BHEF BUSINESS-HIGHER EDUCATION FORUM™

Raytheon

Customer Success Is Our Mission

Elementary and Secondary Education - Modeling Student Interest in Science, Technology, Engineering and Mathematics (STEM)

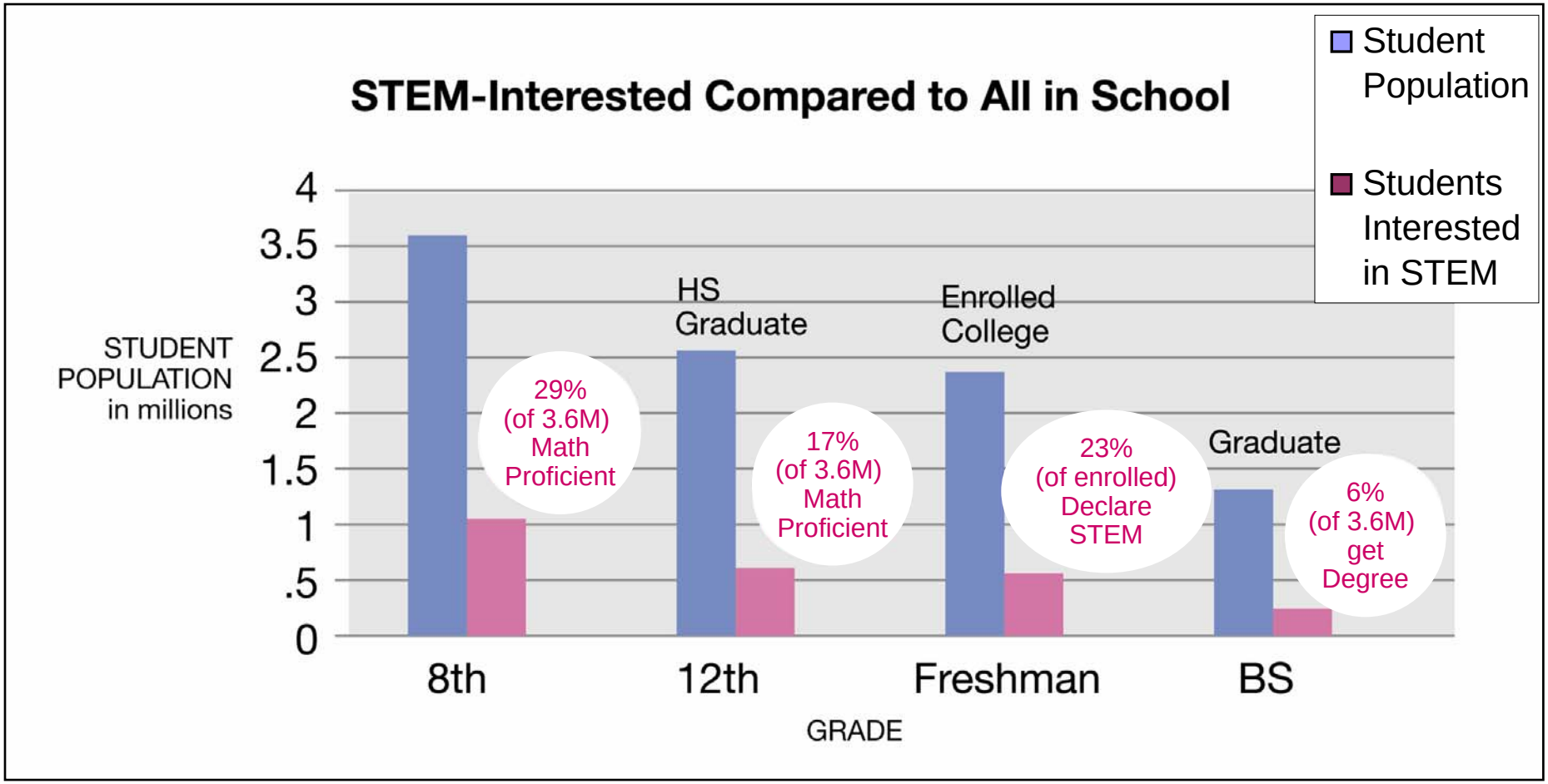
Brian Wells, Raytheon
Chief Systems Engineer

11 February 2008

National Issue

- The downward trend in U.S. science and engineering degree attainment
- Declining Student Interest in Science, Technology, Engineering and Mathematics Education and Careers

Comparison of Student Populations



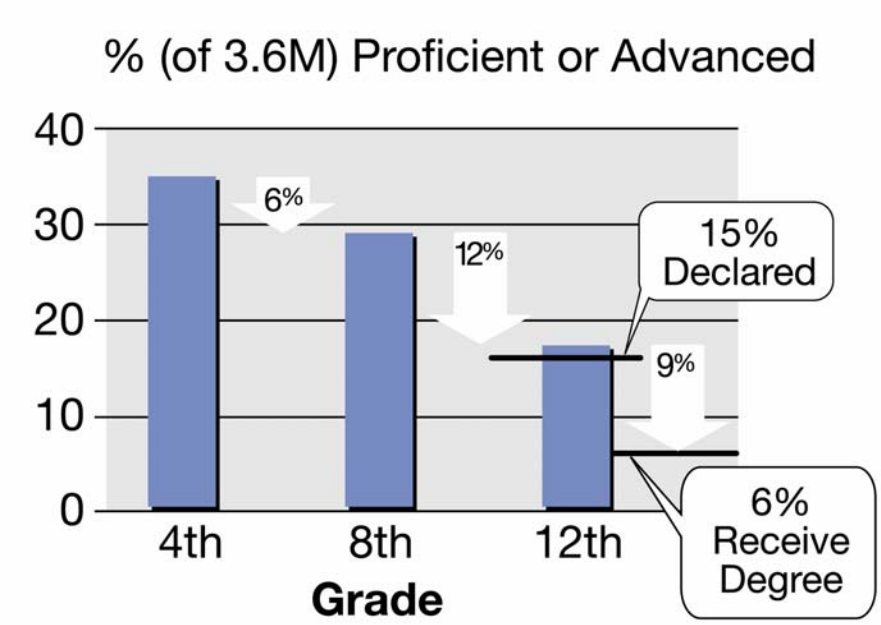
Source Population data: U.S. National Center for Education Statistics, *Digest Education Statistics, 2002*.
Source Proficiency data: *Digest of Education Statistics 2005*, Tables 121 and 122 for 4 and 8th grades.

Relatively small numbers of students make it through the system and obtain a STEM bachelor's degree

Math Proficiency and STEM Bachelor's Degrees Granted

- Math proficiency drops slowly from 4th grade to 8th grade
- Falls 3% per year in high school
- Students declaring STEM majors are approximately the same numbers as those that are proficient
  - 15% declare STEM, 17% are proficient or advanced
- 9% loss during college

(Source: Tables 121 and 122, *Digest of Education Statistics 2005*)

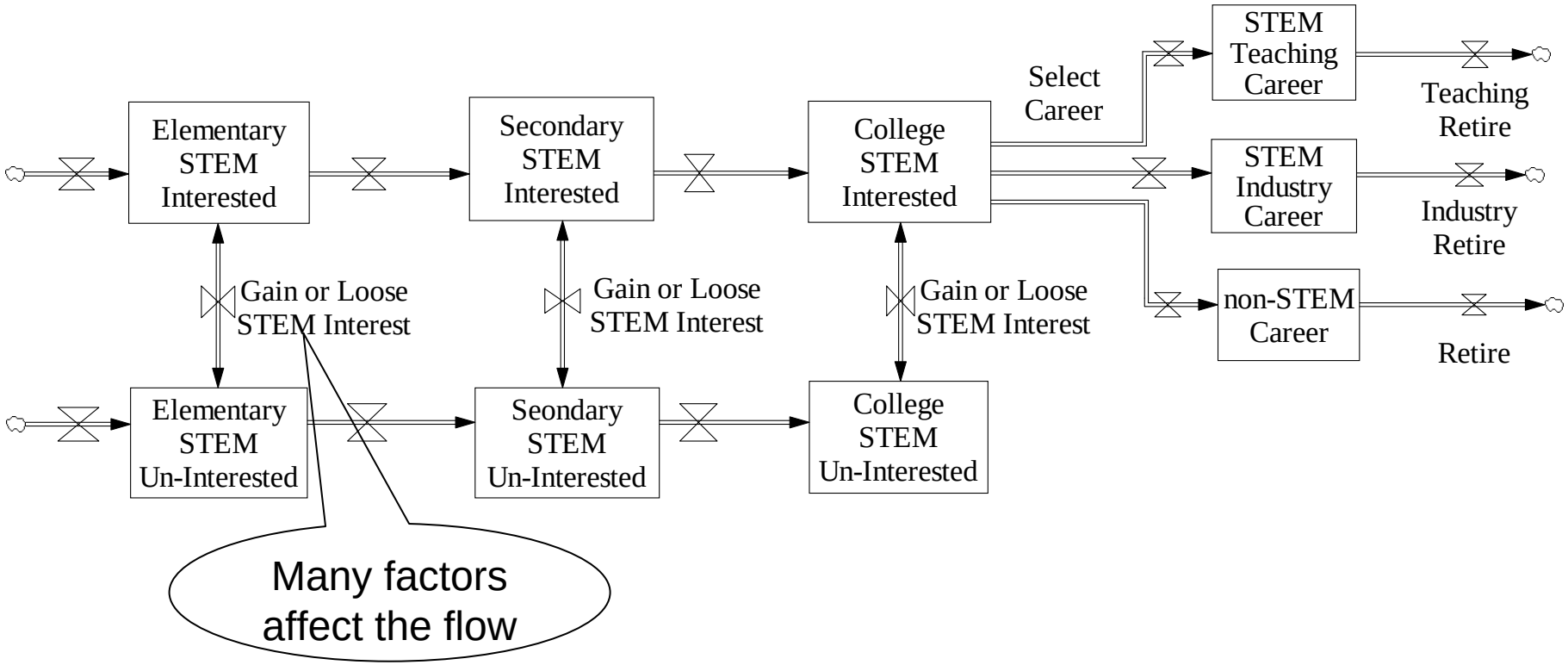


Application of Modeling and Simulation

- M&S Provide a method for predicting how changes in policy will affect the U.S. Education System
- Provides a method for organizing the approach
- Provides a means for thinking through the problem and the solutions

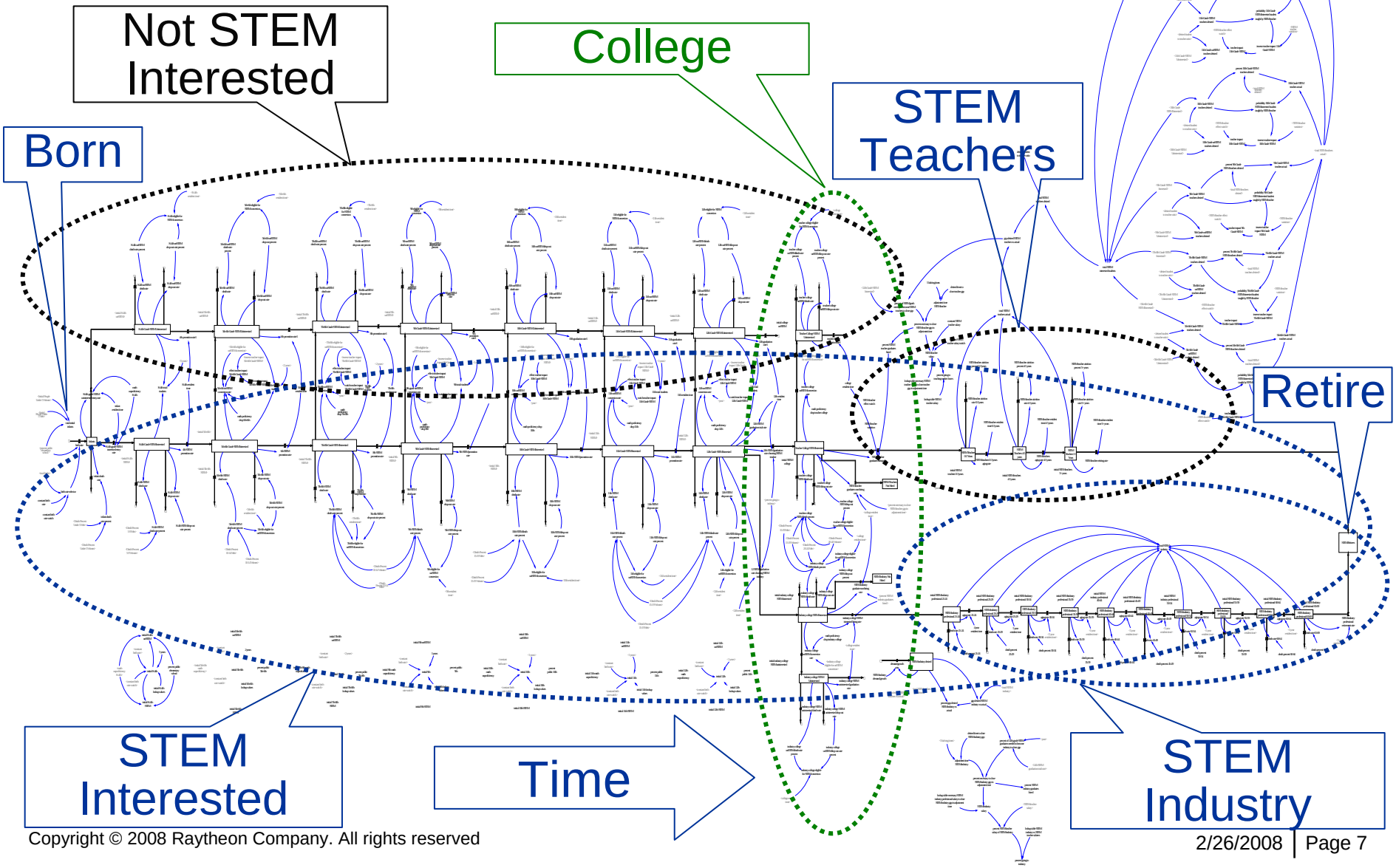
Simplified Representation of the Student Flow Model

- Based on System Dynamics methods created by J. Forrester



Model helps us think about what happens when factors change

Overview of the VenSim Education Model



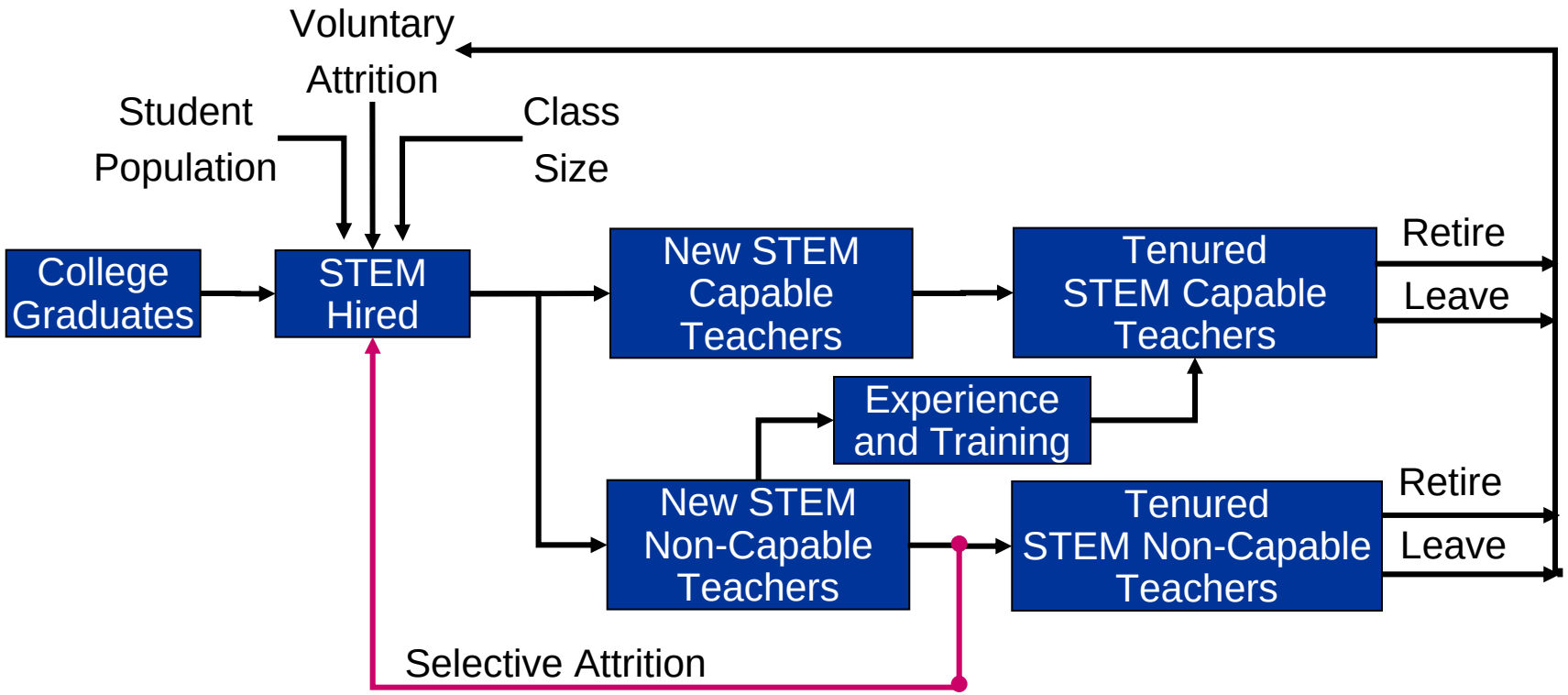
Modeling Experiments

- Examine changes in student STEM interest and attrition (4th to 12th grades) due to an increase in the number of STEM-capable Teachers

- Increase the number of STEM-capable teachers by:
  - Training, mentoring, laying-off or denying tenure to the least capable teachers after 3 years
  - Changing STEM Teacher Salary and Compensation
  - Changing the class size

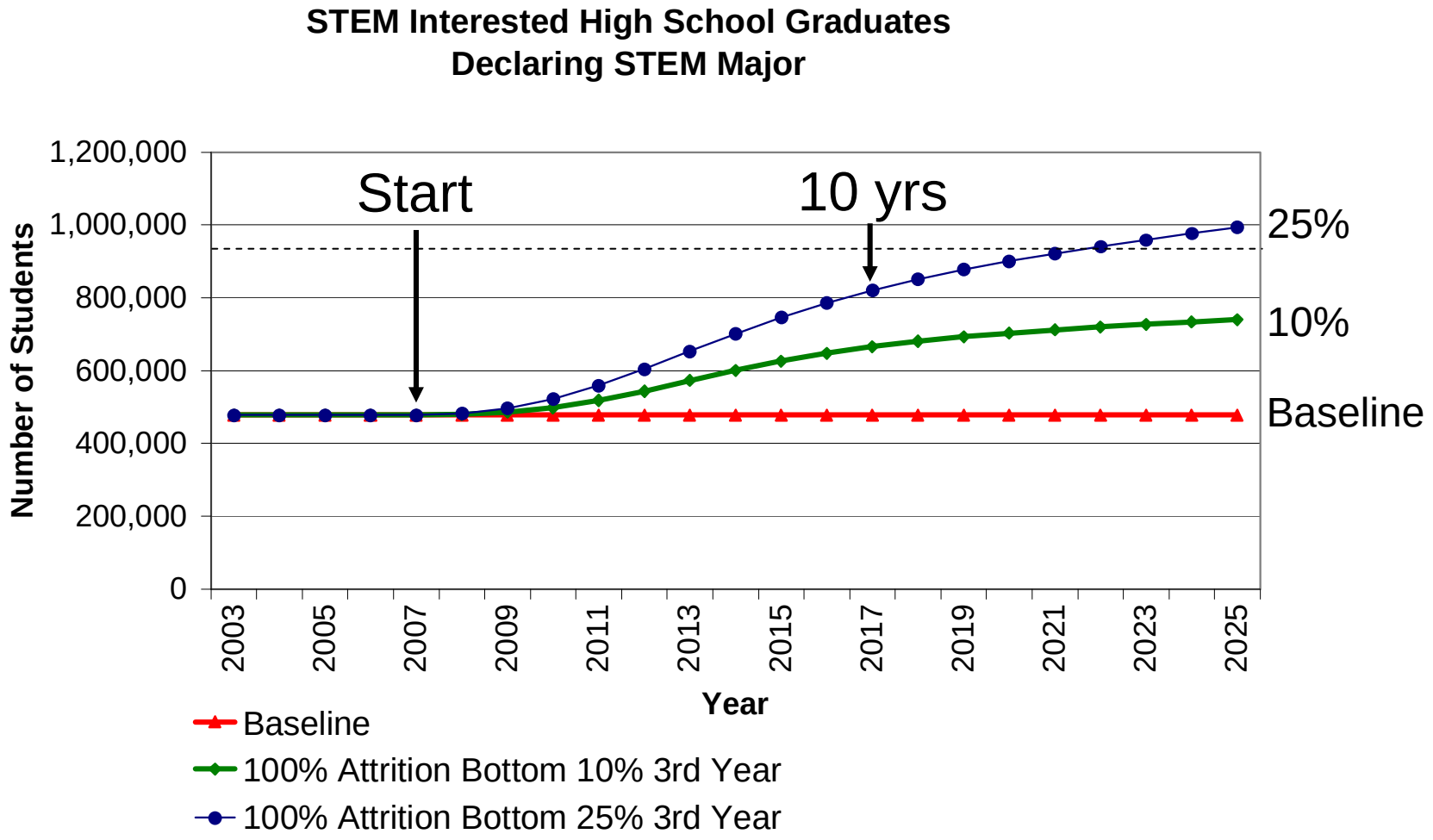
Increasing Number of STEM Capable Teachers

- Increased attrition increases the demand for new teachers and hiring
- Increased attrition of lowest performing teachers before tenure increases the ratio of STEM-capable tenured (experienced) teachers
- Increased hiring improves numbers of new STEM capable, *IF* administrators can differentiate



Increased STEM-Capable Teacher Population Increases the STEM Interested Student Population

- High levels of attrition among the lowest performing teachers are required to double the numbers of STEM-interested students



Conclusions

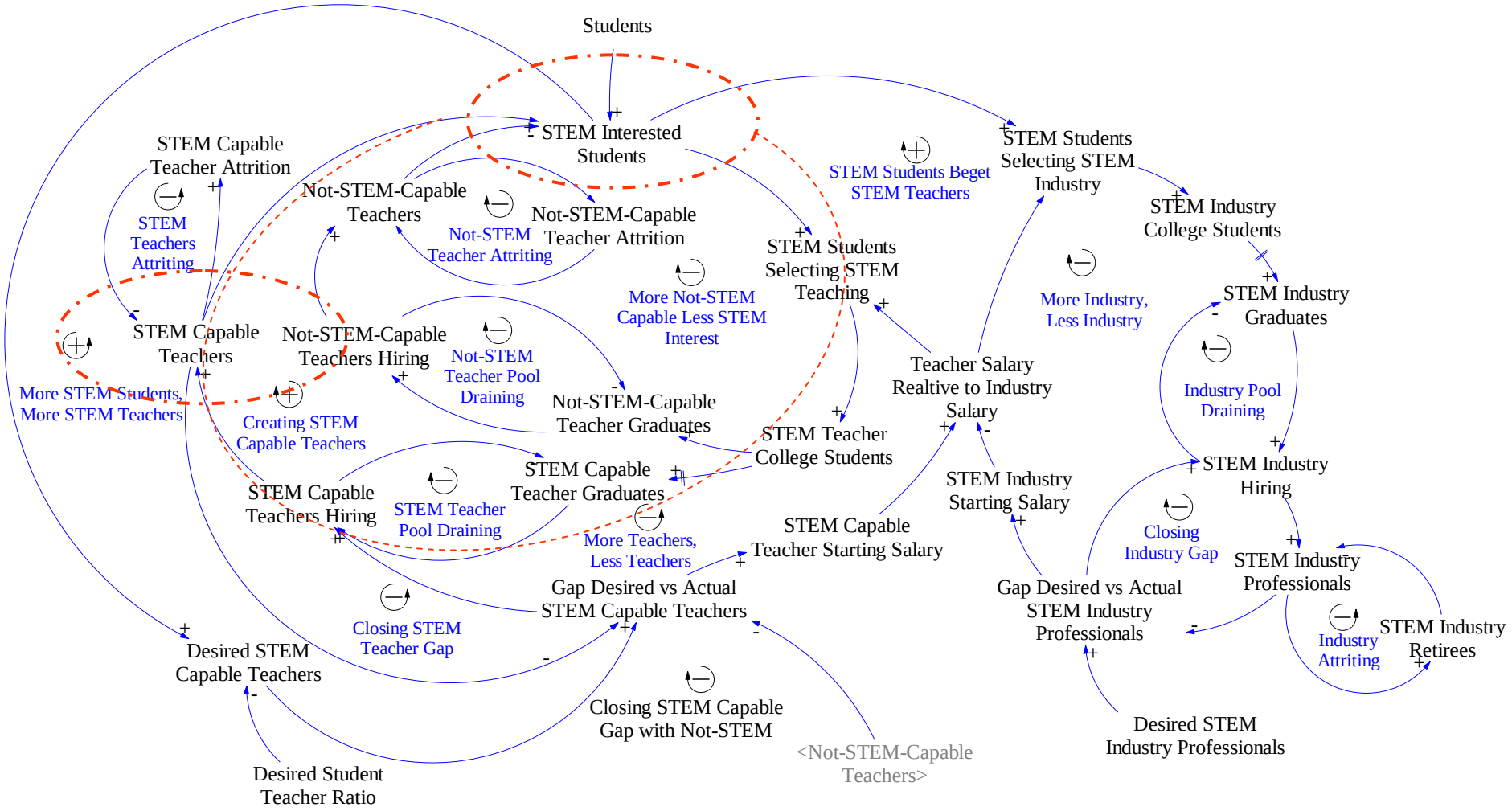
- Modeling provides a means of examining potential changes to the education system
  - Helps discover unintended consequences
  - Provides a means of thinking through the problem
  - Can provide guidance to policy makers

Modeling provide an effective means of examining the U.S. Education System

Back-up Information

Influence Diagram illustrating the Dynamic Hypothesis

- Positive Feedback Loops provide the Means for dramatic changes



Model is dependent upon assumptions

Modeling Assumption	Rationale
STEM interest is closely related to STEM proficiency.	Very little data exist on student interest in STEM. The only datum is students declaring a STEM major in college [18]. This number is very close to the number of proficient and advanced math students in 12th grade.
A STEM-capable teacher maintains STEM proficiency and interest within the class.	For the model, a STEM-capable teacher is defined as one that increases proficiency of the class on average. The model predicts average behavior.
Not-STEM-capable teachers reduce student proficiency average over a year.	This follows from the modeling definition of not-STEM-capable teachers.
Once proficiency (interest) is lost it is not recovered.	While it is possible that students can recover from a bad teacher, research indicates the effects last for years afterwards. This assumption also prevents positive runaway in the simulation that clearly would not be representative of the real world.
Administrators cannot determine which college graduates will become STEM-capable teachers.	Research that examines all teachers as a group indicates that 97% of what makes a good teacher is not quantifiable or well known. Data specific to STEM teachers are limited. The model assumes that the teachers hired match the characteristics of the pool of new candidates (i.e. no sorting occurs when hiring inexperienced teachers).
Denial of tenure will result in attrition of teachers.	There are no data that correlates attrition with denial of tenure. Tenure is rarely denied in the current system, so data collection methods will have limited success.

Follow on Studies in Progress

- Different student populations
  - Augment the model to consider disadvantaged students and women separately
- Changes and Incentives to colleges to reduce STEM fallout
  - Romer paper (2000)
- Creation of a State Version with Instructions

Goal is to release the model in the Spring of 2008