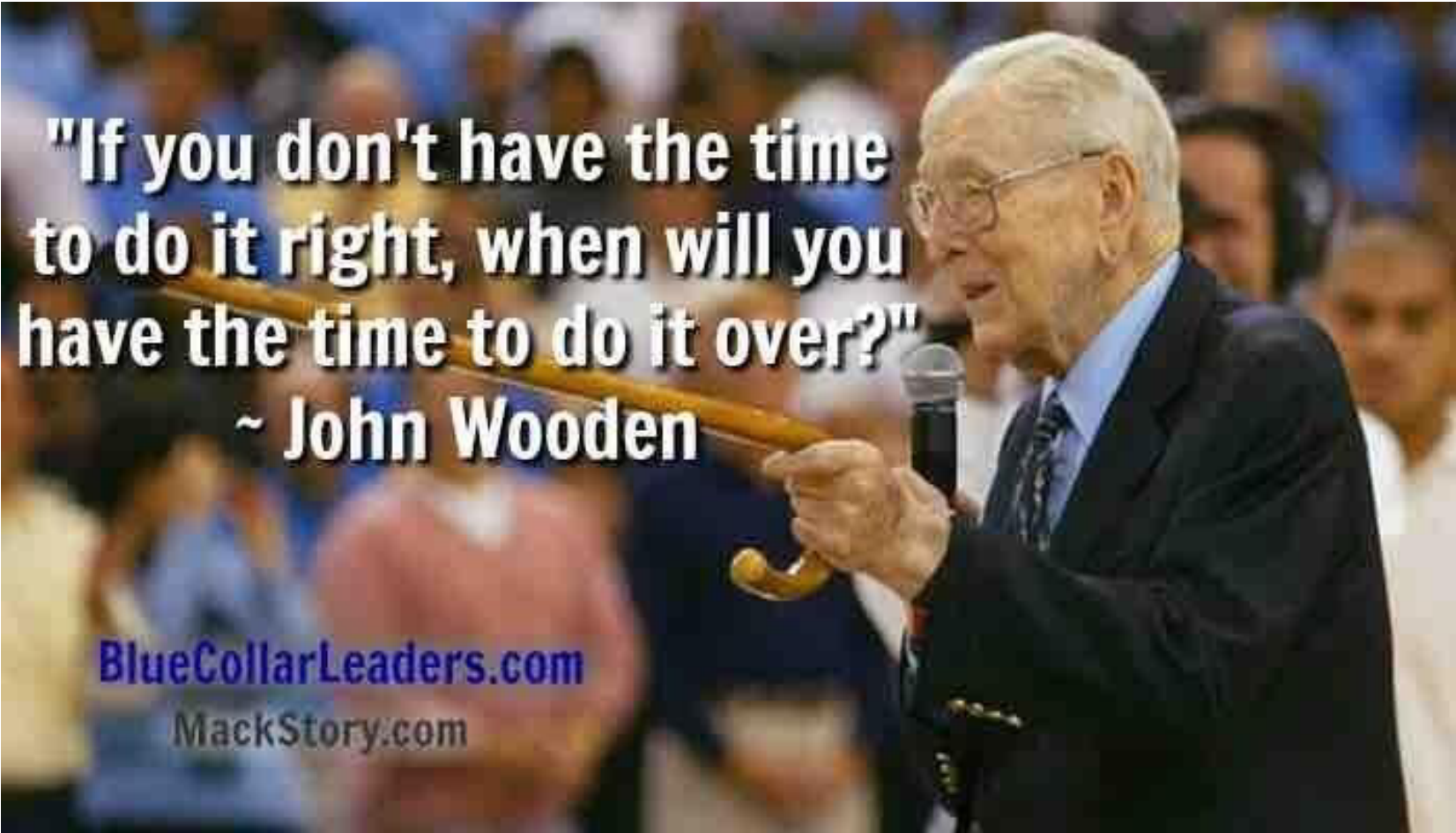


Engineering Math and CS Development at CBU Utilizing the WSU Model

(First Eight Years Results*)

Presented by Dr. Anthony L. Donaldson
Founding Dean of the Gordon and Jill Bourns College of Engineering
8th Annual National Engineering Math Consortium
New Orleans, LA
June 2016

*Partially Funded by NSF Grant DUE
0817332

A photograph of John Wooden, an elderly man with white hair and glasses, wearing a dark suit and a blue shirt. He is holding a golf club in his right hand and speaking into a microphone. The background is a blurred crowd of people.

**"If you don't have the time
to do it right, when will you
have the time to do it over?"**

~ John Wooden

BlueCollarLeaders.com

MackStory.com

Overall Context for this work is somewhat unique

- CBU is a Private University (9000+ students in Riverside California – 32% minority, semester based) 3200 when we started!
- College of Engineering **Started** in 2006 (first classes Fall 2007)
 - 10 BS Degrees now offered: BmE, ChE, CE, CM, CS, ECE, ISE, ME, SwE and Engineering (pre law, agriculture, business and global applications) Added BS ISE, MS SwE, CE last year. Adding BS IoT (3+1 with China) and MS ME (this fall).
 - Incoming class size (55, 67, 81, 111, 152, 175, 189, 192, 232?(est))
Total 580 last fall. Over 630 anticipated this fall.
 - ~40% ethnic minority,
 - ~18% female
 - ~10% international
 - ~15+% of incoming students involved in athletics
 - Full time Faculty (1,2,5,8,13, 18, 22, 26, 32, 34) Currently 8 of 34 faculty are women (top 20 in country for percentage with schools over 25 faculty)

Our NSF team has diverse and complimentary backgrounds

- **Dr. Grace Ni** – PhD ECE preparing new labs
- **Dr. Matt Rickard** – PhD ME preparing new lab
- **Dr. Mark Gordon** – PhD ME preparing new lab/and or demonstration device
- **Dr. Jae Kim** – PhD BME preparing demonstration
- **Dr. Francois Jacobs** – PhD Construction Management preparing new lab
- **Dr. Helen Jung** – PhD in CE, involved in K-12 outreach (*new faculty* taught EGR “100” and developed new labs. Preparing new lab
- Dr. Elizabeth Morris – PhD Mathematics Education (School of Education) – mentored Dr. Jung for EGR “100”
- Dr. Xuping Xu -Masters in Applied Math and PhD in EE from Notre Dame (School of Engineering) taught 2 sections of EGR “101” including follow on to EGR “100”.
- Dr. Anthony Donaldson – PhD in EE, innovative curriculum work at TTU, SPU and CBU (College of Engineering)... intuitive lab for calculus.
- Dr. Ziliang Zhou – PhD in ME, MBA, (*taught multiple sections* of EGR “101”.
- Dr. Rod Foist – *PhD in CpE, new faculty, taught EGR 101 in fall and spring, teaching labs only next year.... FPGA expert, will introduce them in the lab for the course.*
- Dr. Alex Chediak – PhD Material science Cal Berkeley – responsible for teaching and implementing a new inquiry based physics curriculum for our engineering program (joint appointment COE and College of NMS)

Outstanding undergraduate curriculum is a focus and thus a fit for this model

- One of four articulated areas of focus for the College's research activities
- One of ten distinctives desired for our programs
- Faithfulness in using vocational gifts for service is seen as a primary way we worship God and thus curriculum development is seen as directly tied to our College of Engineering's mission statement and its guiding verse ("For we are Christ's workmanship created in Christ Jesus for good works that God prepared in advance for us to do." Ephesians 2:10)

History of CBU adaptation of WSU model shows continual development

- **2014-2016 - Beta tested modified WSU CS approach, new 1 unit lab only part of course, new hardware for signals based calculus lab implementation (FYEE 2016)**
- 2013-2014 –Continued development and utilization of our intuitive calculus labs, developed and tested new NAO robots and surveying for use in engineering trig labs, 2007-2008 – algebra, precal or calculus entry points (WSU 100 1.0 introduced in fall, WSU 101 1.0 introduced for first two groups in spring 2008.)
- 2008-2009 – WSU 100 2.0 (labs added), WSU 101 2.0, Math anxiety assessment begun for 100.
- 2009-2010 – WSU 100 3.0 (EGR faculty and vertical integration “VI”) WSU 101 3.0 (required course, VI and customized text started) Assessment using WSU questions was conducted.
- 2010-2011 – WSU 100 & 101 4.0 (Recitation sections and new labs-closing feedback loop. Adding additional VI feedback from Mathematics dept.), Optional labs for those placing out of Calc I and II. Math anxiety assessment for 101 started.
- 2011-2012 – WSU 100 and 101 continued to be refined and assessed.
- 2012-2013 - Lab section only of WSU 101 was added for those students we wanted to have the lab experience but placed out of or transferred in Calculus credits, intuitive calculus labs piloted. Use of WSU official textbook started. Developed beta version of our own lab notebook.

Curriculum was added to one more new major this past year!

- This brings our total number of majors where the this approach is now required in its curriculum to ten!
- Another new majors went through curriculum with shared EGR core (i.e. required EGR 182)
- More majors (additional MS and a PhD in Engineering Education.)
- We anticipate new lab and demonstration modules for coming from internally funded research this summer.

NSF WSU curriculum implementation

		Example:	BS Electrical and Computer Engineering		
			We also have BS CE, ME and general Engineering degrees		
		Fall			Spring
		Course #	CR	Description	Summer
Year 1					
		EGR 182		4 Engineering Math II	MAT 245
		EGR 101		3 Engineering from a Ch	EGR 102
		EGR 121		3 Problem Solving and	PPHY 201
		ENG 113		3 Composition I	EGR 122
		EGR 103		1 Engineering Service I	EGR 192
		GST 100		1 Focus	
				15	16
Alternative		EGR 181		4 Intro to Egr Math I	EGR 182
					4
					MAT 245 Calc I
Year 2					
		PHY 203		4 E/M Optics	EGR 202
		EGR 231		4 Circuit Theory I	EGR 232
		MAT 255		4 Calculus II	EGR 234
		ENG 123		3 Composition II	
				3 GE#3	
					EGR 221
				18	18
					* BIO 146 or 153 or CHE 115
					** preferred MAT 403, 413

Note: EGR 181 is similar to WSU 100 but with a lab. EGR 182 is Wright State's 101
3 hours lecture, 1.5 hours lab 15 weeks.

We added a one unit lab to allow the hands on lab for those testing/placing/transferring out of the lecture.

All undergraduate students thus take some part of this curriculum.

Three gateways: EGR 182 (142,145) ((precalc or calc ready), EGR 181(40,55) (college algebra ready), and EGR 182L (32,49)(placed out of calculus or higher)

Longitudinal retention results for 'at risk' students are encouraging!

- 62% of 'at risk' students entering '100' since inception (150/241) were still in the program after 1 year, Last year it was 39/55 or 71% (Note: WSU (MPL3) went from 26 to 48 %)
- Over 2/3rds of those not in engineering were still in the university in other majors.

Computer Science Modifications

"There are no secrets to success.
It is the result of preparation, hard
work, and learning from failure."
– Colin Powell

The data was telling us something was wrong!

In spring of 2015 I noticed that we had a student take our required Introduction to C++ 4 times before passing in his senior year.

I printed out all of our data for our first four graduation classes 2011, 2012, 2013, 2014 and all but two students that flunked (D or F) their first time did not persist to graduation! And those two students were in the first class.

CS modifications

“In the river of life’s opportunities, a lot of interesting things occur in the eddies.” ALD

“....with our freshman CS curriculum modification our graduation % went from 15 to 45% !?!!!” Dr. Klingbeil at last years meeting

“Every ordinary encounter has the opportunity to be an extra-ordinary encounter, if it is yielded to God to accomplish His purposes!” ALD

Engineering a solution

- Recognize we have a problem
- Understand what WSU/best practice did
- Get department buyin (CSDS)
- Find a professor champion
- Design our version
- Identify at risk CS students
- Encourage or require them to take the new sequence
- Evaluate and modify

Our beta test of our first year of a modified CS intro was successful!

- Our pass (C or better) rate for the students compared to similar group the previous year went 60% to 86%!

Future Plans involve expanded impact of this type of curriculum.

- We are in the middle of a campaign for a new 100,000 ft² engineering building with utilization for STEM education year round for the entire Southern CA region. Opening July 2018
- We are planning to begin a PhD in Engineering Education in Fall 2017 with an emphasis on undergraduate engineering education in different cultures/countries of the world.

Grant and New Faculty Opportunities in Sunny Exciting CA

- We would delight in partnering with other institutions (K-12 and Universities) for Engineering and STEM education grants.
- We currently have an opening for a tenure track position in Computer Science starting this fall (Fa 2014).
- We will likely have openings in Industrial, Chemical, Computer Science and at least one another area (ECE, ME, CE, BmE, CM) next year.
- For more information contact Anthony Donaldson, Founding Dean of the California Baptist College of Engineering using LinkedIn or adonaldson@calbaptist.edu

Special Thanks

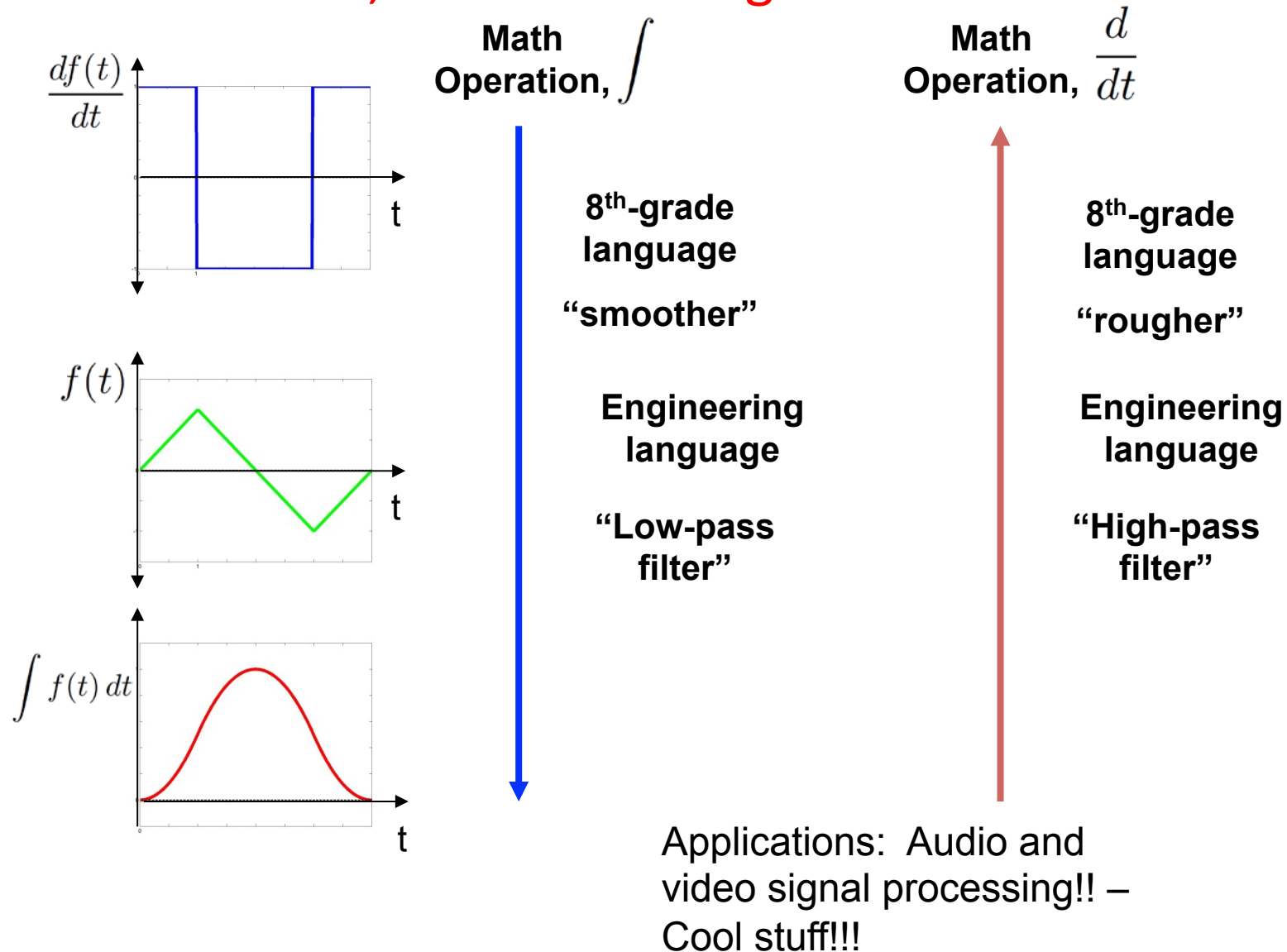
- Jeff Froyd (Head of Faculty development at Texas A&M) – suggesting to Dr. D to contact Nate in summer of 2007(ASEE- Hawaii)!
- Nate Klingbeil at Wright State University
 - Allowing us to be on the initial team and providing great leadership
- The National Science Foundation
 - For funding projects that make a difference!

Intuitive Calculus Lab beta tested last year were further developed.

- The next two slides show the new calculus lab we beta tested this year. (Introduced to this group last summer).
- We have some refinements to do with the hardware (new FPGA etc) this summer in order to roll out for all students in the fall.

Calculus Made Fun With EE Hardware

or, “Intuitive Integrals & Derivatives”

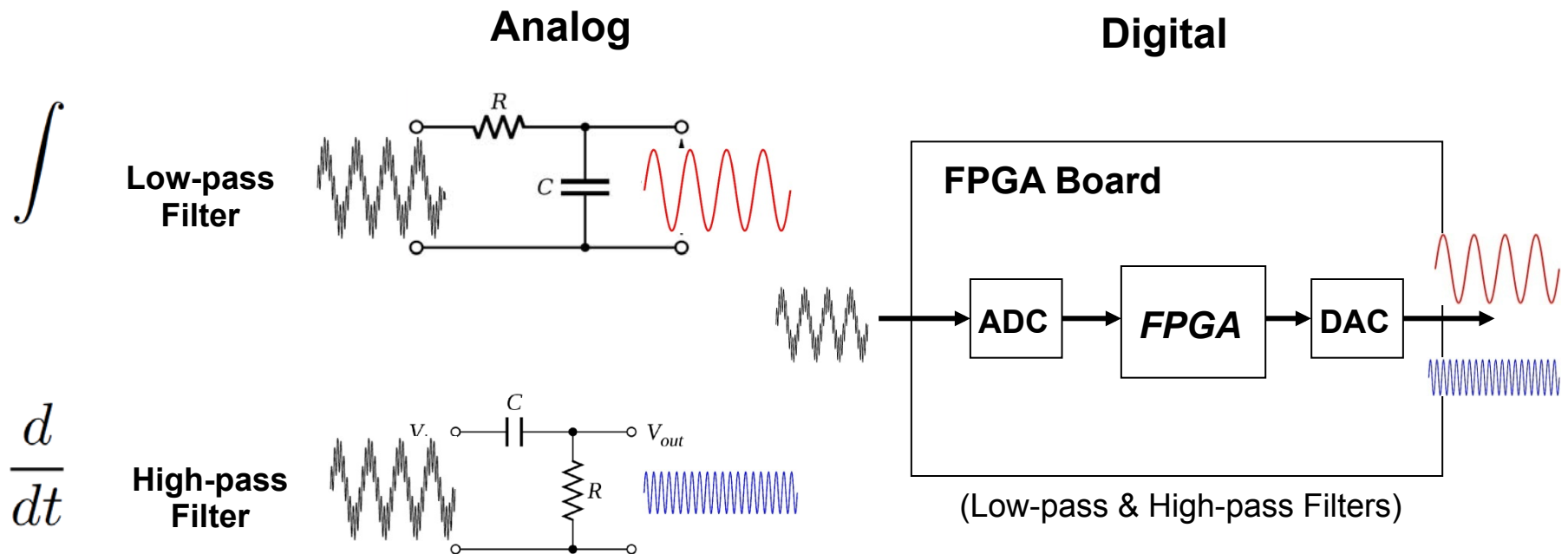


New “WSU EGR 101” Lab

(Analog & Digital Implementations of Calculus)

**Math
Operations**

**“Signal”
Operations**



FPGA = Field Programmable Gate Array

ADC = Analog-to-Digital Converter

DAC = Digital-to-Analog Converter

New labs and demonstrations were developed this year!

- Dr. Grace Ni and Dr. Rod Foist (ECE) used NAO robots to illustrate trigonometry.
 - Paper planned to be given at 6th First Year Engineering Experience Conference, August 7-8, 2014, College Station, Texas
- Dr. Rod Foist and Dr. Anthony Donaldson (ECE) used Electronic Filters (Analog and Digital(FPGA)) to illustrate derivatives and integrals.
 - Paper planned to be given at 6th First Year Engineering Experience Conference, August 7-8, 2014, College Station, Texas

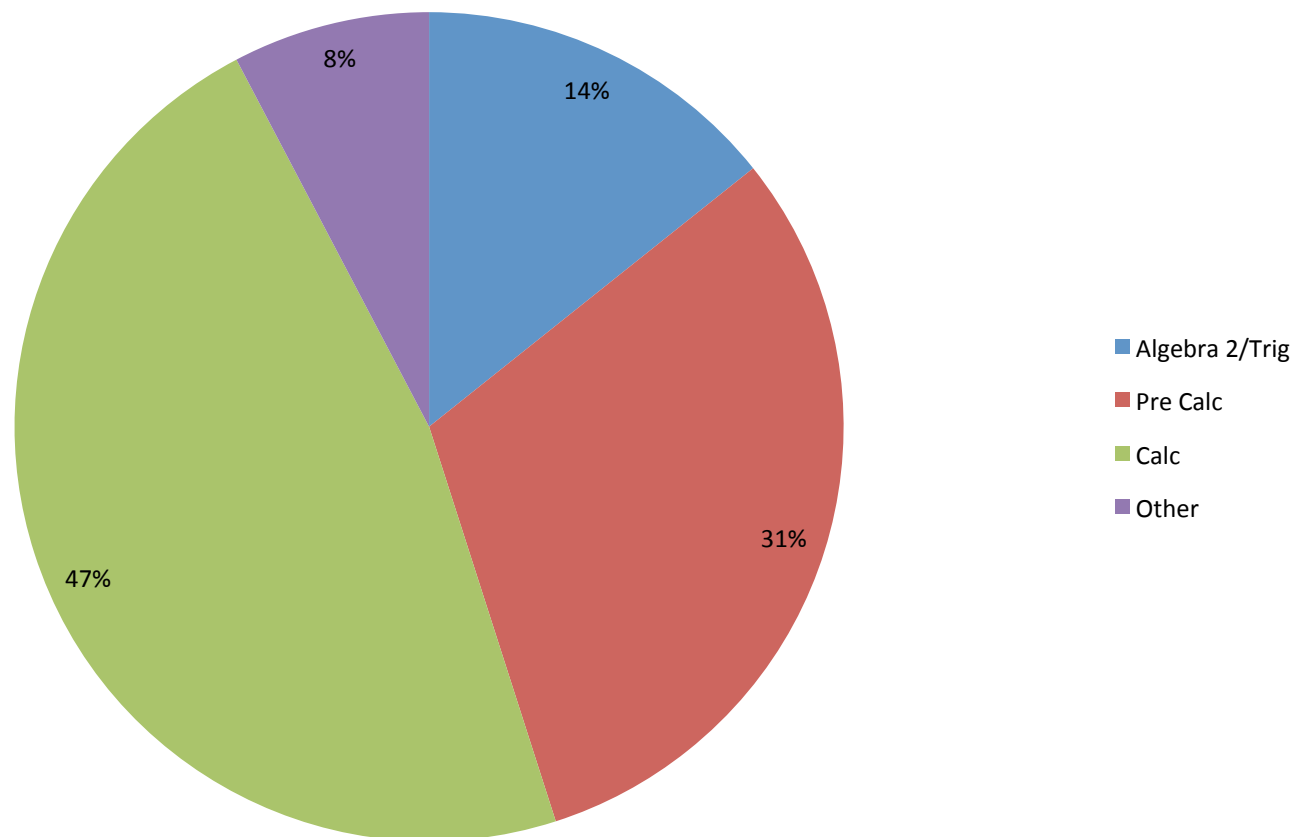


Overall impact has been very good for a new college of engineering!

- This fall we will surpass over 1000 students that have been positively impacted by our versions of WSU's 100 and 101!!
- Provided mechanism to continually improve critical starting math classes for our students
- Provided mechanism for many faculty to contribute and in some cases innovate.

Highest High School Math

(all 1st year EGR students for 2011-2012)



Additional assessment is being implemented

- Math anxiety (pre and post for 101 as well)
- Correlation for student performance in Calculus (w and w/o 101) is planned
- Correlation for student performance on National FCI for Physics is planned
- Specific new lab modules for intuitive learning of calculus.