



Let's Think about Social Responsibility in Engineering

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Division of Engineering Education & Centers

→ **PFE = Professional Formation of Engineers**
(Award # 1544147)

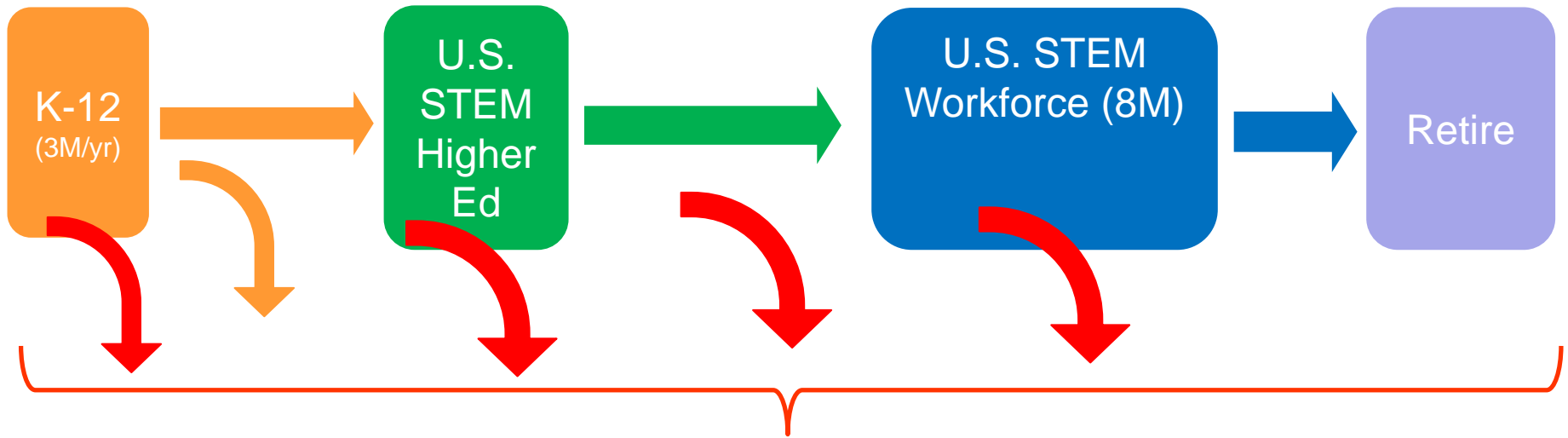
- the formal and informal processes and value systems by which people become engineers.



"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation."



- RFE: The end goal is people working in the engineering profession.



We lose quantity.



We lose diversity in thinking.



We lose the investment.



- What Do Value Systems have to do with PFE?

1) COGNITIVE



- Our intellectual skills.
- The first thing we think of when we talk about “learning”.

In engineering we tend to live in the cognitive domain.



- What Do Value Systems have to do with PFE?

1) COGNITIVE



- Our
- The talk a

STEM higher ed is starting to pay attention to the impact of this domain.

2) AFFECTIVE



- Our feelings (attitudes, motivation, willingness to participate, value of what is being learned).
- Heavily influences success of cognition.

3) PSYCHOMOTOR



- Motor skills.
- Cognition is underlying component, but practice-makes-perfect.



- **Expectancy-Value Theory of Motivation**

Motivation



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Motivation



More than just wanting good grades & lots of money...

- Propels learning and fuels engagement during the engineering formation process.
- Will the person “choose” an engineering degree?
- Will the person “choose” an engineering career?
- Will the person “choose” to remain in engineering?



- **Expectancy-Value Theory of Motivation**

Motivation = Expectancy x Value

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(Atkinson 50's 60's, Eccles 80's)



- **Expectancy-Value Theory of Motivation**

Motivation = Expectancy x Value



Beliefs about one's own ability and chances for success.

- self efficacy
- self confidence

(Atkinson 50's 60's, Eccles 80's)



- **Expectancy-Value Theory of Motivation**

Motivation = Expectancy x Value

Beliefs about the importance of the task.

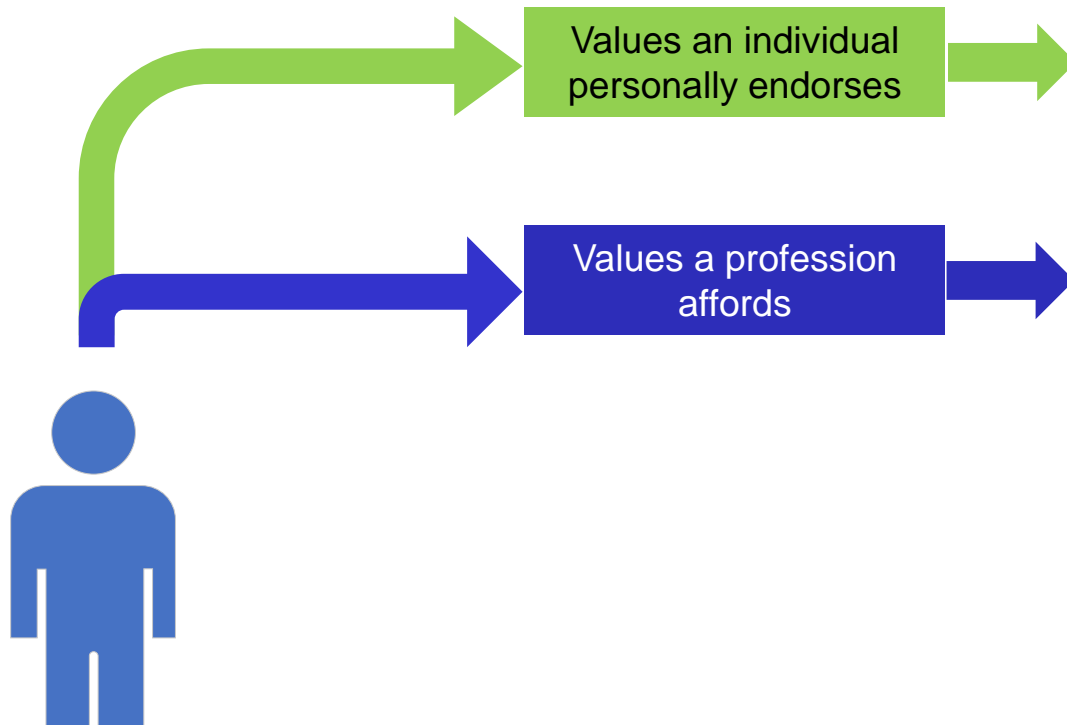
- attainment (importance for identity)
- intrinsic (enjoyment or interest)
- cost (effort)
- and utility (relevance).

(Atkinson 50's 60's, Eccles 80's)



- **Goal-Congruity Theory**

People are more motivated to pursue careers that afford the values that they endorse

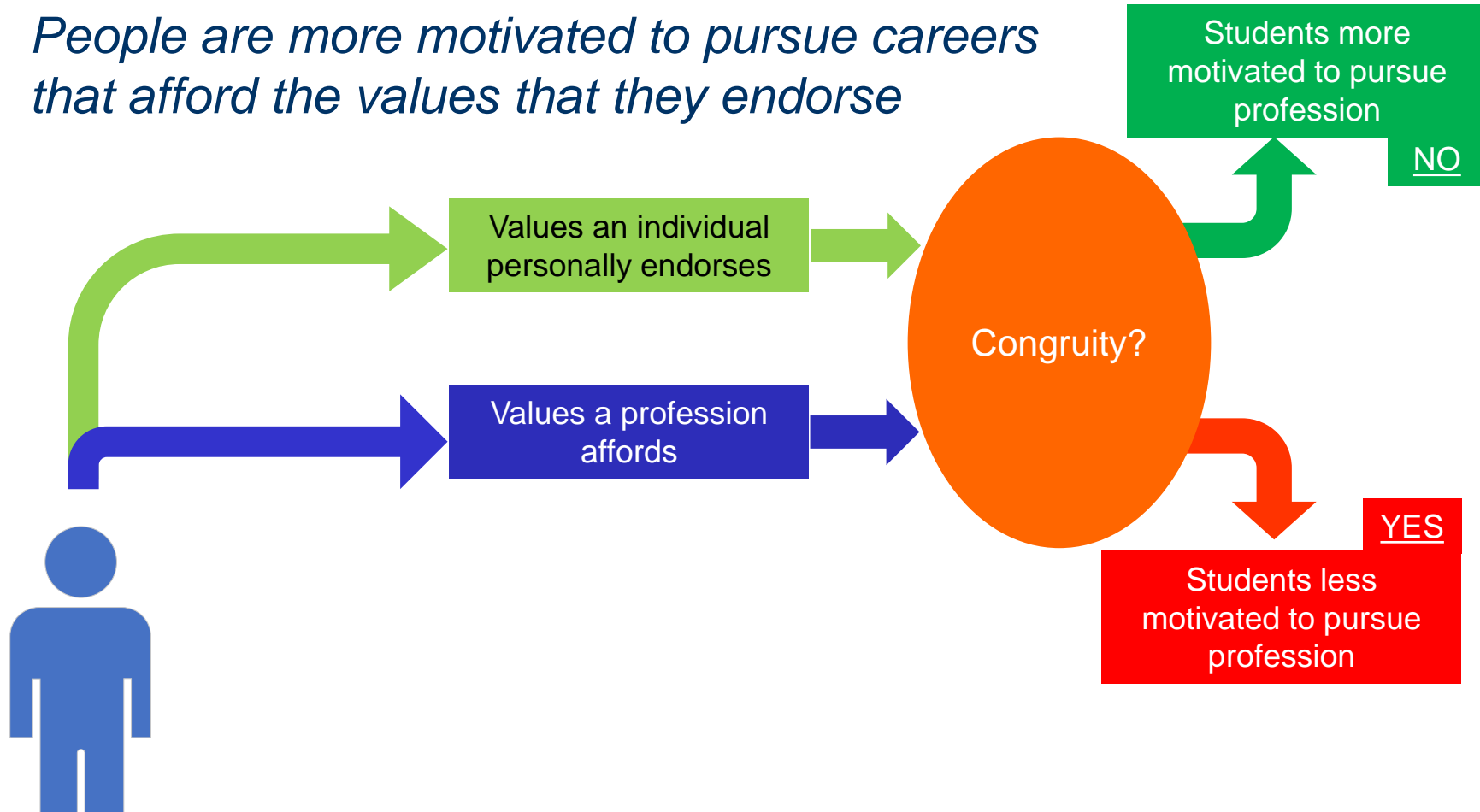


(Diekman 2010, 2011)



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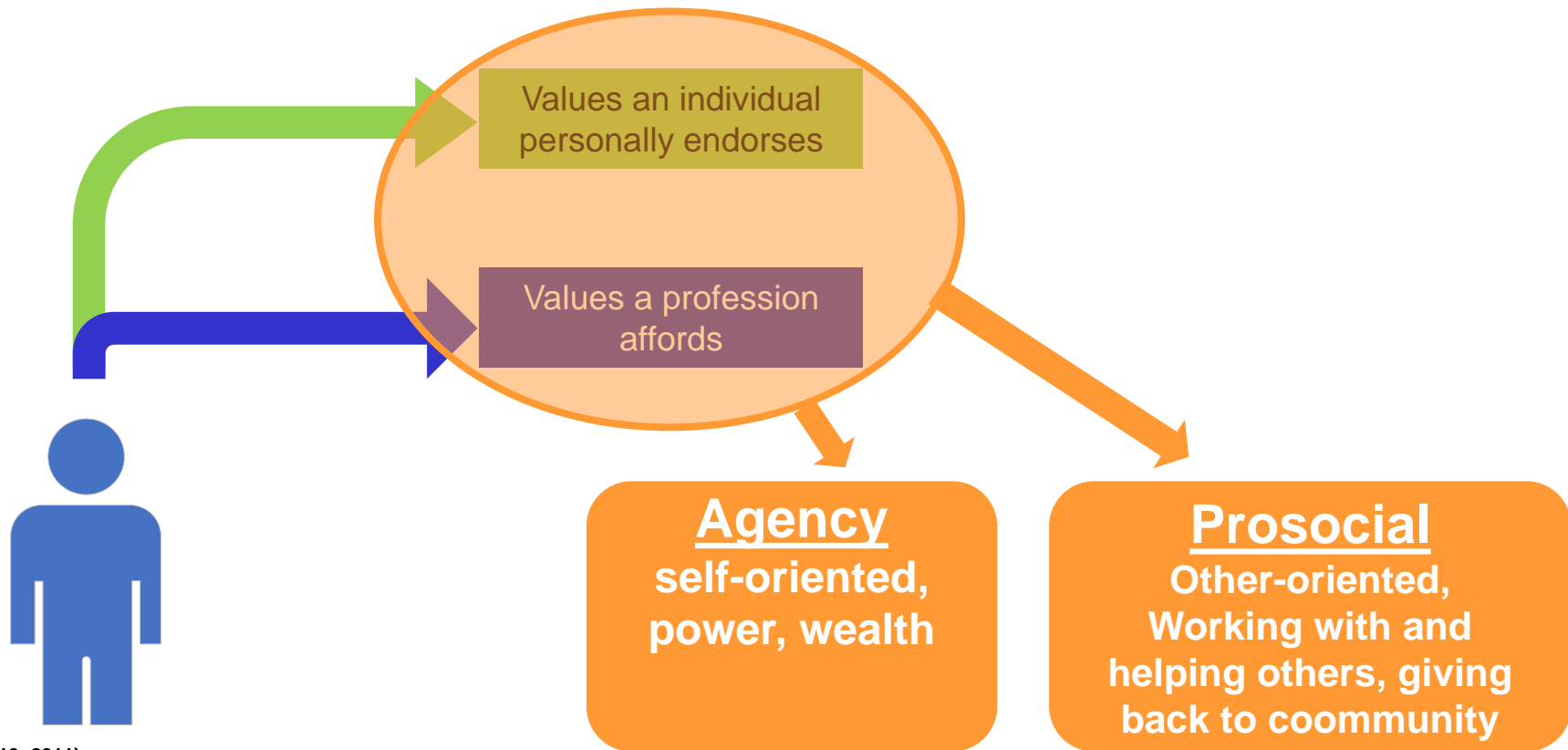


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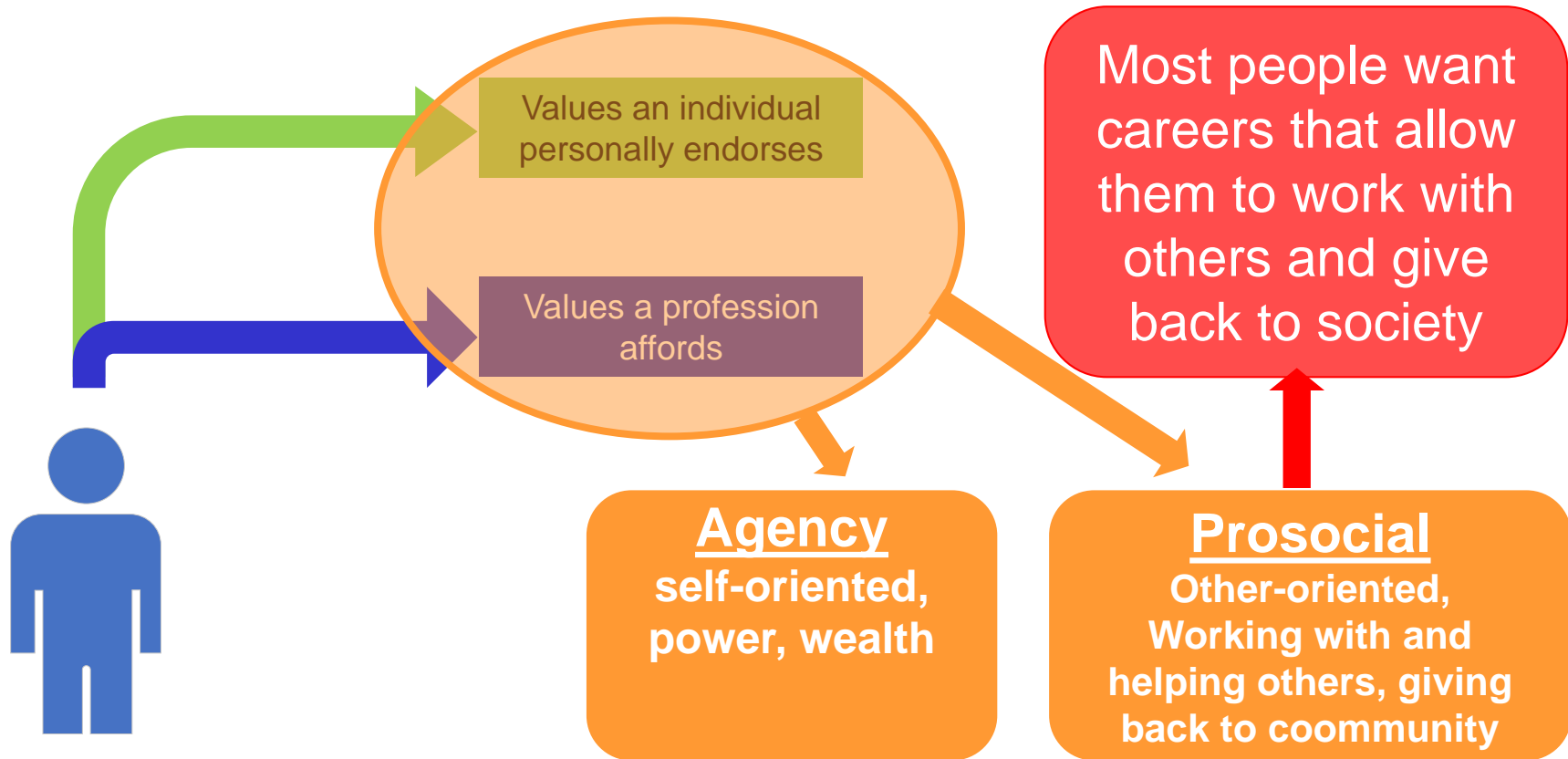


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- **Goal-Congruity Theory**

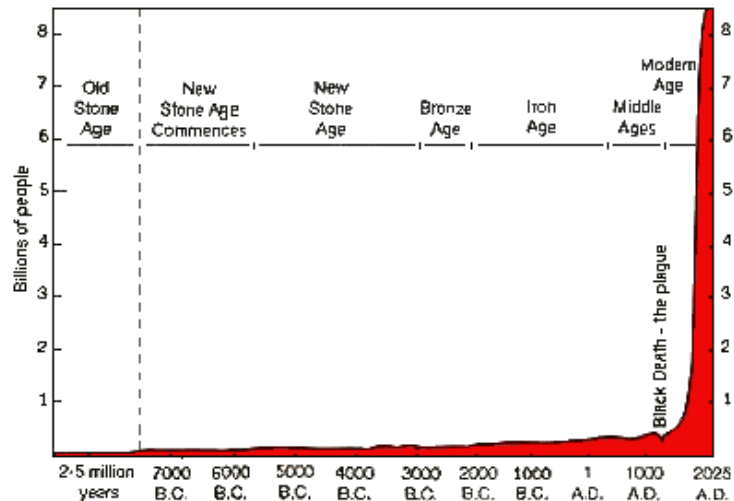
People are more motivated to pursue careers that afford the values that they endorse



- **This is a good thing!**

- The problems society faces in the 21st century are massive.
- We need an engineering workforce that wants to benefit society.
- We need an engineering workforce that wants to work with others to solve large-scale problems.

World Population Growth Through History



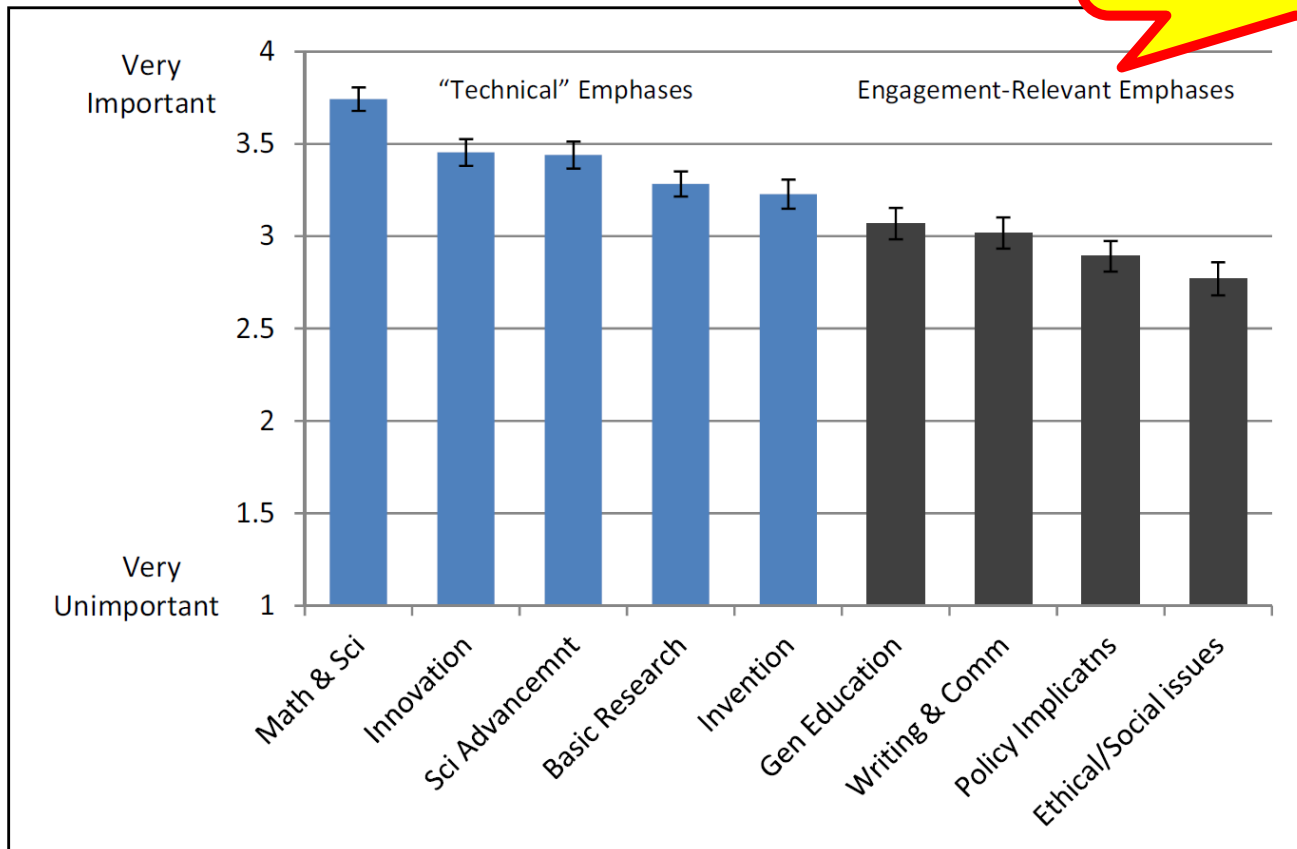
- **The problem (affordance beliefs)**

- Engineering isn't always perceived as affording high prosocial value.
- Prosocial trait endorsement has been shown to diminish over time in engineering.



- The problem (trait endorsement)

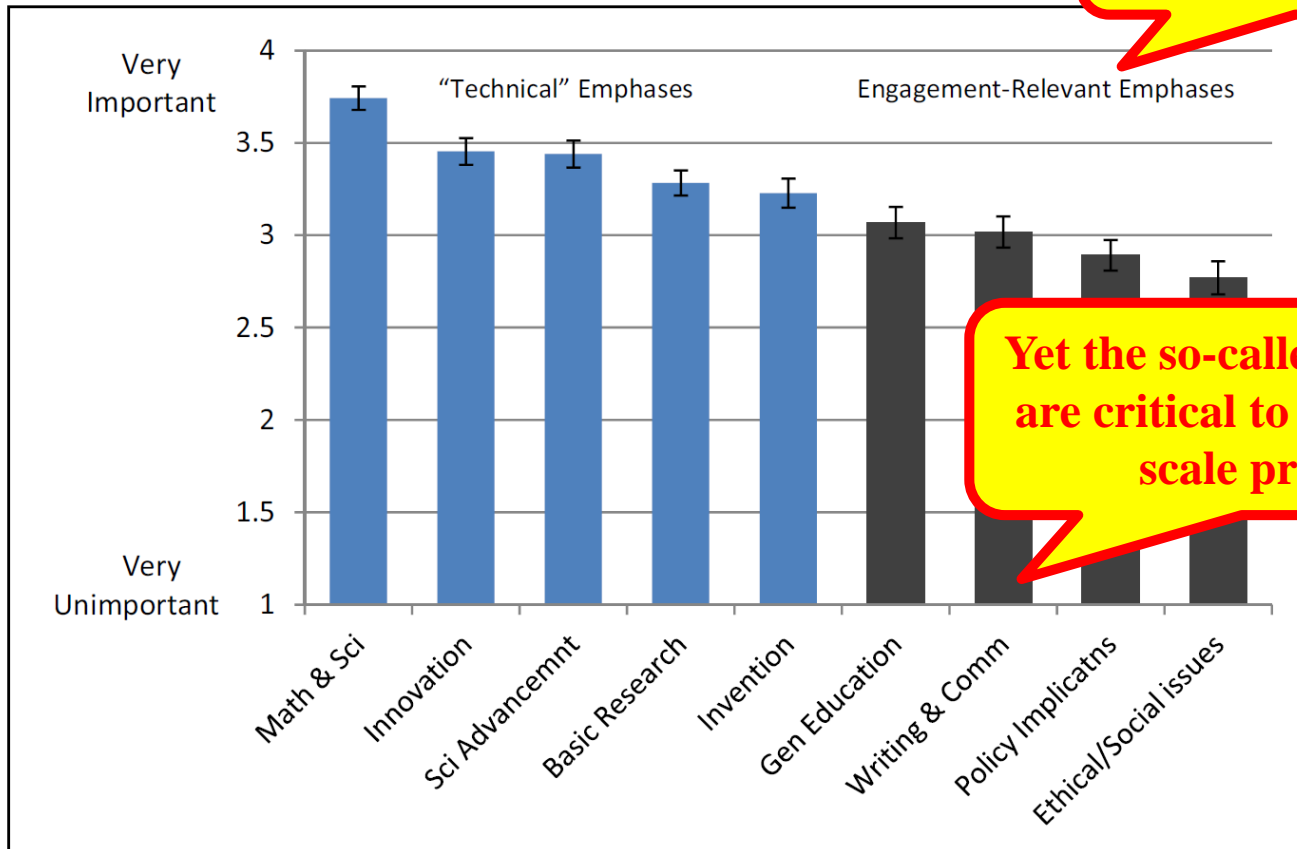
Technical skills are most valued.



(Cech 2014)



- The problem (trait endorsement)



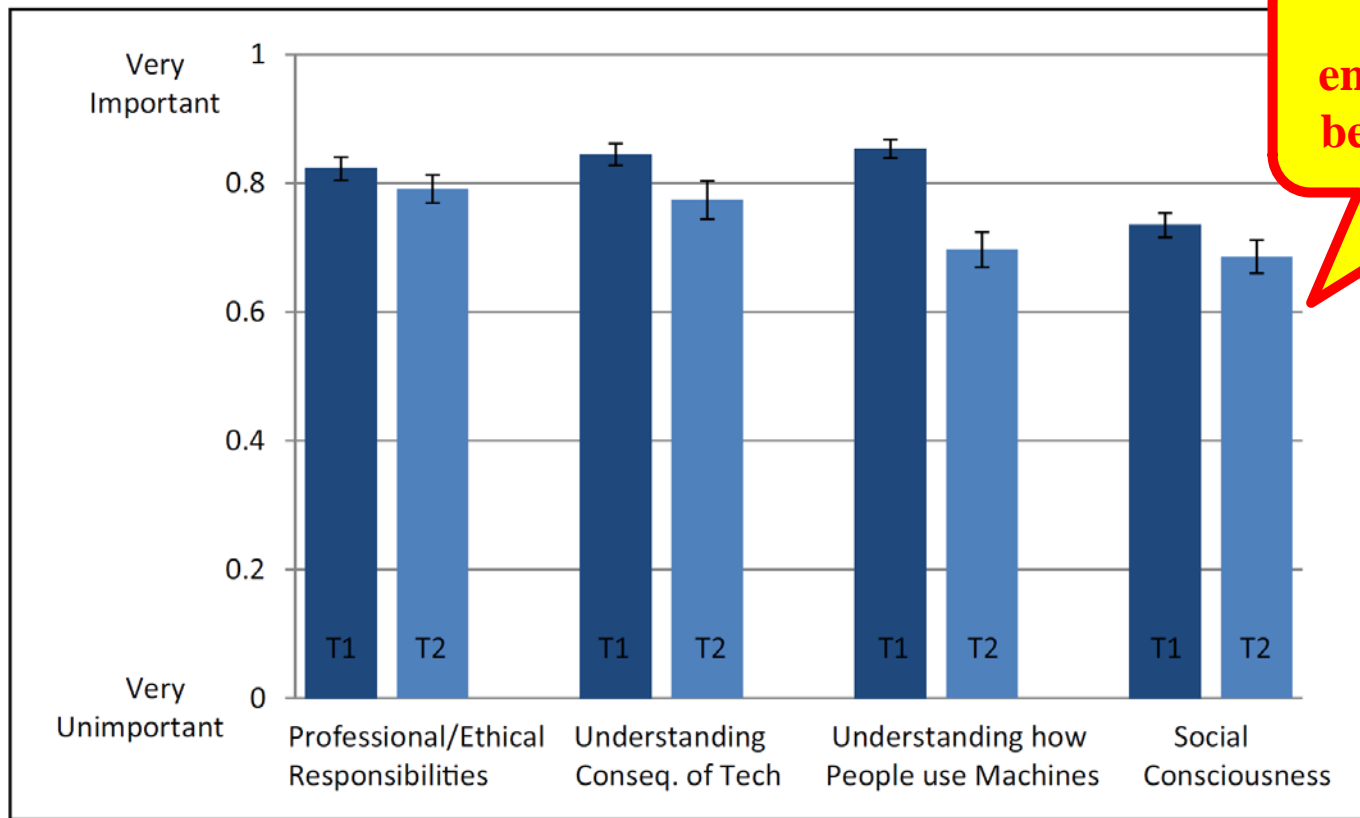
Technical skills are most valued.

Yet the so-called “soft skills” are critical to solving large-scale problems.

(Cech 2014)



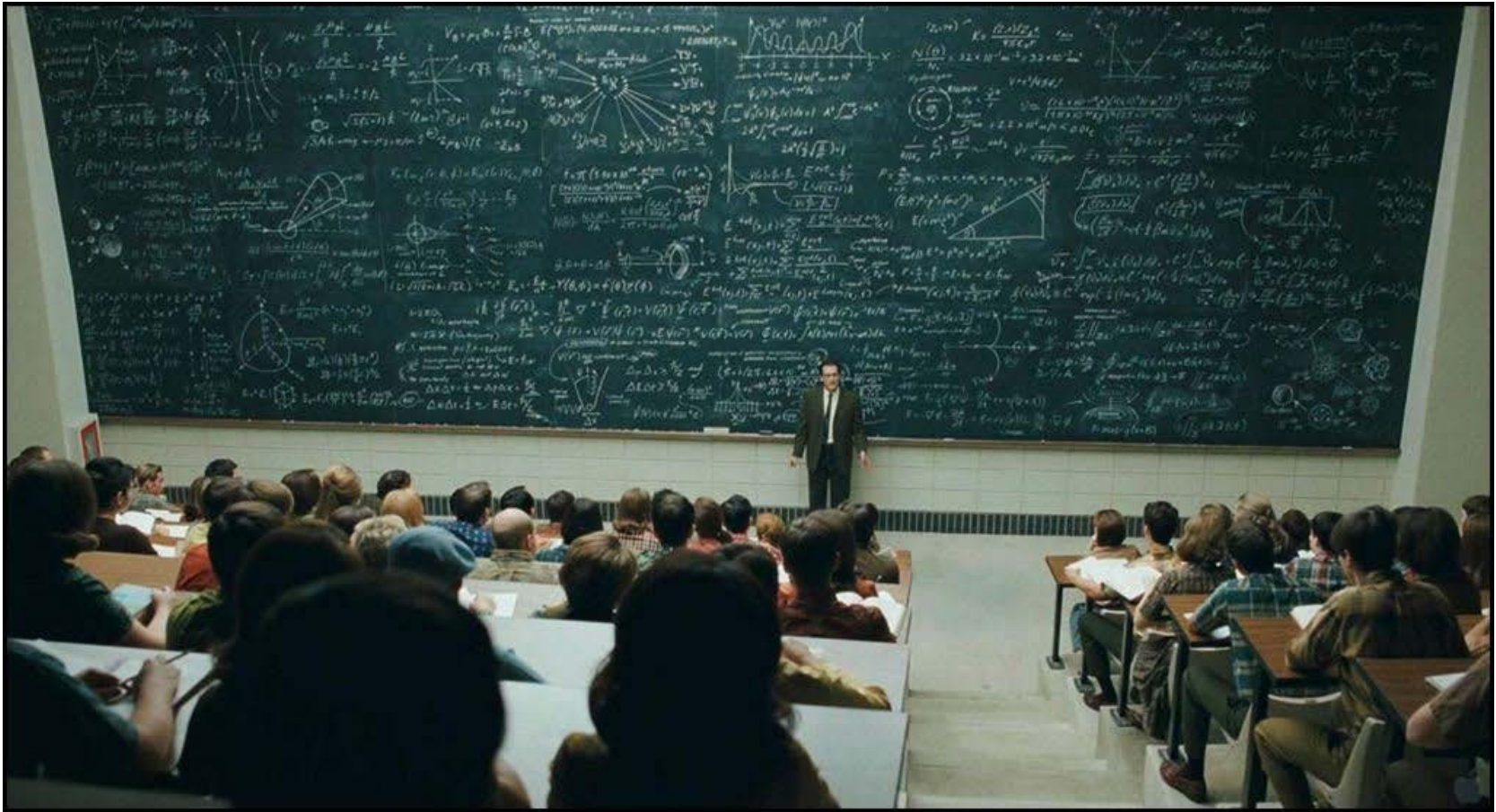
- The BIG Problem: Diminishing Prosocial Trait Endorsement**



(Cech 2014)



- What are we doing to these kids???



- **Measure Prosocial Engagement within Electrical Engineering**

R1: Do the prosocial beliefs and traits change between first-year and senior year?

R2: Are prosocial (or agency) beliefs about the EE profession associated with intentions to persist in first-year students?

R3: Can an intervention that makes students “think” about the prosocial value of engineering change their stereotypes?



- **Survey Design – Overview**

- 133 question survey that took 10-15 minutes to complete.
- Administered in required 100 and 400 level electrical engineering courses.
- Given 6th week into the semester.
- Cover story was that we were collecting feedback on classroom environment preferences for future engineering building (under construction next door).
- \$10 amazon.com gift card offered for completion.
- Deception questions added about learning environment preferences.
- Attention check questions added throughout.
- Voluntary, confidential, no impact on student grades.



- **Survey Design – Instrument Selection**
 - **Used instruments that were tested for validity and reliability in other studies.**
 - **Prosocial Trait Endorsement** (trait empathy, concern for public welfare)
 - **Agentic and Communal Affordance Beliefs about the EE Profession.**
 - **Experience of Interest**
 - **Persistence Intentions**



- **Participants**

	<u>Freshman Class</u>	<u>Senior Class</u>	
Enrollment	117	66	Total = 183
Took Survey	85 (73%)	53 (80%)	Total = 138
Major			
- EE	51 (60%)	34 (64%)	
- Computer Eng	24 (28%)	14 (26%)	
Gender			
- Male	65 (76%)	40 (75%)	
- Female	13 (15%)	8 (15%)	
Race			
- White	62 (73%)	39 (74%)	

Note: Only reporting most significant groupings.



- **One-sample T-tests were conducted to find strength and direction of rating.**
- **Independent t-tests were conducted to test for degree and direction of differences between freshman and senior students.**
- **Where applicable, a paired sample t-test was conducted to test for differences in ratings between two constructs.**
- **Relationship among variables were tested with a specified path analysis with a maximum likelihood estimation and indirect effects using bootstrapped standard errors.**



- Descriptive Statistics and T-Test Values**

TABLE I
DESCRIPTIVE STATISTICS AND T-TEST VALUES FOR STUDY VARIABLES

Variable	Class	n	M (SD)	Between Group T-Test	Cohen's d Senior vs. Freshman	One Sample T-Test ⁺
EE Agency Affordance	Advanced Novice	51 77	3.88 (.84) 3.78 (.72)	0.68	0.13	7.52* 9.63*
EE Prosocial Affordance	Advanced Novice	51 77	3.52 (.81) 4.01 (.64)	3.84*	-0.67	4.56* 13.96*
Ethical Responsibilities	Advanced Novice	49 79	3.98 (.74) 4.20 (.93)	1.38	-0.26	9.27* 11.34*
Empathic Concern	Advanced Novice	51 76	2.49 (1.13) 3.85 (0.78)	8.04*	-1.40	-6.41* 3.90*
Experience of Interest in EE	Advanced Novice	51 77	3.19 (.45) 3.98 (.63)	7.76*	-1.44	3.12* 13.79*
Persistence Intensions in EE	- Novice	- 77	- 4.46 (.58)	-	-	- 22.19*

Note 1: EE = Electrical Engineering.

Note 2: ⁺ Tested value was the midpoint of the scale. Greater numbers indicate stronger endorsement.

Note 3: All items are on a 1 to 5 scale (midpoint = 3) with the exception of empathetic concern, which was on a 1 to 6 scale (midpoint = 3.5).

Note 4: * indicates a significance level of at least $p < .01$ as required by Bonferroni correction.



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Persistence Intentions in EE	-	-		-	-	-
	Novice	77				22.19*

Both freshman and seniors had significantly high levels agency affordance beliefs about the EE profession.

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Seniors had significantly lower prosocial affordance beliefs about the EE profession than freshman.



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Both freshman and seniors believed ethical responsibilities were important for the EE profession.



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Seniors had significantly lower empathic concern for the impact of EE decision than freshman.



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Both freshman and seniors showed significant interest in the EE profession.



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Overall, freshman showed significant intensions to persist in the EE curriculum.

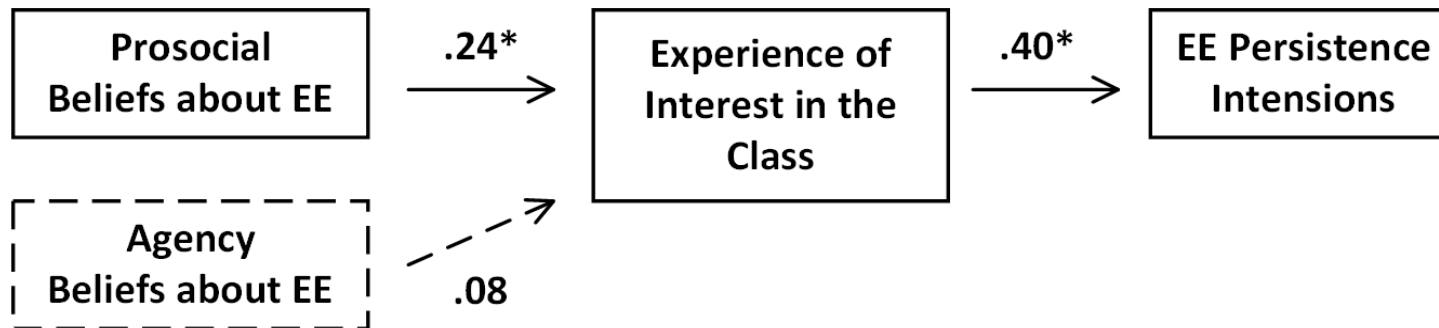


- **Testing associations between affordance beliefs and intentions to persist.**
 - Both prosocial & agency *beliefs* were correlated to interest.
 - *Interest* was correlated to *Intentions to Persist*
 - We created a process model to control for agency vs. communal



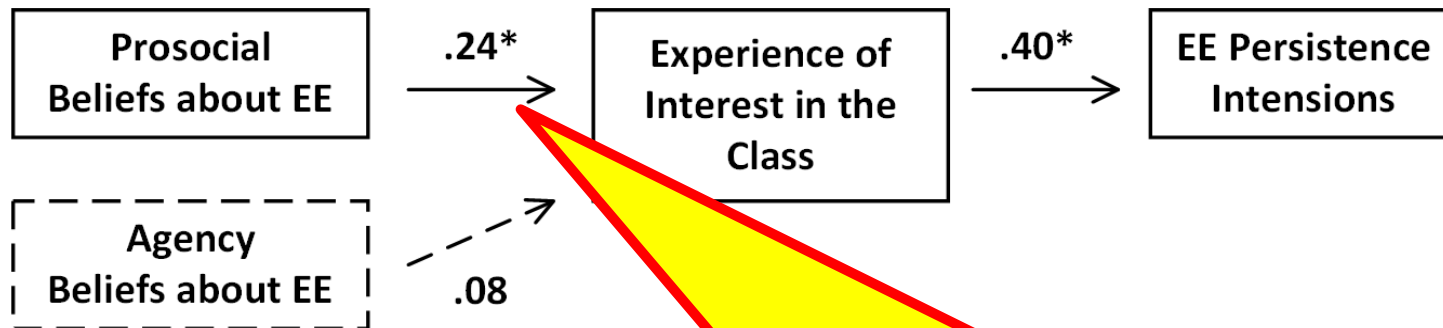
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The more students believed EE afforded prosocial value (and not agency), the stronger their intentions to persist.



- Freshman students (**predominantly MALE**) enter the program with high levels of prosocial affordance beliefs about EE and high levels of prosocial trait endorsement.
 - This is good! The students with the values we need to solve the grand challenges facing society are entering EE programs.



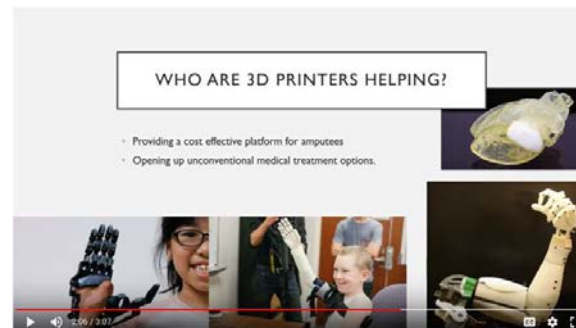
- **Freshman students (predominantly MALE) enter the program with high levels of prosocial affordance beliefs about EE and high levels of prosocial trait endorsement.**
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- **Prosocial affordance beliefs about the EE profession diminished between freshman and senior students.**
 - Why: Did students that viewed EE as affording prosocial value leave the program? or did the curriculum marginalize this value? Or both?



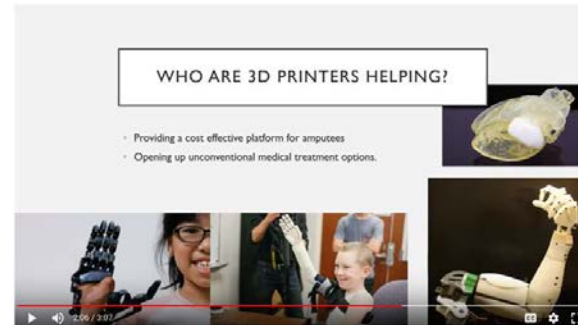
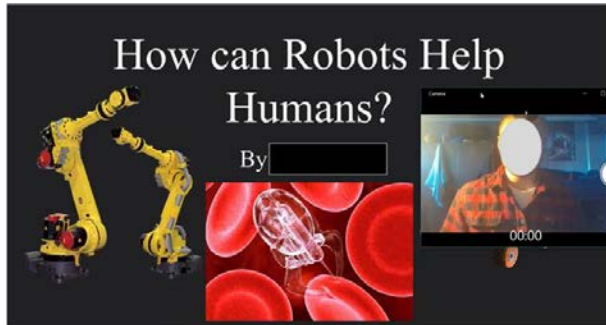
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- **Prosocial affordance beliefs about the EE profession diminished between freshman and senior students.**
 - Why: Did students that viewed EE as affording prosocial value leave the program? or did the curriculum marginalize this value? Or both?
- **Trait Empathy of EE students diminished between freshman and senior students.**
 - Why: Did students with high levels of trait empathy leave the program? or did the change the students? Or both?



- **Can we increase the prosocial affordance beliefs about engineering by explicitly making the students “think” about how the profession works with and helps others?**
 - Students were assigned 3-minute video production assignments.
 - The cover story was that the video was to help them develop public communication skills.
 - **Control group:** “explain an engineering concept covered in this class in your own words.”
 - **Experiment group:** “explain how one of the of the concepts covered in this class requires you to work with others and benefits society.”
 - When the students uploaded video, they were asked to fill out a survey on the video production experience.



- No statistical differences between groups on any measure.



Group Statistics

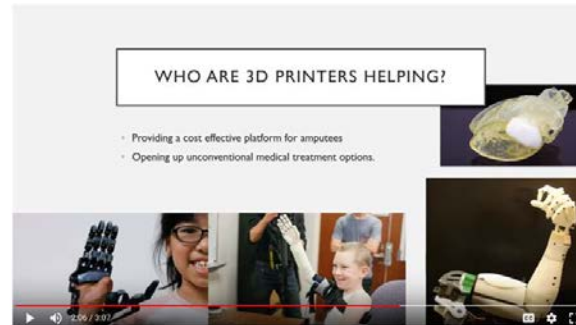
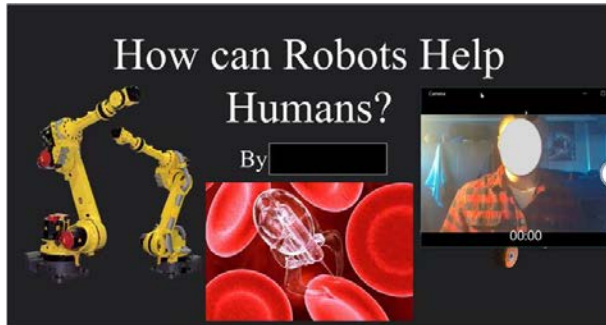
	Group	N	Mean	Std. Deviation	Std. Error Mean	p
EE Prosocial Affordance	Control	29	4.2069	.86563	.16074	0.755
	Experiment	29	4.2759	.80706	.14987	-----
EE Agency Affordance	Control	29	3.6092	.96904	.17995	0.411
	Experiment	29	3.4023	.93171	.17301	-----

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean	p
Experience of Interest in EE	Control	29	3.9828	.91433	.16979	0.373
	Experiment	29	4.1782	.73454	.13640	-----
Persistence Intensions in EE	Control	29	4.1552	1.45837	.27081	0.206
	Experiment	26	4.5769	.87969	.17252	-----
Satisfaction in EE	Control	29	4.1207	1.21490	.22560	0.403
	Experiment	27	4.3519	.76980	.14815	-----



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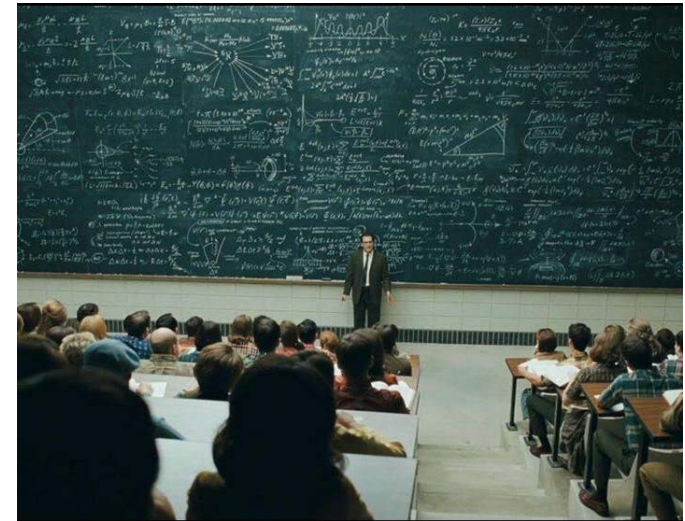
Upon inspection of the videos it was found that <5% of the students followed the directions!



- **Simplify the instructions and retry the intervention.**



- **Prosocial affordance beliefs about engineering lead to increased persistence intentions.**
- **If the curriculum is actually diminishing the prosocial traits of our students, we need to step back and re-think engineering education.**
- **Students don't read instruction!**



Questions

