

# Engineering Math Development at CBU Utilizing the WSU Model (First Seven Years Results)

Presented by Dr. Anthony L. Donaldson  
Founding Dean of the Gordon and Jill Bourns College of Engineering  
And Dr. Helen Jung, Associate Dean

7<sup>th</sup> Annual National Engineering Math Consortium  
Seattle, WA  
June 2015

# How we got involved

- Met Dr. Jeff Froyd (faculty development at Texas A&M) in spring of 2005
- Remet at ASEE June 2007 (in Hawaii)
  - “What are you doing these days.....”
    - “Think about how you do Mathematics!”
    - “You need to talk with Nate Klingbeil, who has done great things and is assembling a national rollout team”
- Called Nate, was chosen as the 15<sup>th</sup> school.
- Started implementing that fall.



# Overall Context for this work is somewhat unique

- CBU is a Private University (8000+ students in Riverside California – 32% minority, semester based) 3200 when we started!
- Gordon and Jill Bourns 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 degree and an Ag E concentration this last year.
  - MS CE and MS SwE start this fall.
  - Incoming class size (55, 67, 81, 98, 111, 152, 172, 189, 210+?(est)) Total 515 last fall. Over 600 undergrads anticipated this fall.
    - ~35% ethnic minority,
    - ~19% female (last fall freshman class 24% women)
    - ~10% international
    - ~20+% of incoming students involved in athletics
  - Cohorts of students on presidential scholarship from Rwanda (11/12, 16/19, 14/16, 3/7, 2/7, 3/7, 2/5, 7/7)
  - Full time Faculty (1,2,5,8,11,15,19,23, 27, 32 ) Currently 7 of 32 faculty are women including the associate dean and one department chair.





# We have outstanding faculty and staff!



Fall 2012 – 19 faculty and 4 staff  
Fall 2013 – 23 faculty and 4 staff  
Fall 2014 – 27 faculty and 4 staff  
Fall 2015 – 32 faculty and 4 staff

Most have industrial experience

All EGR faculty have PhD's ,  
1 CIS faculty is ABD

PhD's are from 'top' schools:  
UC Berkeley, Georgia Tech,  
U of Mich, Notre Dame, Stanford,  
Princeton, Purdue, Texas A&M, U  
of Texas, etc

All are committed Christians who  
have a passion for teaching  
young people and helping them  
achieve their unique purpose.

7/32 women, 20/32 non  
caucasian, 7 countries of origin



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# 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)





## Our numerous curriculum distinctives attract value driven students!

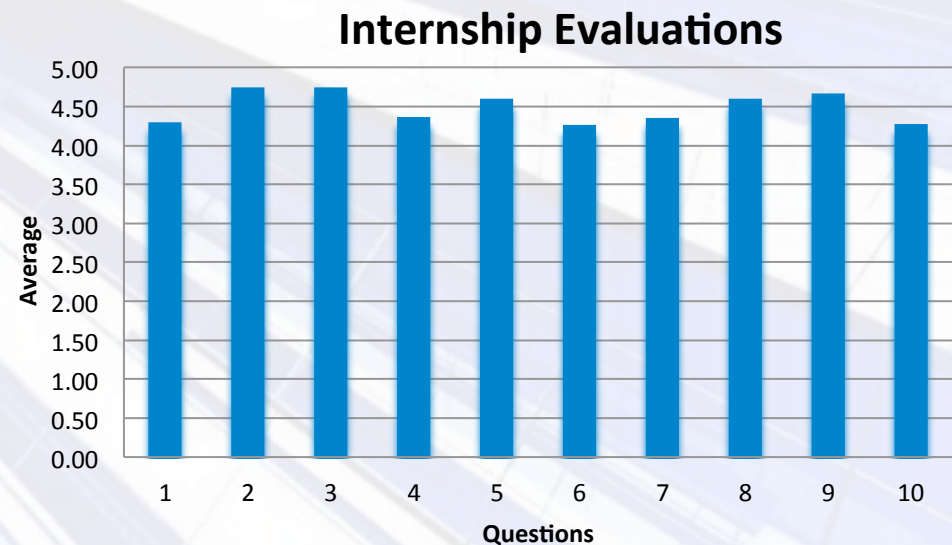
- All students taught with the Wright State Model for mathematics
- All students start with Intro to engineering from a Christian Worldview
- All student provide service in the community (30 hours their first year)
- All students required to fulfill a cross cultural requirement
- All students required to do internship before graduating
- All technical courses have at least two people in industry and one person at another university giving the prof in charge feedback on their course once a year.
- Hands on design all four years.
- All students take a leadership cohort (7 person class) their junior year.



# Industry loves our students!

- Effective **Design** skills
- Ability to **Conduct** experiments
- Ability to **Design** experiments.
- **Writing** skills.
- **Communication** skills.
- **Problem solving** skills.
- Use of **software** tools.
- Use of **hardware** tools.
- **Teamwork**
- **Leadership**

5 – Superior  
4 – Above Average  
3 – Average  
2 – Below Average  
1 – Unsatisfactory



# History of CBU adaptation of WSU model shows continual development

- **2013-2015—Continued development and utilization of our intuitive calculus labs, developed and tested NAO robots and surveying equipment for use in engineering trig labs. ( full paper at W 227 8:45 am )**
- 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.





# Longitudinal results are encouraging!

- 58% of 'at risk' students entering '100' since inception were still in the program after 1 year (Note: WSU (MPL3) went from 26 to 48 %)
- Over 2/3rds of those not in engineering were still in the university in other majors.



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

- This fall we will surpass over 1100 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.



# Trigonometry has some issues

- Trigonometry can be easily one of the least favorable math topics among high school and college freshmen
- Lack of adequate connection between classroom learning and engineering applications in the real world
- An engineering student can barely pass calculus I and still be lacking some critical skills in handling trigonometry problems in statics and circuits

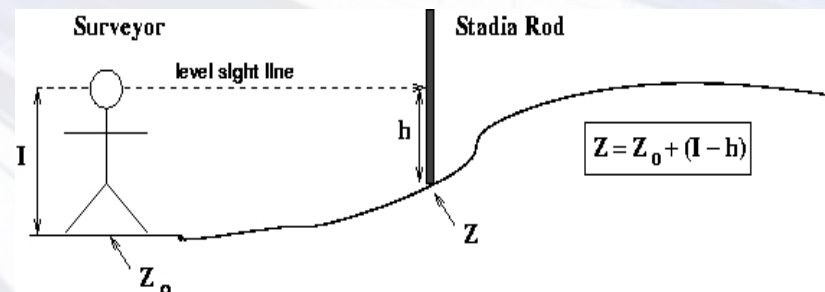
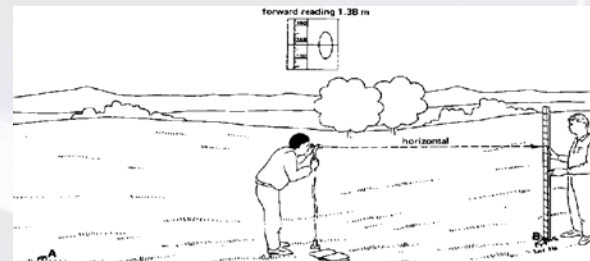




# Implement Surveying Lab to teach trigonometry – Slope

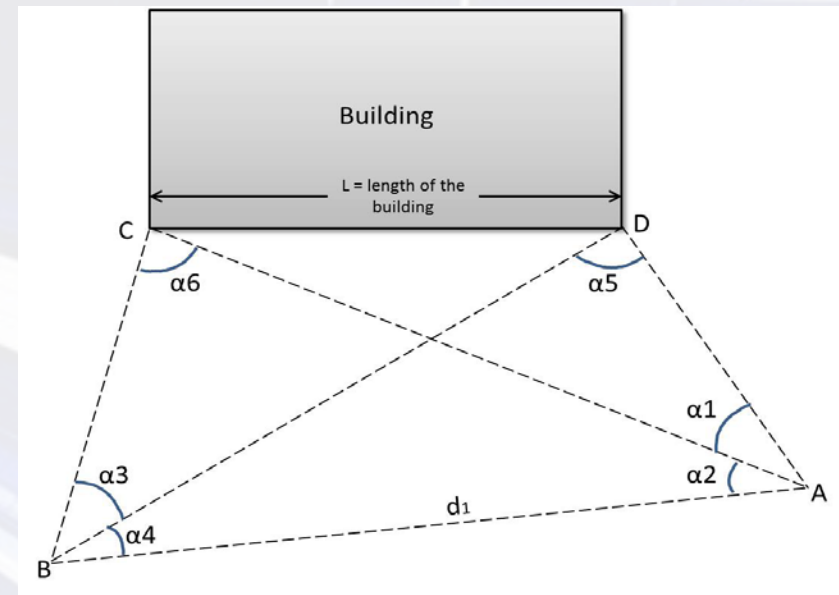
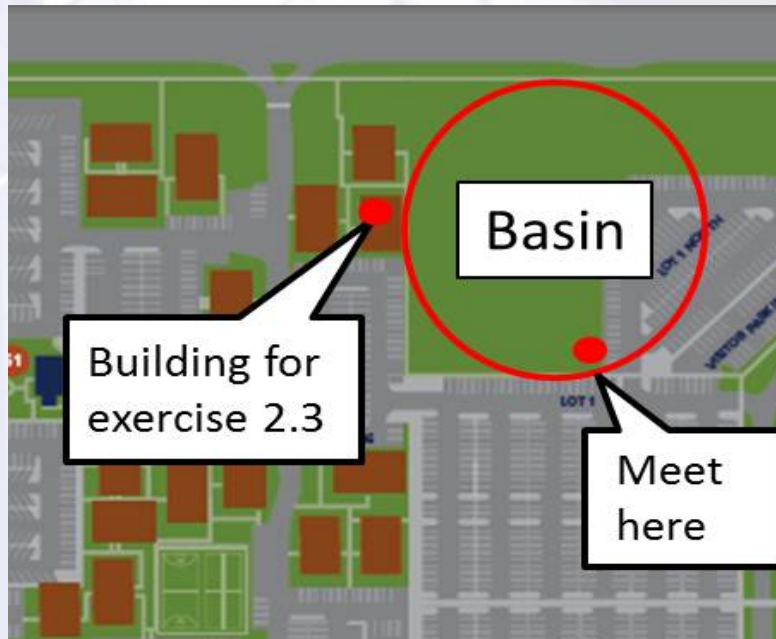


- Leveling, to find the slope of a hill.



# Implement Surveying Lab to teach trigonometry – Law of Sine and Cosine

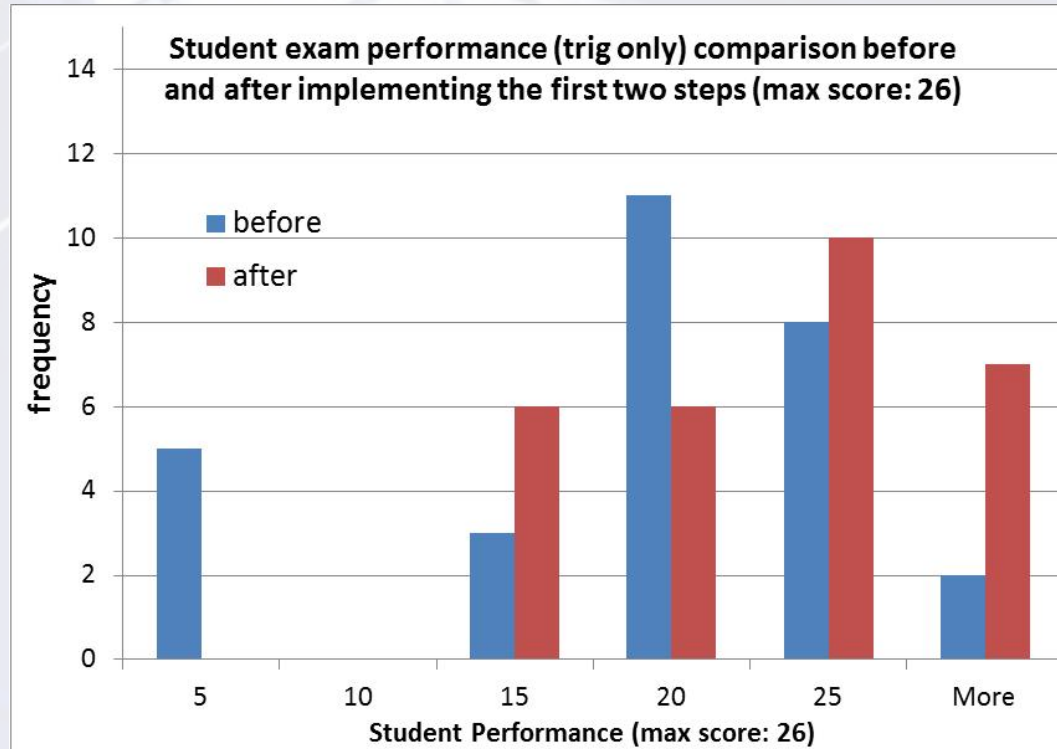
- Theodolite to find a length of a building without a direct measurement due to an obstruction in the way of measurement.



Measure the angles alpha 1, 2, 3 and 4  
Measure d1  
Calculate L, the length of the building

# Class average performance improved 22%

A trig exam problem was assessed for two groups of students:  
30 students each: before and after implementing the first two steps  
Maximum score: 26



Class average performance improved 22%  
(Two groups of students with similar background)

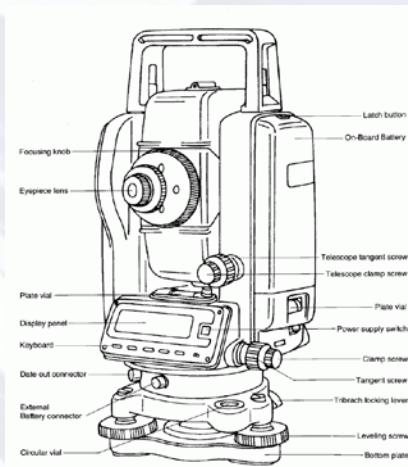


# Improvement is substantial, but not good enough!

67% passing rate in trigonometry



New Surveying Lab will help!



A detailed instructors' guide is needed.

Report the findings after the full implementation

# Future Plans involve expanded impact of this type of curriculum.

- We are in the middle of a campaign for a new 100,000 ft<sup>2</sup> engineering building with utilization for STEM education year round for the entire Southern CA region.
- 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.



# New Initiatives

- New concentrations/minor
  - Agriculture 2015 (within BS E degree)
  - Aeronautical 2016 (within BS ME degree)
- New degrees (anticipated dates of first graduating class)
  - BS Biomedical Engineering – (Spring 2016)
  - BS Chemical Engineering – (Spring 2016)
  - BS Software Engineering + minor – (Spring 2016)
  - BS Computer Science – (Spring 2017)
  - MS Software Engineering -(Spring 2017))
  - MS Civil Engineering -(Spring 2017)
  - PhD Engineering Education – (Spring 2020)
- New departments
  - Chemical, Fall 2015
  - Computing, Software and Data Sciences Fall 2015





# 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 will likely have several tenure track positions in the fall.
- We would welcome applications for faculty on sabbatical.
- For more information contact Anthony Donaldson, Founding Dean of the California Baptist College of Engineering using LinkedIn or [adonaldson@calbaptist.edu](mailto: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!



# 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!
- Two new major in 2014-15 (computer science and biomedical engineering) went through curriculum with shared EGR core (i.e. required EGR 182)
- Two more majors under consideration for the future: IE and PE, as well as a PhD in Engineering Education.
- We anticipate new lab and demonstration modules for these majors as well.





## NSF WSU curriculum implementation

Example: BS Electrical and Computer Engineering  
We also have BS CE, ME and general Engineering degrees

	Fall	Spring	Summer
Year 1	Course # CR	Description	
	EGR 182	4 Engineering Math II	MAT 245
	EGR 101	3 Engineering from a Ch	EGR 102
	EGR 121	3 Problem Solving and P	PHY 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	
		18	EGR 221
			18
			0 Worldview Reflection
			4 Circuit Theory II +Design
			4 Digital Logic Design
			4 Science Elective*
			3 Upper Division Math**
			3 Data Structures

\* 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.**

- New pathways are:
  - Fall: EGR 182L (1) or lab exam, and MAT 343 (4) Calc III or science course (Assumes placed out of or took lecture equivalent through Calc II at another school with a B or better.)
  - Fall EGR 182L (1) or lab exam, and MAT 255 (4) Calc II (Assumes placed out of or took lecture equivalent of Calc I at another school with B or better.)



# Intuitive Calculus Lab beta tested last year were further developed.

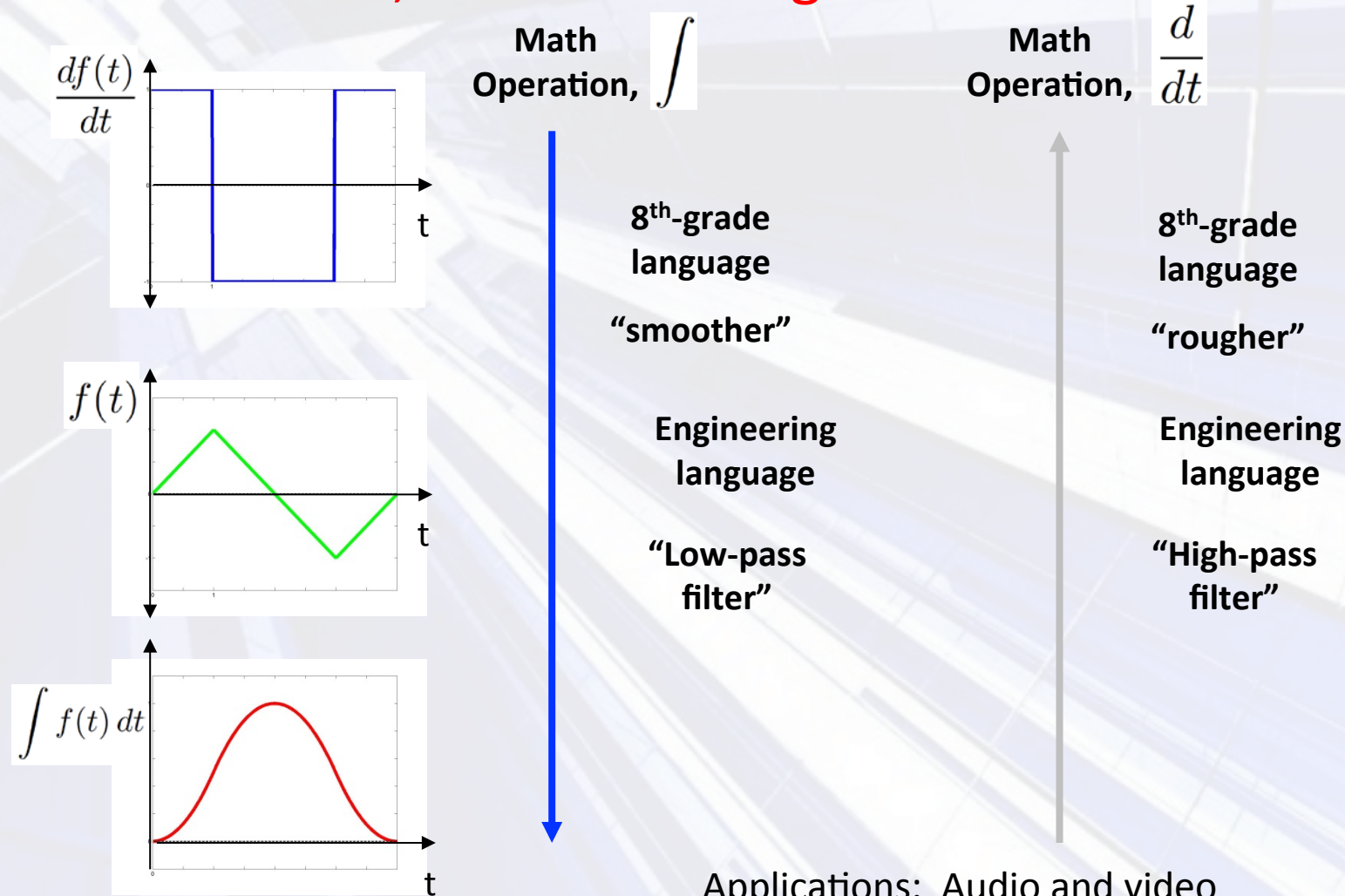
- The next two slides show the new calculus lab we beta tested this year. (Introduced to this group last summer).
- We have some refinements to do with the hardware (new FPGA etc) this summer in order to roll out for all students in the fall.





# Calculus Made Fun With EE Hardware

## or, “Intuitive Integrals & Derivatives”



Applications: Audio and video  
signal processing!! – Cool  
stuff!!!



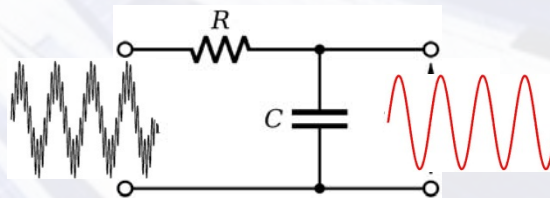
# New "WSU EGR 101" Lab

## (Analog & Digital Implementations of Calculus)

### Math Operations

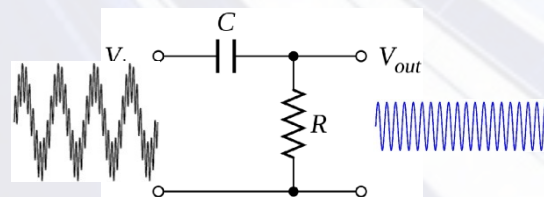
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Low-pass Filter



$$\frac{d}{dt}$$

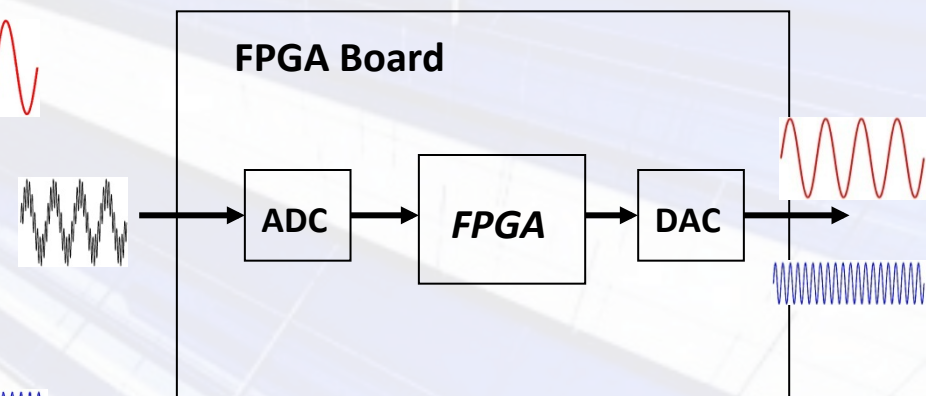
High-pass Filter



### "Signal" Operations

#### Analog

#### Digital



(Low-pass & High-pass Filters)

FPGA = Field Programmable Gate Array

ADC = Analog-to-Digital Converter

DAC = Digital-to-Analog Converter



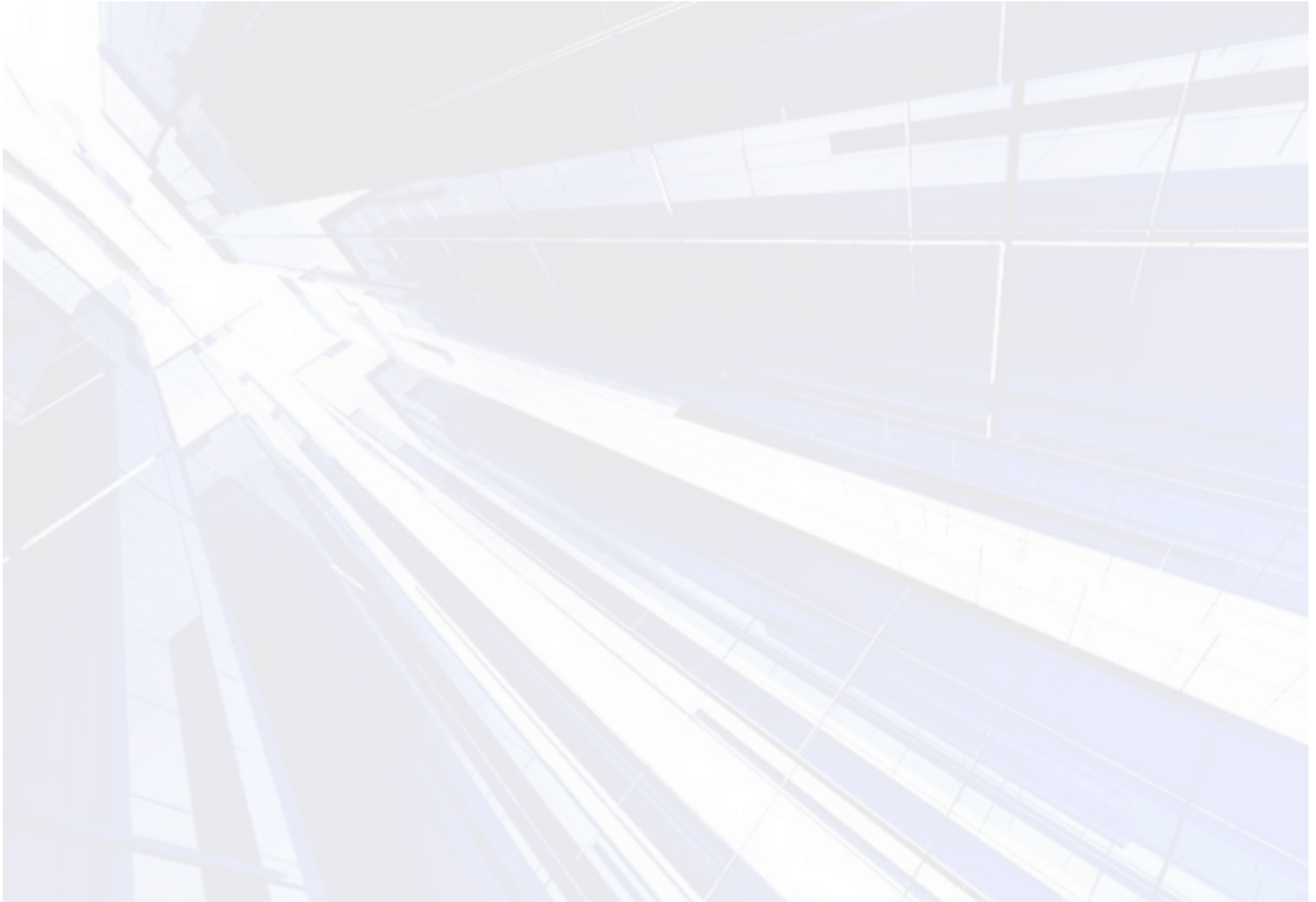
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# New labs and demonstrations were developed this year!

- Dr. Grace Ni and Dr. Rod Foist (ECE) used NAO robots to illustrate trigonometry.
  - Paper planned to be given at 6<sup>th</sup> 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 given at 6<sup>th</sup> First Year Engineering Experience Conference, August 7-8, 2014, College Station, Texas

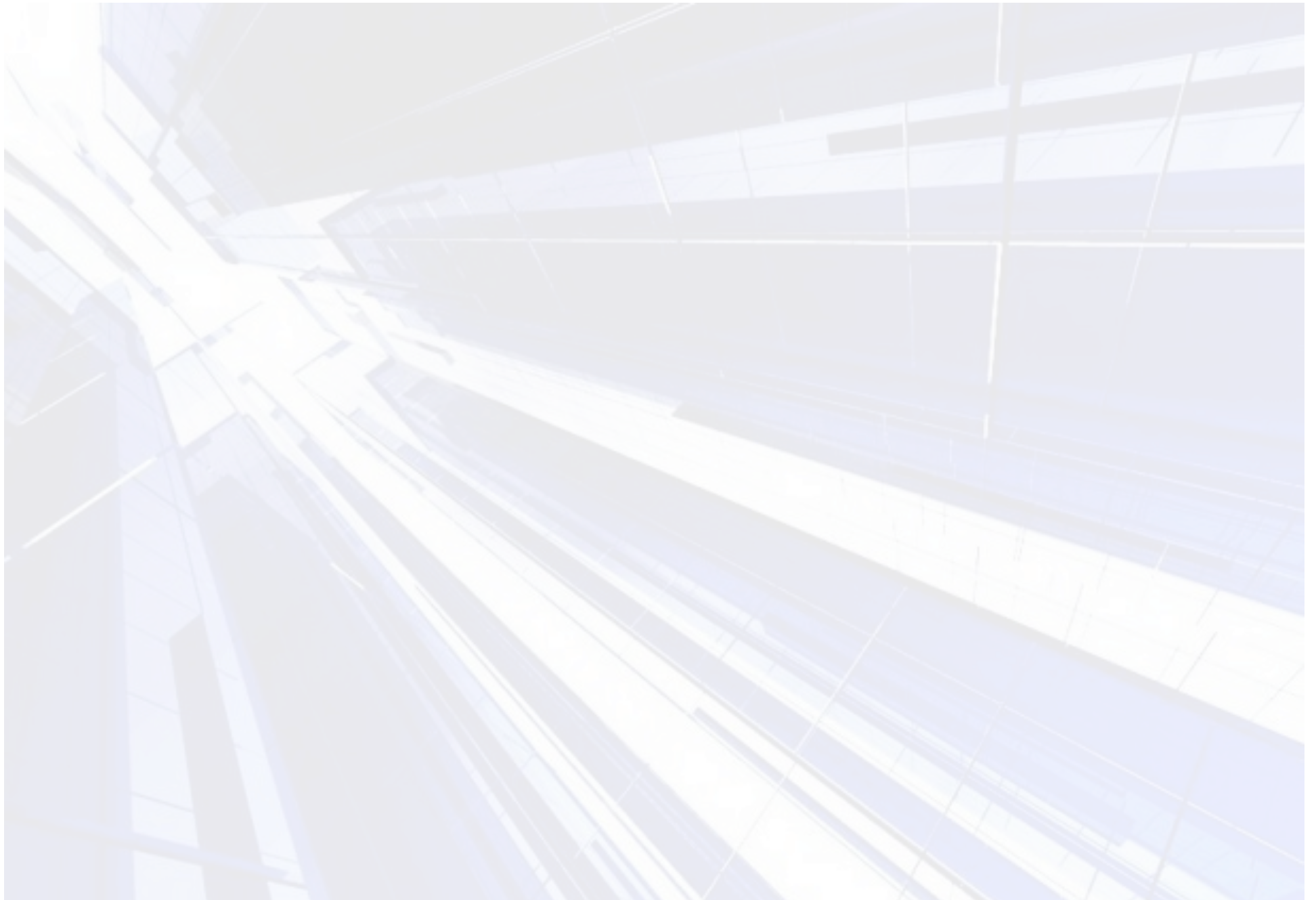






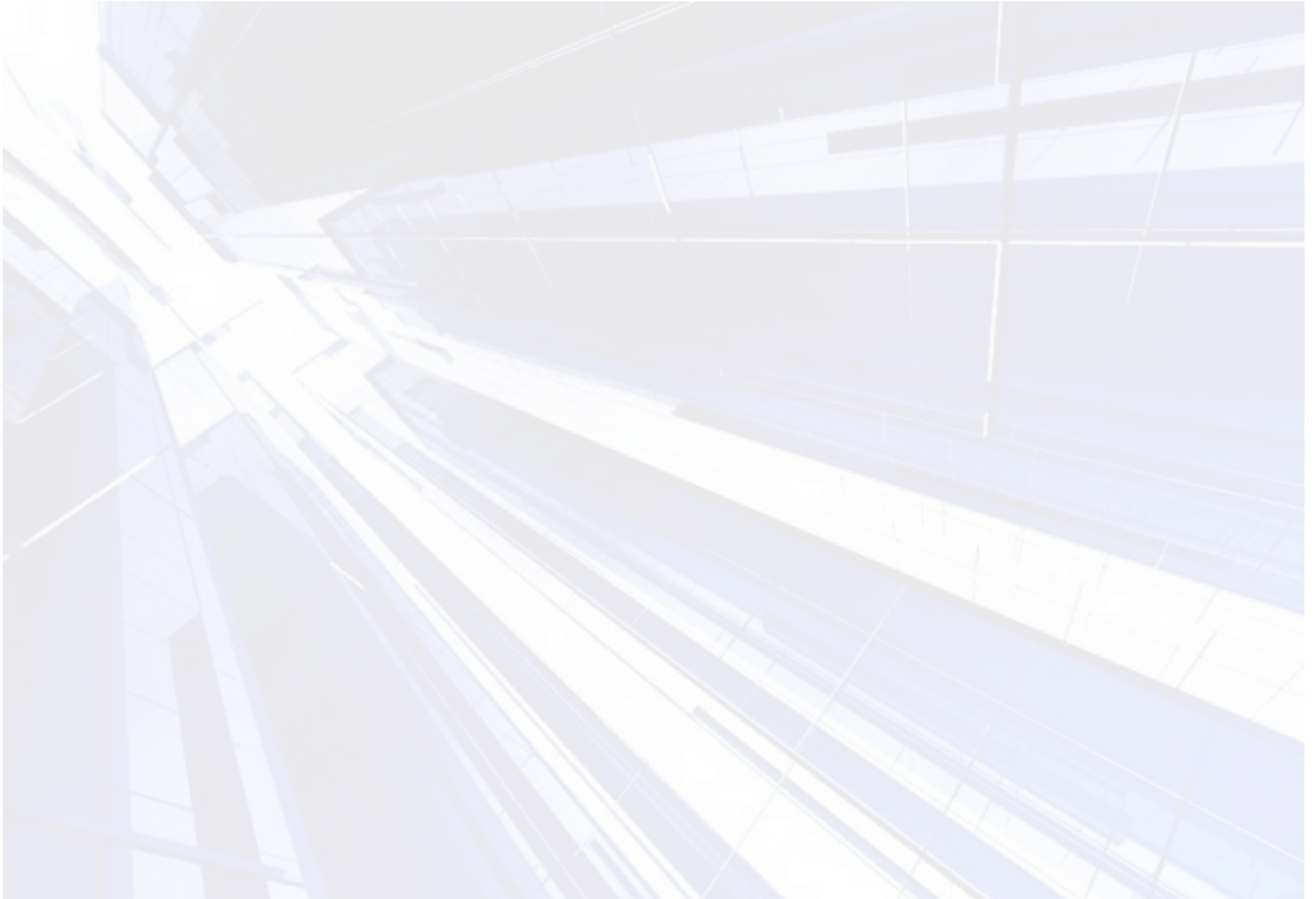
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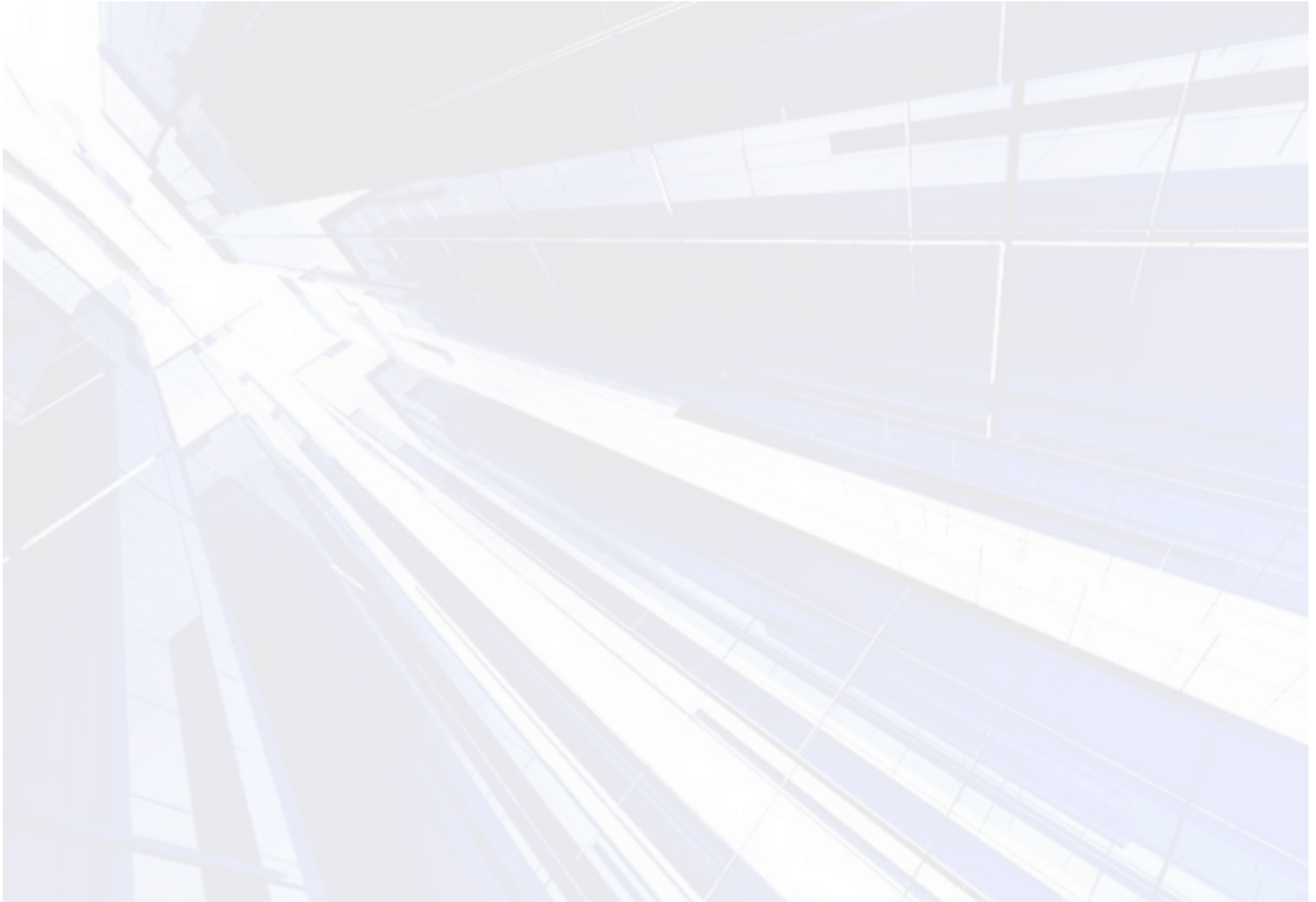
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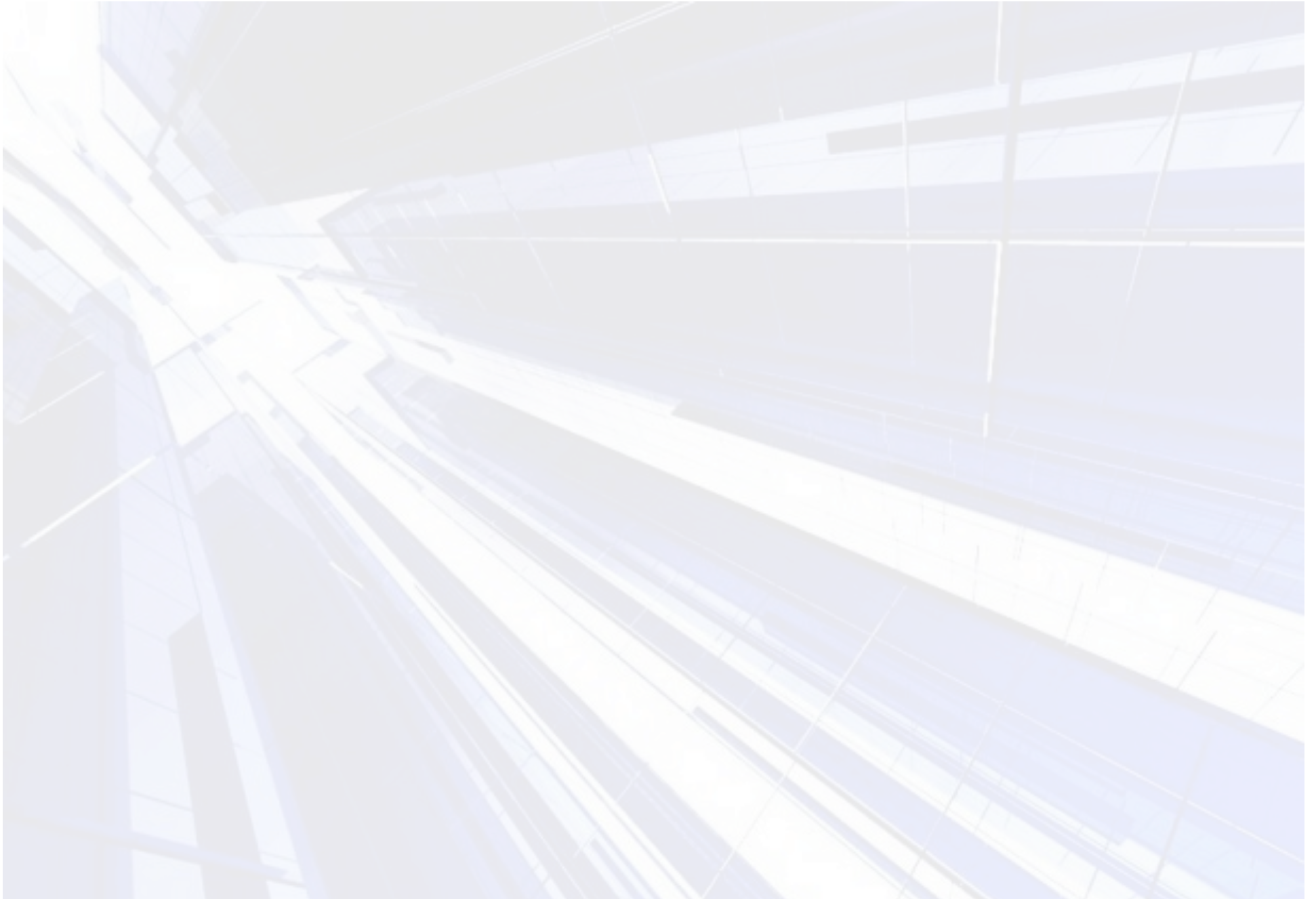
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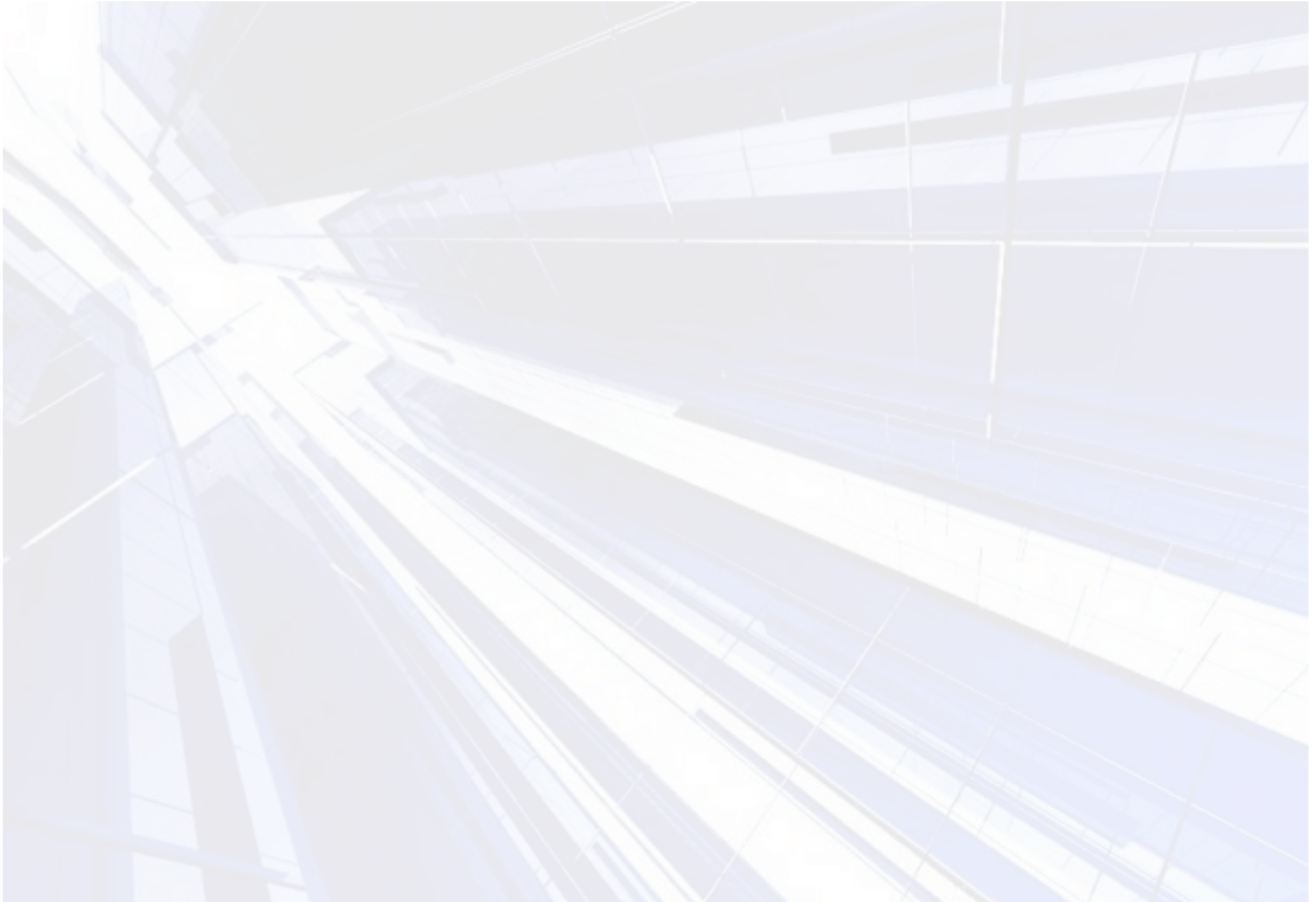


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