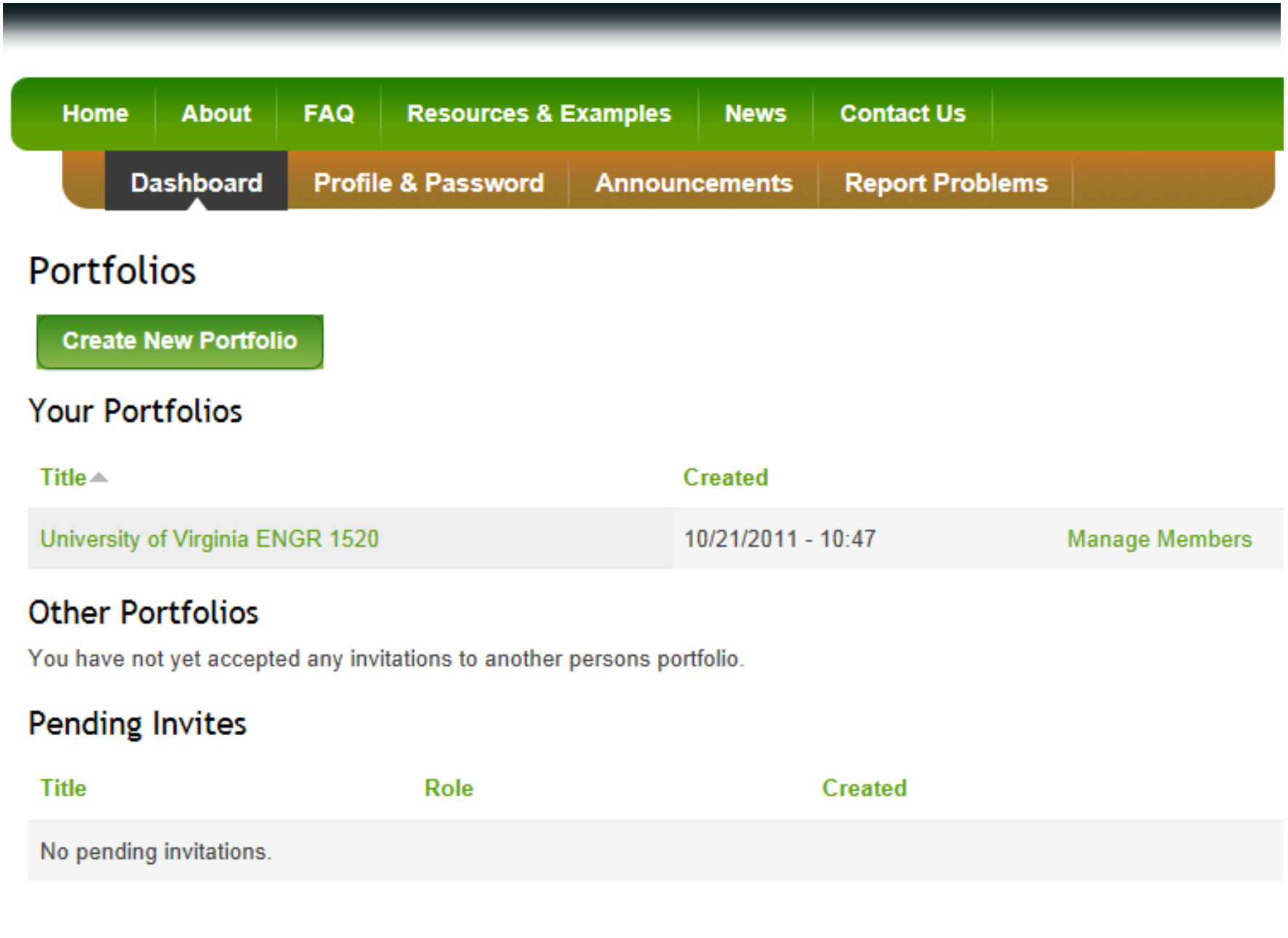
# What has guided Portal development?

- Desire to build a functional, open access engineering design repository
- Internet accessible yet secure
- Accessible for multiple uses
- Standard guide for portfolio development (The EDPPSR)
- Opportunity to serve as a central “bulletin board” for:
  - Opportunity announcements
  - Teacher training materials

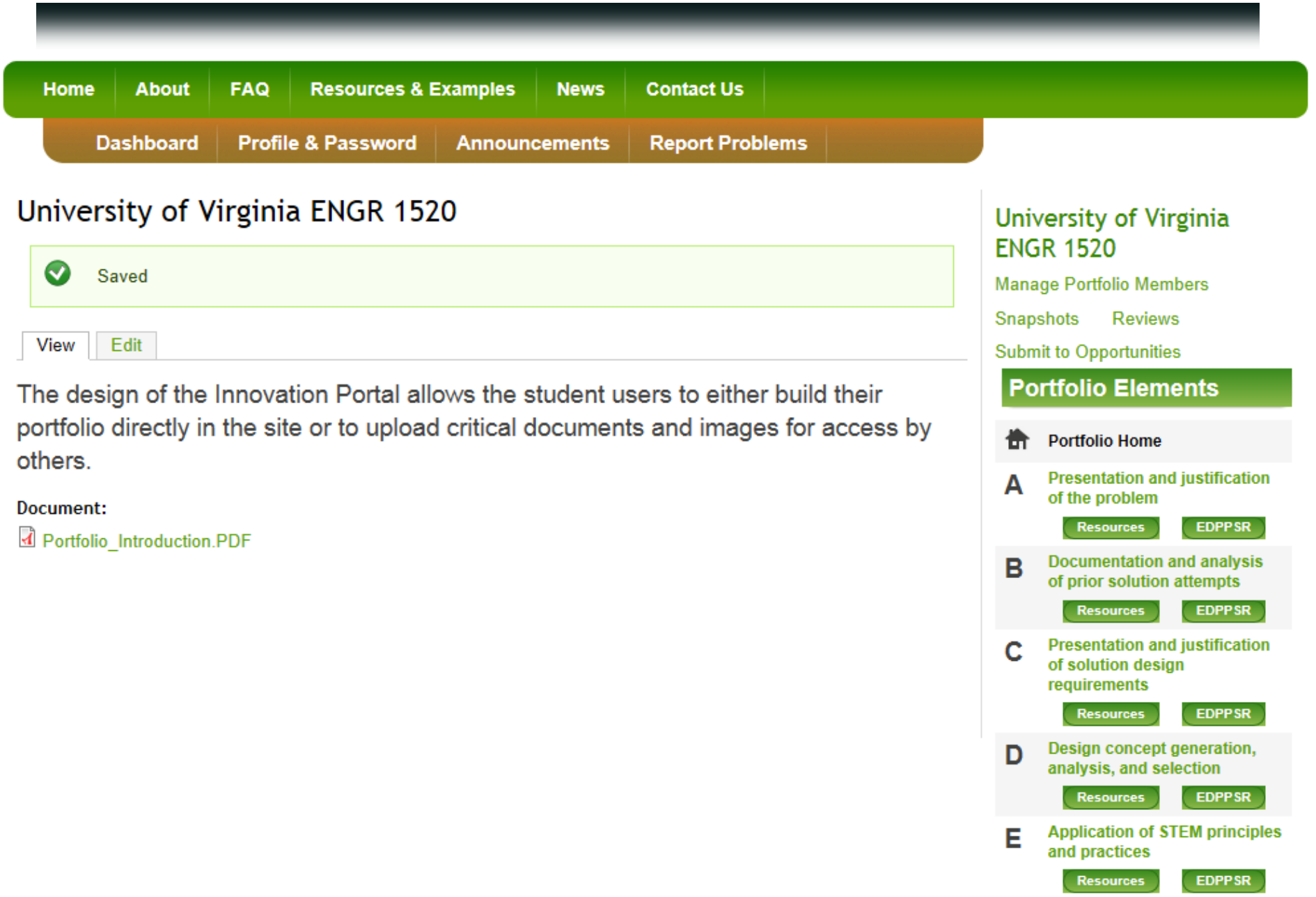




# Create, organize, and manage portfolios



# Building a portfolio



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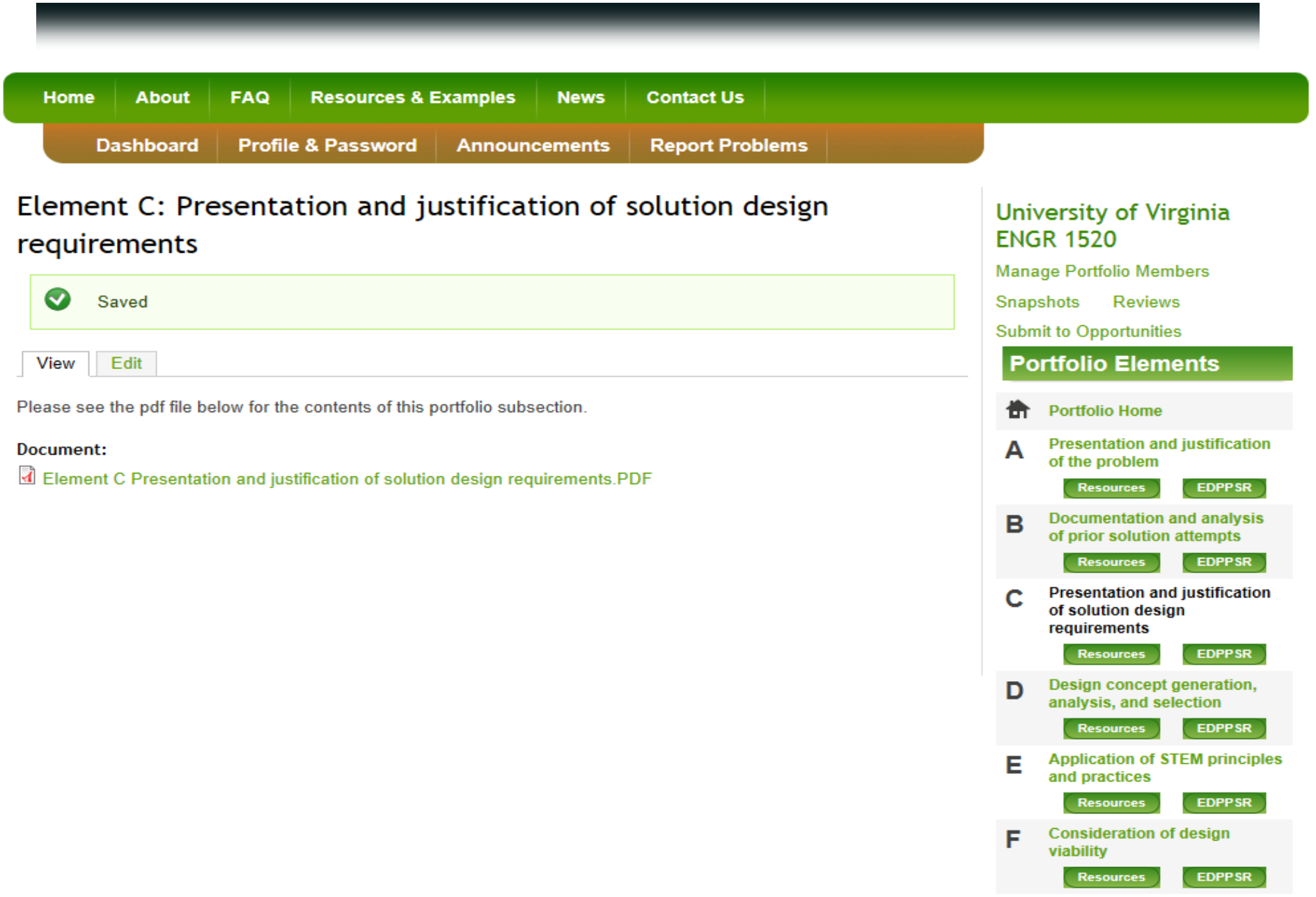

# Connecting to resources…



## Element C Resources - Presentation and justification of solution design requirements

These resources and examples are specific to helping students develop a comprenensive and robust portfolio entry for Element C

"Presentation and justification of solution design requirements"

### EXAMPLES: Annotated Portfolio Examples for Element C

1. Snow Clear LED Traffic Signal Visor - (PDF) averaged reviewer score = 1
2.
3.

### IDEAS and RESOURCES: Presentation and justification of solution design requirements

# and the rubric



## Presentation and justification of solution design requirements

| Score | Description |
|---|---|
| 5 | Design requirements are listed and prioritized, and they are consistently clear and detailed; these design requirements presented are consistently objective, measurable, and they would be highly likely to lead to a tangible and viable solution to the problem identified; there is evidence that requirements represent the needs of, and have been validated by, many if not all primary stakeholder groups. |
| 4 | Design requirements are listed and prioritized, and they are generally clear and detailed; these design requirements presented are nearly always objective and measurable, and they would be likely to lead to a tangible and viable solution to the problem identified; there is evidence that requirements represent the needs of, and have been validated by, several primary stakeholder groups. |
| 3 | Design requirements are listed and prioritized, and they are generally clear and somewhat detailed; these design requirements presented are generally objective and measurable, and they have the potential to lead to a tangible and viable solution to the problem identified; there is evidence that requirements represent the needs of, and have been validated by, at least a few primary stakeholder groups. |

# Convening of expert panels

- **Students upload artifacts** (e.g., notes, learning logs/journals, data displays, models, drawings and schematics, online automation, videotape, etc.) from a variety of contexts—formal and informal, secondary and undergraduate level project activities.

- Once the e-portfolios have been collected, and permission granted, trained **reviewers will evaluate to make determinations regarding students' engineering design process proficiency.**

# The June 22 and 23 EDPPSR Workgroup

- **Activities (Facilitated by Dr. Gail Goldberg):**
  - ✓ **The Innovation Portal** as a platform for creating and accessing e-portfolios
  - ✓ **Key elements** rubric design (language and format)
  - ✓ **Judgment-based scoring sessions:** holistic, analytic, and modified (focused) holistic – 11 Experts, 4 Secondary Experts, and 2 Scribes (Secondary, Community College, Four-year)

- **Sampling of Initial Findings:**

| Key Questions Underlying Workshop Activities | What We Learned as a Result of Workshop Activities |
|---|---|
| What, if anything, that might contribute to an element score decision is not cued for via the score point descriptors (but should be). | Nothing major was identified; minor additions may be made to the descriptors |
| Are there any instances in which the language of a score point descriptor leads to perceived errors in assignment of score level (cognitive dissonance)? | Some instances of unrealistic demand were noted and will be corrected – **e.g. consultation and involvement of experts that would impact weighting and substituion** |

# Next Steps

- **Continue the research** to address the College Board's Criteria.
- **Review portfolios** across '**Challenges,' programs and faculty** committed to participate (FIRST®, SeaPerch®. PLTW, TN Tech, UMD, USNA,UVA, and Vanderbilt).
- **Understand, define and document** how the EDPPSR / *e*-portfolio aligns to grades 10 to 16 informal activities, Introduction to Engineering courses, course related design projects and CAPSTONE courses.
- **Develop and test** training processes for the scorers / raters, teachers, faculty and mentors.
- **Develop scoring and reporting tools.**

# Supported by


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- NSF PRIME Award 1118755 – Dr. Mary Moriarty (PO)


- **Note:** Research conducted under a series of IRB protocols from 2005.

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