Transforming How We Teach Power Engineering

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ONR/NSF/UMN Faculty Workshop

Reforming Electric Energy Systems Curriculum

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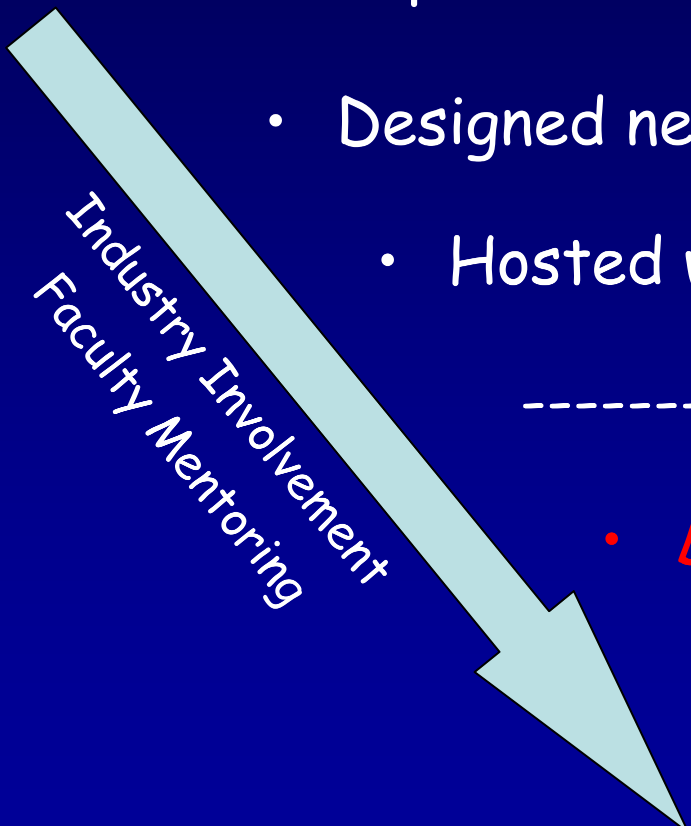
Progression of UMN Initiatives

- Updated technical learning objectives
  - Developed textbooks to address objectives
    - Designed new lab activities & equipment
      - Hosted workshops, webinars, continuing ed



- *Designing in-class activities*
  - Outlining graduate-level courses
    - Integrating research & teaching

Motivation…

Video clip from “Minds of Our Own”

University graduates struggle with batteries & bulbs

Motivation…

How do you encourage deep, lasting learning?

- Response 1: Bill motivates students by discussing common, real-life applications of the technical content (e.g., power supplies for the students' personal electronic devices)
- Response 2: Bruce engages the students with pictures and movies of power system disasters, while discussing the technical details behind how these disasters occurred
- Response 3: Paul wraps a story around an important concept, which humans are naturally inclined to pay attention to and remember
- Response 4: Another audience member uses open-ended design problems to encourage deeper understanding of technical content
- Response 5: Another audience member uses hands-on but not "cookbook" activities, so students experience applications of the technical knowledge but don't mindlessly follow a written set of procedures

Transforming How We Teach

For student learning, move from:

- "Covering it"
- Transferring instructors' notes into students' notes

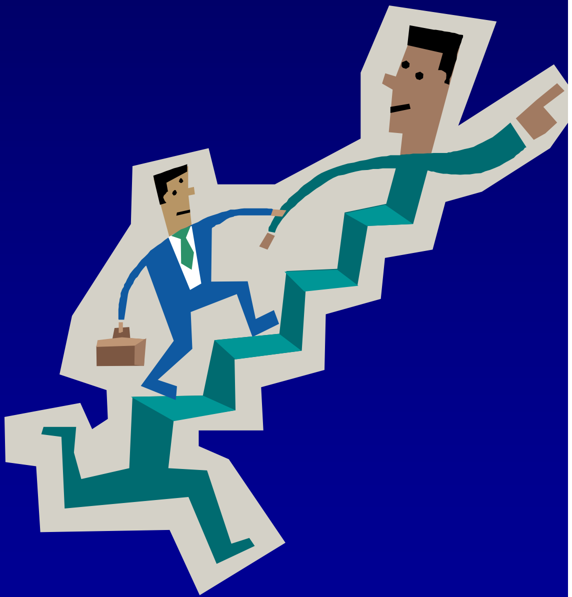
Move to:

- Active engagement, "minds-on" more than "hands-on"
- Relevant, real-world problems of student interest
- Collaborative peer interactions
- Face-to-face, meaningful faculty interactions
- Higher-level critical thinking and problem solving

Transforming How We Teach

For instructors, move from:

- Fear of teaching unknown content
- Hiding behind the podium, sticking with "safe" material
- Telling
- Ineffective use of time



Move to:

- Well designed, evaluated class activities
- More enjoyable student interactions
- Support from highly qualified colleagues
- Rapid proficiency, success in new teaching methods
- Improved student enrollment, retention, grades

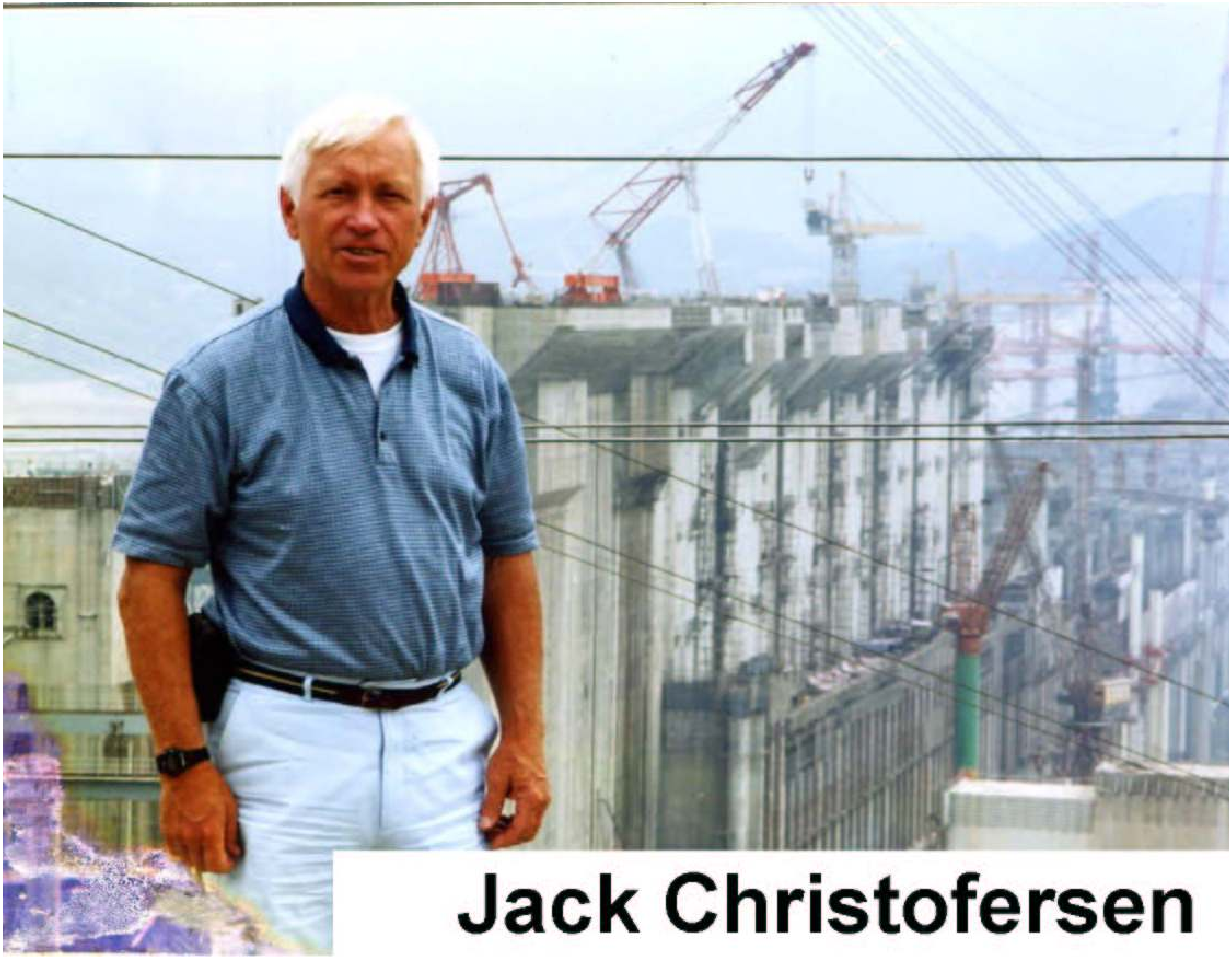
Step 1: Recording Experts' Stories

Save institutional knowledge in case studies

Example contributors:

- Chris Henze – Designed charger for 1st electric car
- Jim Hendershot – Designed numerous motors & generators
- Jack Christofersen – 40 yrs working on T&D
- Pratap Mysore – 30 yrs working on protection systems

Jack is writing his first case…



Jack Christofersen

Reforming Electric Energy Systems Curriculum

Ned Mohan's Reform School
3 Gorges Project 22,500 MW
2nd largest civil engineering project

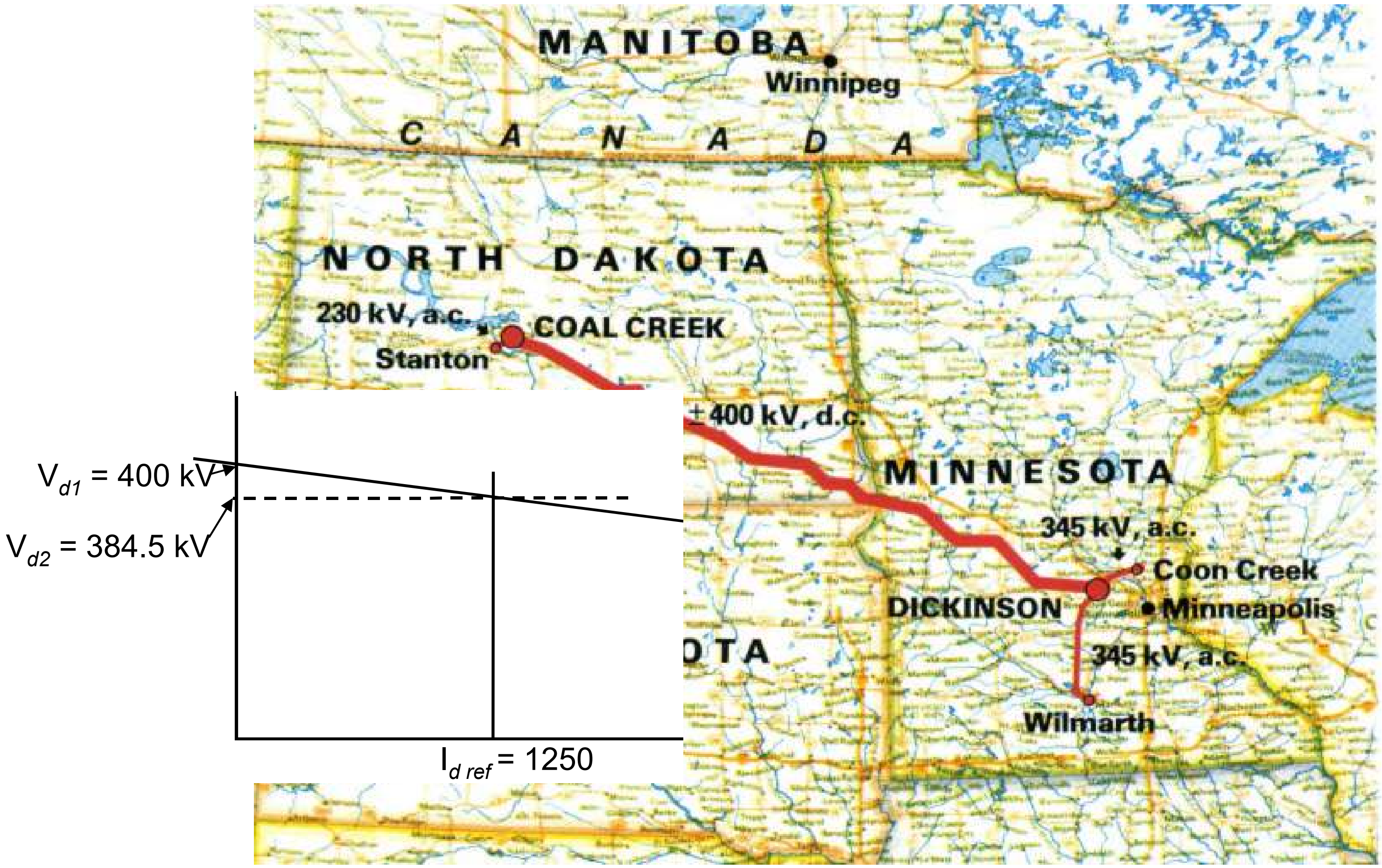


Fig. 1 CU Transmission System [2]

An early thyristor valve system commissioned in 1979.
Real-world case studies from
initial design, permitting and commissioning to
present life extension projects after operating over 30 years.

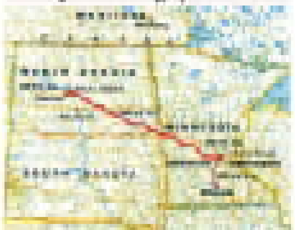
The primary applications for HVDC:

- **The economic alternative for transmitting power over long distances.**
- **Transmitting power underground or undersea at transmission voltage levels with distances over 30 km.**
- **The only alternative for power transfer between asynchronous systems.**

HVDC was chosen for the CU Project because of the long distance and system stability.

- **Definition of HVDC Terminal Components**
- **CU One-line Diagram and Project Specifications**
- **Performance Review**
  - **Transmission Line and Electrode**
  - **Electric and Magnetic Fields**
  - **Converter Configuration**
    - **Thyristor Valve**
    - **Bipolar and Monopolar**
- **National Electrical Safety Code (NESC)**

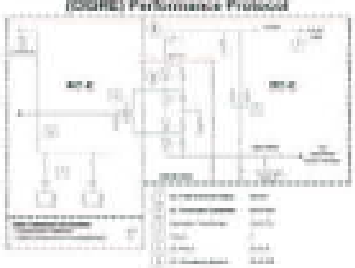
Hope to see you during the Poster Session



The GU Project

The GU Project

Definition of HVDC Terminal Components (CIGRE) Performance Protocol

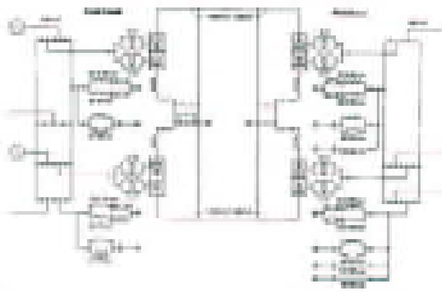


HVDC System Components

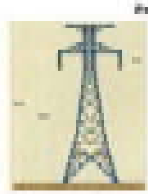
One-line Diagram

1000 Mw

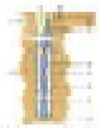
Coal Creek, North Dakota to Dickinson, Minnesota



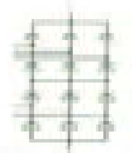
Performance Review



Transmission Structure



Dickinson Station Ground Electrode



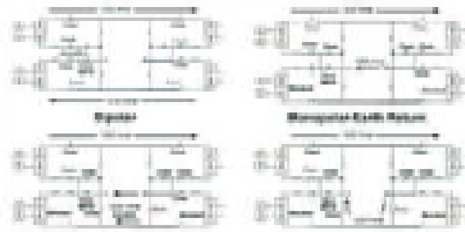
Twelve pulse converter

Valve Hall

Electric Fields

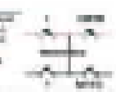
Magnetic Fields

Bipolar and Monopolar Configurations



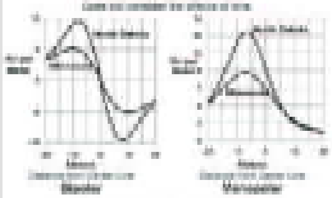
Bipolar

Monopolar Earth Return



National Electrical Safety Code

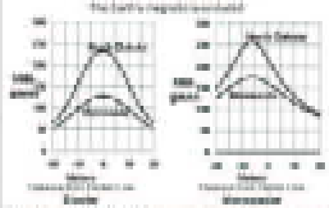
Calculated Electric Field



Bipolar

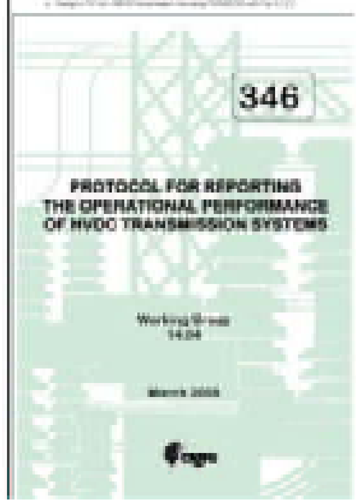
Monopolar

Calculated Magnetic Field



Bipolar

Monopolar



Step 2: Develop In-Class Activities

- Instructors identify core, important concepts in each case
- Instructors coordinate with engineering education specialist to outline each activity
- Support materials for teachers & students are developed
- Ned records on-line 30-minute video modules (lecture material to support case)

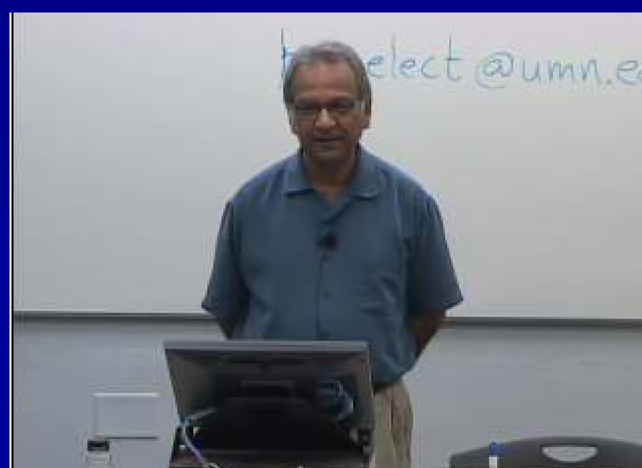
Step 3: Assess In-Class Activities

- Materials tested at UMN and NAU
- Implementation and results of each activity professionally assessed & revised
- Timeline:
  - Power Electronics, Fall 2010
  - Power Systems, Fall 2011
  - Electric Drives, Fall 2012

Step 4: Dissemination

- Spring/summer dissemination workshops after each assessment

- New instructors additionally supported by:
  - Ned's video modules
  - Weekly teleconferences with resource faculty



Possible Follow-on Activities

- Implementation, assessment, and revision at several other institutions
- Collection & distribution of other outstanding in-class activities, homework assignments, simulations, tricks & techniques, etc.
  - Emphasis on integrating research and contemporary issues into the curriculum
- More intensive training sessions

Resources

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