

Studying Change in STEM Higher Education

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Facilitating Change in STEM Education

Four Categories of Change Strategies
from an interdisciplinary literature review

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More at: <http://www.stemreform.org>

C. Henderson, N. Finkelstein, & A. Beach A. (to appear). "Beyond Dissemination in College science teaching: An Introduction to Four Core Change Strategies." *Journal of College Science Teaching*.

Common Goal

shift from instruction paradigm
 to the learning paradigm*

The Instruction Paradigm	The Learning Paradigm
 <p>Traditional Physics class at University of Rochester</p>	 <p>Clicker use at UC Riverside</p> <p>White boards at Western Michigan University</p> <p>Workshop Physics Classroom at Dickinson College</p> <p>SCALE-UP Physics class at Clemson University</p>

*From Barr, R. B. and Tagg, J. (1995) From teaching to learning - a new paradigm for undergraduate education. *Change* (November/December), 13-25.

Starting Point:

We know a lot about:

- effective teaching and learning of STEM subjects
- how to apply this knowledge in individual classrooms

Now all STEM classrooms produce knowledgeable, skilled students who have positive attitudes toward science ...



Why Change Strategies are Important

Evolving Change Strategies of the Foundation Coalition*

Foundation Coalition:

- What: 6 institutions to develop and implement a new 4-year engineering curriculum
- When: First grant – 1993-1998 (\$14M)



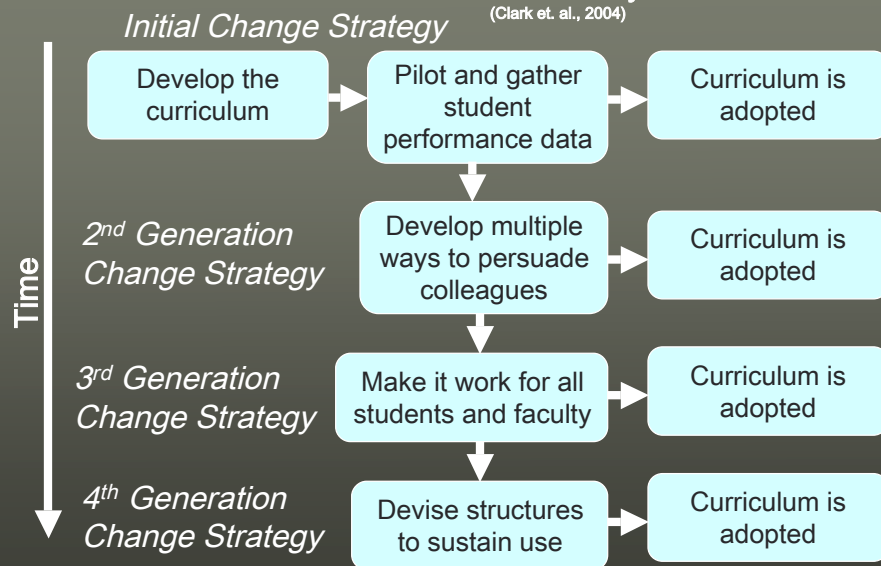
Award Number	Title	NSF Organization	Program(s)	Start Date	Principal Investigator	State	Organization	Awarded Amount to Date
9802942	Foundation Engineering Education Coalition	EEC	ENGINEERING EDUCATION	10/01/1998	Froyd, Jeffrey	TX	Texas Engineering Experiment Station	\$14,191,167.00
9221460	The Foundation Coalition	EEC	ENGINEERING EDUCATION	10/01/1993	Freir, Karen	TX	Texas Engineering Experiment Station	\$14,000,000.00

*C. M. Clark, J. Froyd, P. Merton and J. Richardson, "The evolution of curricular change models within the foundation coalition," Journal of Engineering Education. **93** (1), 37-47 (2004).



Implicit Change Strategies Inferred by Researchers

(Clark et. al., 2004)





Literature Search: Models of Change in STEM Ed

- ~ 400 Articles
- Primary Databases: [Web of Science](#), [ERIC](#)
- Search Terms: [change](#), [improvement](#), [reform](#), [teaching](#), [instruction](#), [higher education](#), [college](#), [university](#), [tertiary](#)
- Dates: [1995-2008](#)
- Use Title and Abstract to determine inclusion
- Subset (130) used to identify 4 core strategies and sub-categories & preliminary findings
- Applied to remaining
- Delphi (distilling findings from experts)



Key Findings

- Isolated communities
- Little connection to prior literature
- Little connection to research / experimental studies
- Meta-level categorization scheme suggests 4 key approaches

<http://www.stemreform.org>

<http://homepages.wmich.edu/~chenders/Projects.htm>

Two Important Strategic Dimensions

What does the change effort intend to directly impact?

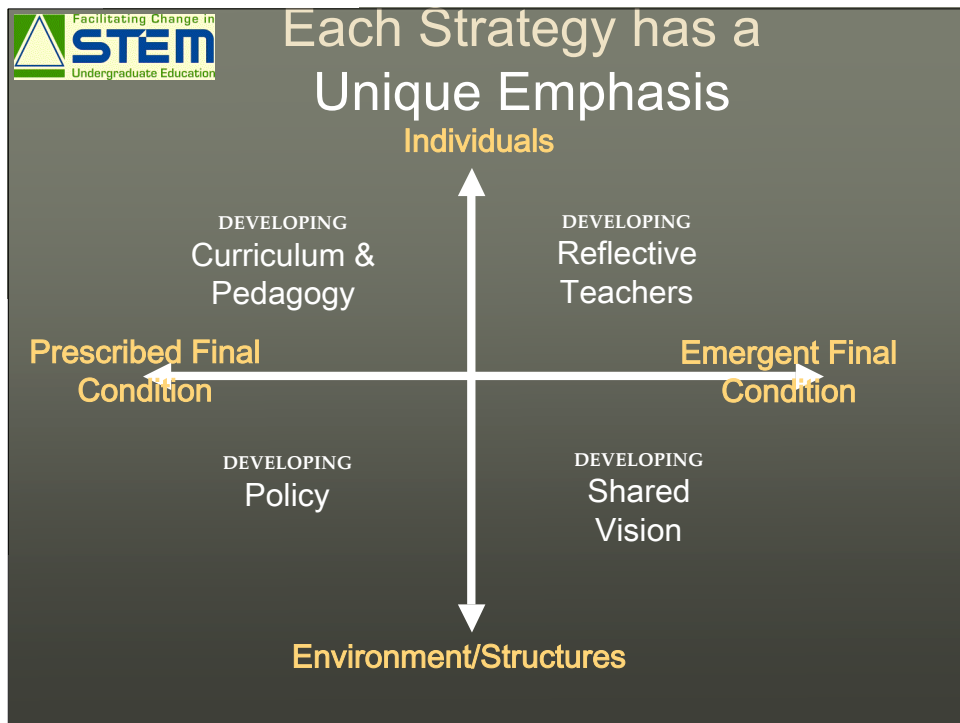
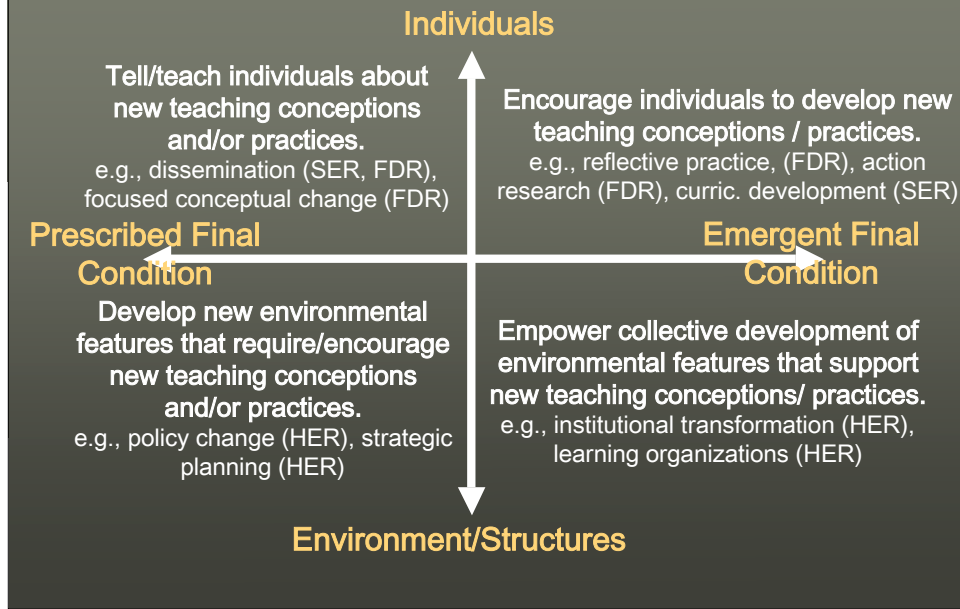
Individuals	Environments and Structures
<p>personal characteristics of single individuals, such as beliefs, knowledge, behaviors, etc.</p>	<p>impact characteristics of the system such as rules, physical characteristics of the environment, norms, etc.</p>
<p><u>Implicit Assumption:</u> Individuals' actions influenced by own volition</p>	<p><u>Implicit Assumption:</u> Individuals' actions influenced by external environments</p>

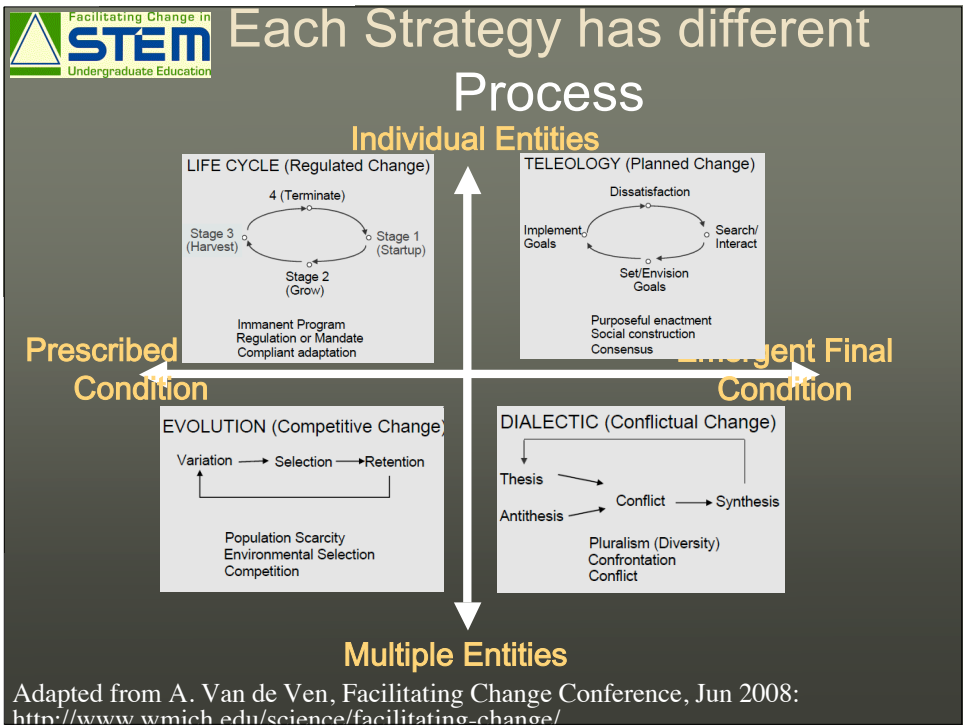
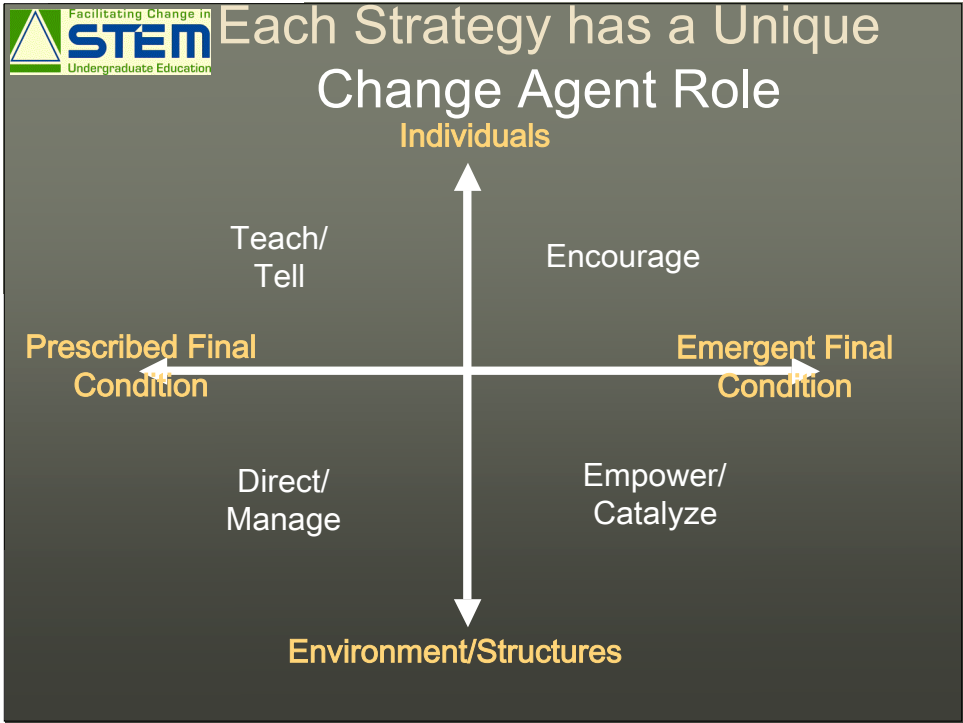
Two Important Strategic Dimensions

To what extent is the outcome prescribed in advance?

Prescribed Final State	Emergent Final State
<p>final state is known at the beginning of process</p>	<p>final state is developed as part of the process.</p>
<p><u>Implicit Assumption:</u> Important knowledge known to a few people (e.g., experts). Small group should determine the intended outcome.</p>	<p><u>Implicit Assumption:</u> Important knowledge throughout the system. Variety of stakeholders should be involved.</p>

Four Categories of Change Strategies

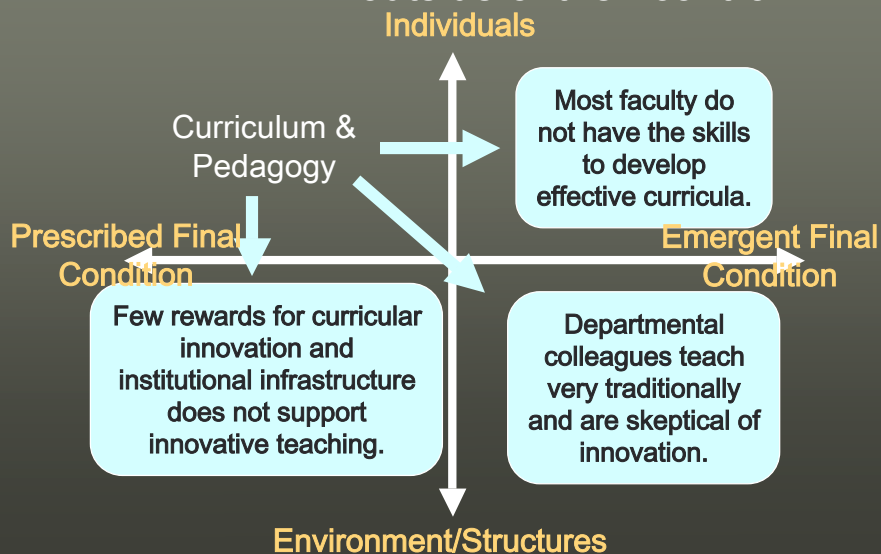




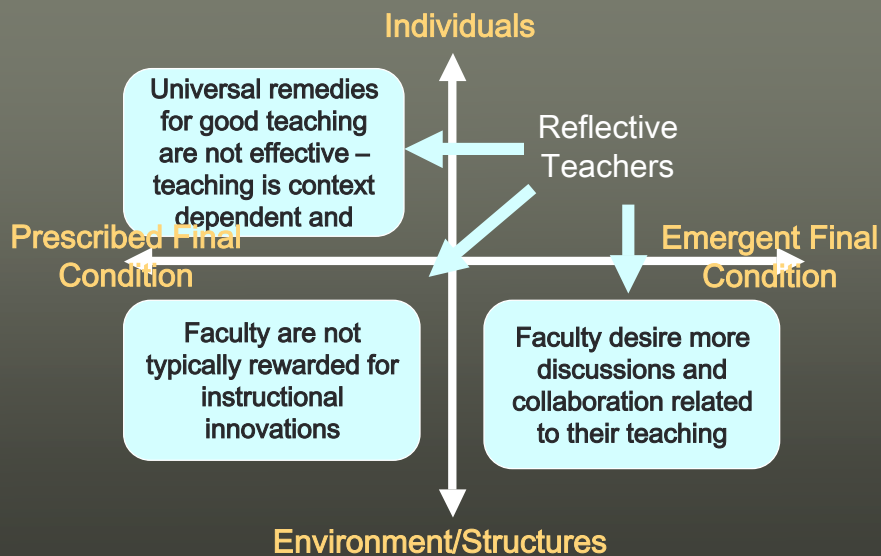
Adapted from A. Van de Ven, Facilitating Change Conference, Jun 2008:
<http://www.wmich.edu/science/facilitating-change/>



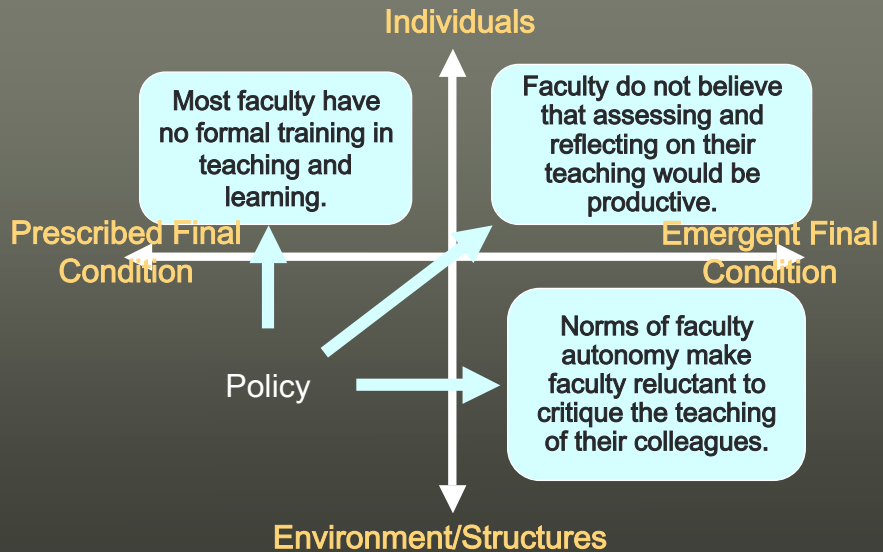
Each change strategy sees areas of influence of other strategies as outside of their control



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Key Implication:

working across quadrants

- Identifying Change Levers / Agents
- Top down meets bottom up
- Coordinate Processes
- Attend to scales:
temporal, spatial, cultural

facilitated through research

The person who says it
cannot be done should not
interrupt the person doing it.

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Chinese proverb

fin

See:

per.colorado.edu (for this talk and more)

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<http://www.stemreform.org>