A Core Lighting Curriculum for University Students and Lighting Professionals

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Beginning with the end

https://blogs.oregonstate.edu/kevinhouser/nuckolls-project

ARE 361—Fundamentals for Lighting Design

Catalog Description: Demonstrate critical thinking about illuminating engineering and applied lighting in the built environment. Explore lighting terminology, photometric quantities and units, the visual response of the human eye and brain, luminous radiative transfer, lighting equipment, elementary lighting design procedures, and basic lighting calculations.

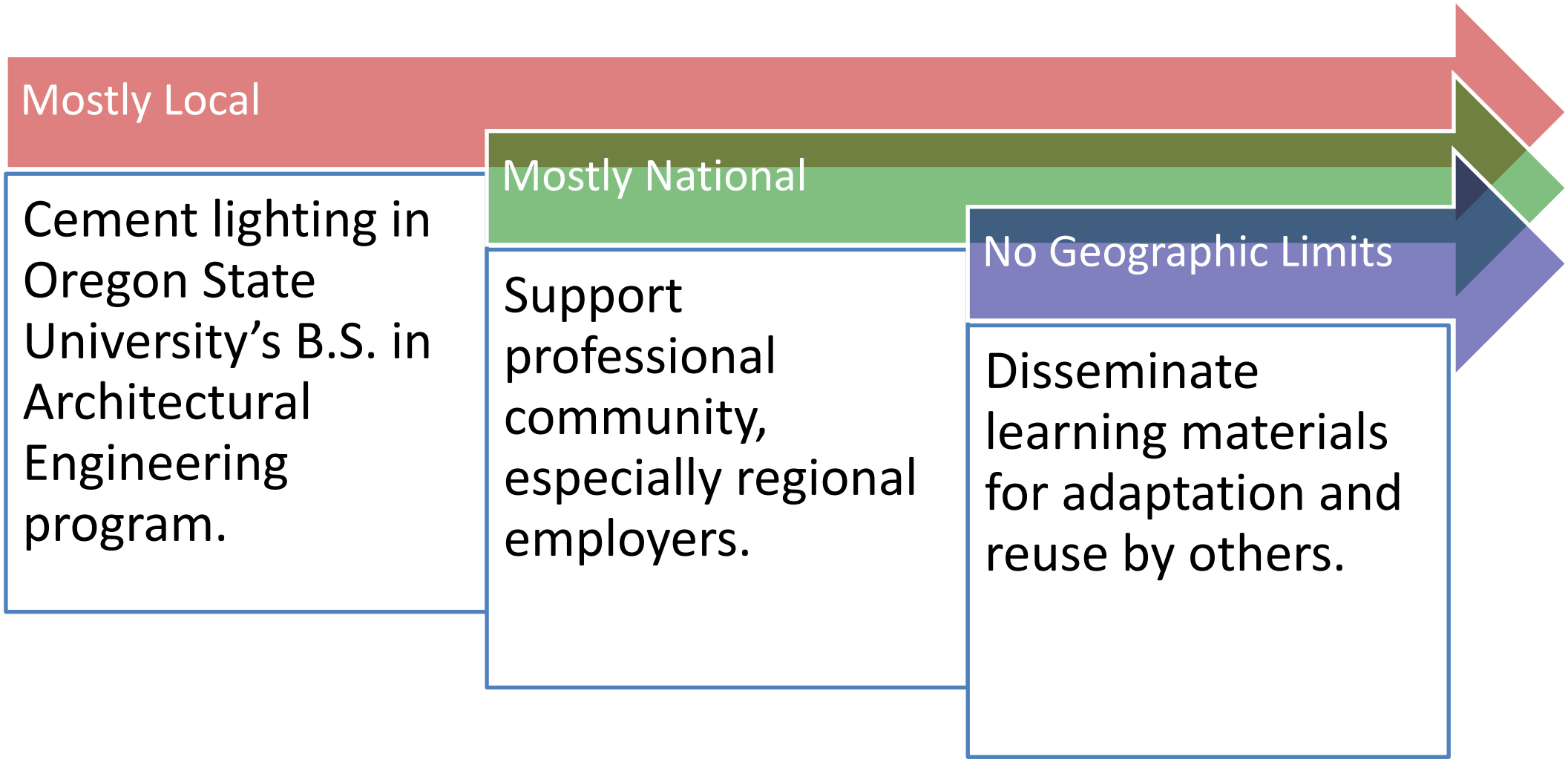
ARE 461—Lighting Design for the Built Environment I

Catalog Description: Builds upon ARE 361 to advance critical skills in illuminating engineering and applied lighting for the built environment, emphasizing integration between the lighting design process, technical fundamentals, and application to design. Extends depth in photometry by calculating illuminance with diffuse radiative transfer. Establishes design criteria, employs computer-based calculations as a verification tool, and creates solutions compliant with compulsory standards.

ARE 462—Lighting Design for the Built Environment II

Catalog Description: Builds upon ARE 461, extending lighting design skills and technical knowledge in applied illuminating engineering to produce defensible solutions to open ended engineering problems. Prioritize and balance competing criteria that addresses lighting requirements for the visual experience (e.g., vision, visual comfort, psychological reinforcement, color quality) and human health, while accounting for energy use and complying with compulsory standards. Demonstrate facility with the lighting design process, luminaire photometry, applied colorimetry, and software-based simulation.

This project has three goals.



Lighting includes ***timeless topics*** in a ***rapidly evolving context***.

Solid State

Parametric Modelling

Visual (dis)comfort

Circadian Photobiology

Building Information Modelling

Artificial Intelligence

ALAN/Ecology

Health

Controls Technologies

LEED

Spectrally-Based Simulation

Physiology

WELL

Circular Economy

Sustainability

Flicker

Vision

Light Justice

Psychology

Design Lights Consortium

How should the breadth of all possible lighting knowledge be prioritized, organized, and delivered?

A universal “lighting syllabus” will always be elusive.

Academic factors →	*architecture, interior design, engineering, theatre*
Accreditation requirements →	*NAAB, CIDA, ABET, NAST*
Institutional factors →	*culture, facilities, support*
Instructor factors →	*Interest, capabilities, availability*
Employers →	*Expectations for employability*

Twofold mission of Architectural Engineering.

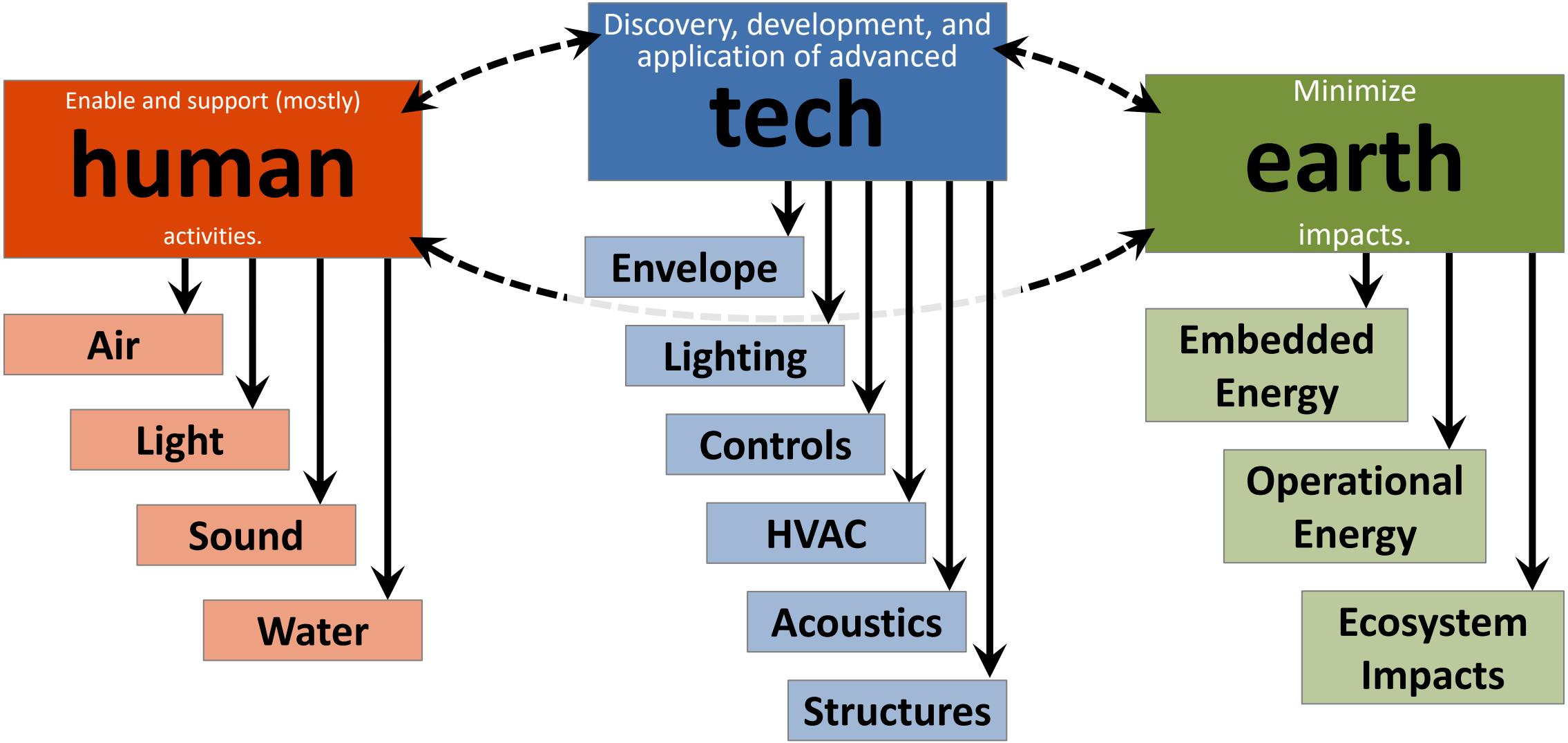
Improve the quality of life for

people

Minimize detrimental effects on

planet earth

Taxonomy of Architectural Engineering

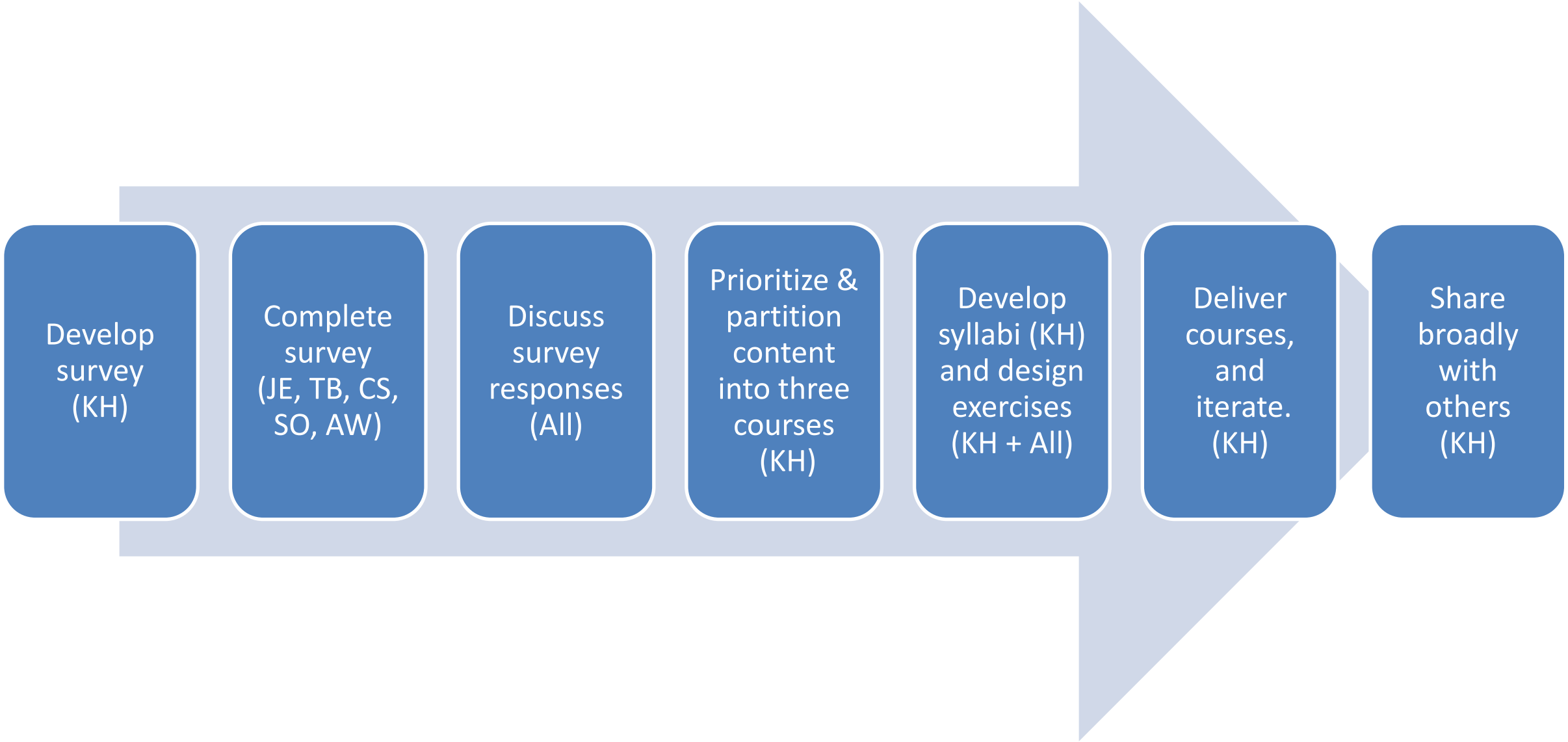


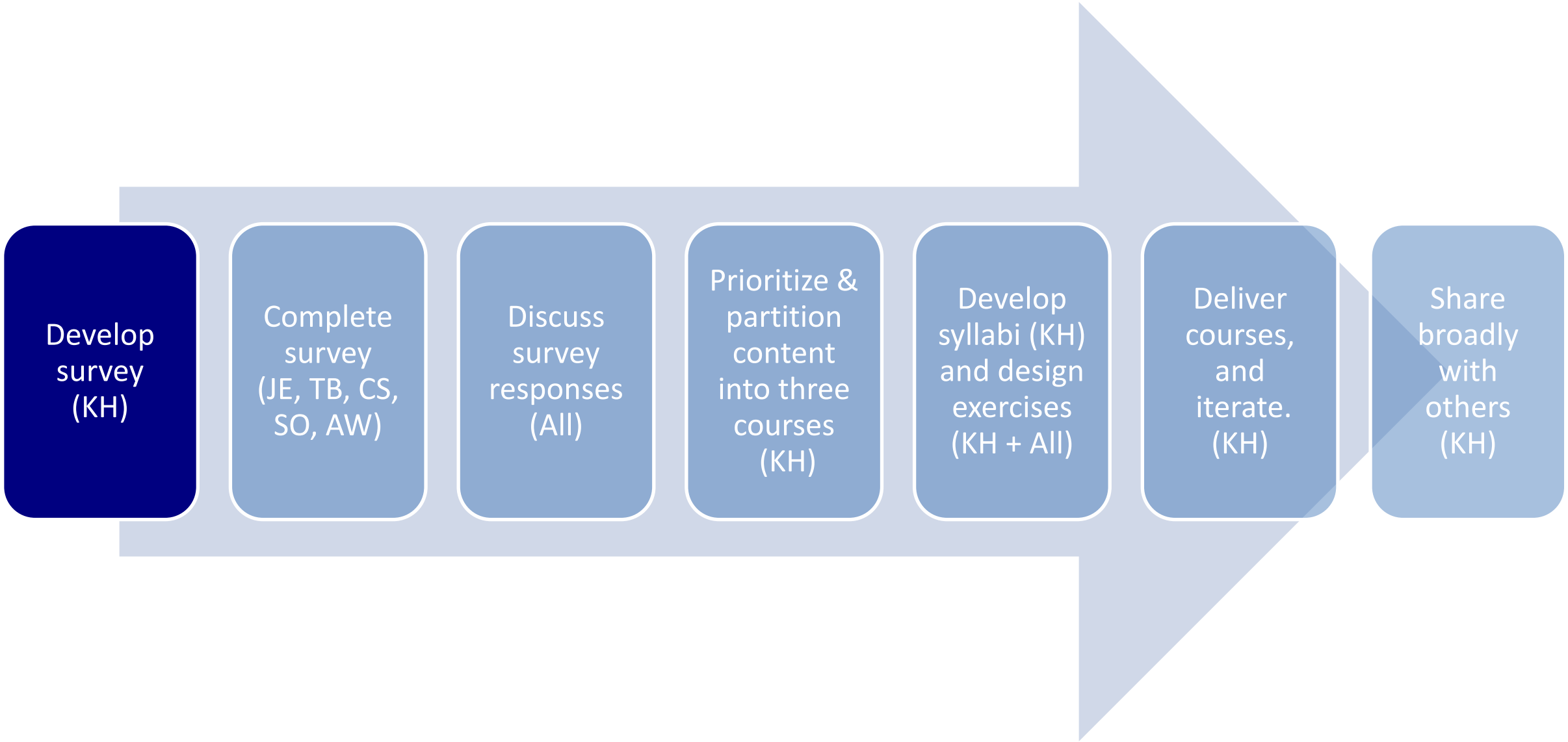
Lighting as Science vs. Lighting as Art

Cooper Lighting

James Turrell

A priori belief regarding benefits of professional collaboration.




Develop survey (KH)
Complete survey (JE, TB, CS, SO, AW)
Discuss survey responses (All)
Prioritize & partition content into three courses (KH)
Develop syllabi (KH) and design exercises (KH + All)
Deliver courses, and iterate. (KH)
Share broadly with others (KH)

Survey was inspired by Bloom's Taxonomy.

Cognitive

- Remembering
- Understanding
- Applying
- Analyzing
- Evaluating
- Creating

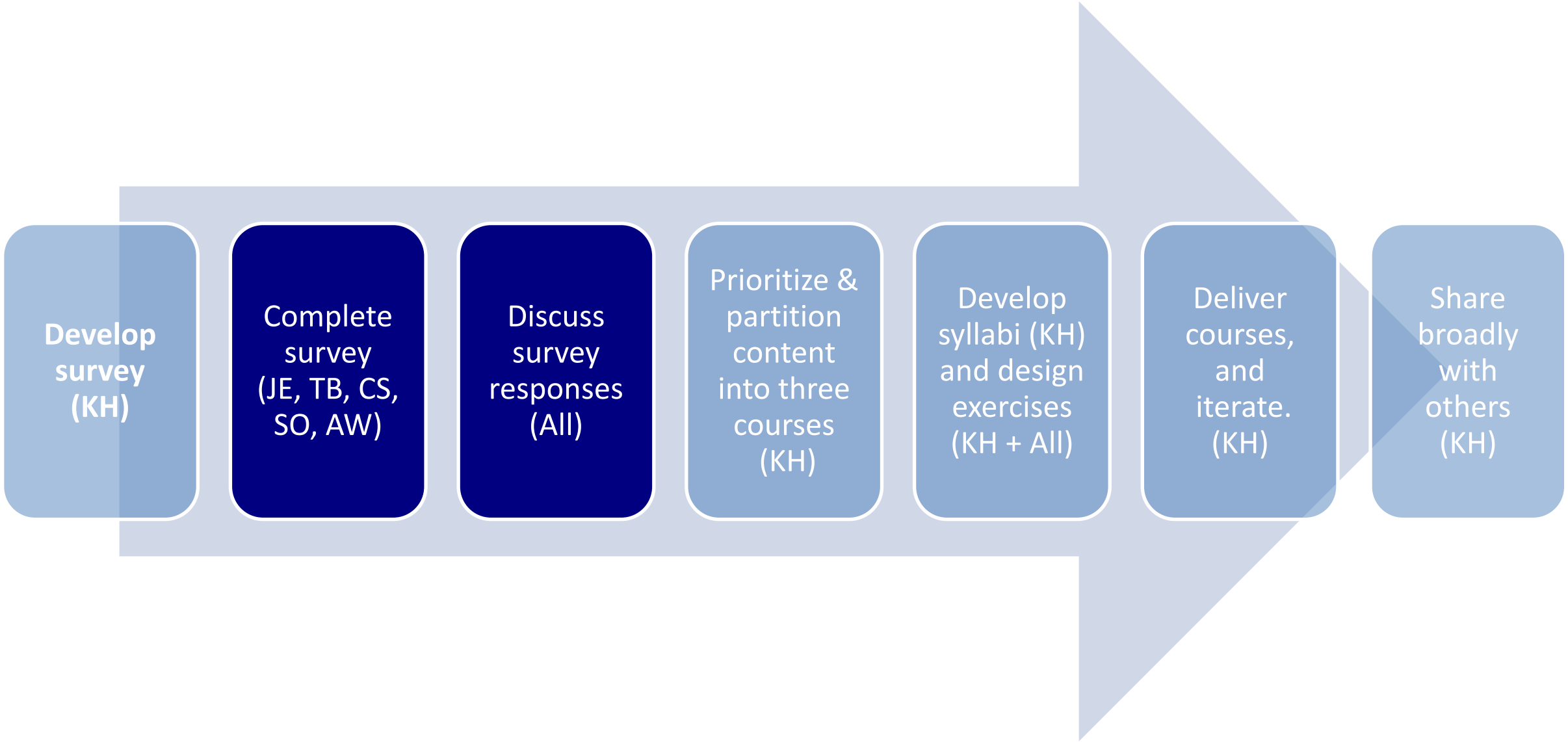
Affective

- Receiving
- Responding
- Valuing
- Organization
- Characterization by a Value or Value Complex

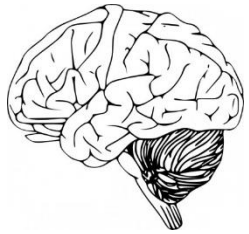
Psychomotor

- Imitation
- Manipulation
- Precision
- Articulation
- Naturalization

Survey-responses initiated discussions about topical priorities.

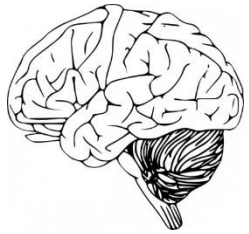


Cognitive | Unsorted



		COGNITIVE DOMAIN LEARNING LEVEL													
		Non-Lighting AE Students							Lighting AE Students						
		Not Important	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Not Important	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1	**Emotive terms and vocabulary to describe the effects of light and lighting**			2.6									5.2		
2	**Physics of light and light generation (e.g., particle, wave, atomic structures, light emission)**			2.6								4.2			
3	**Eye/brain Physiology**			2.7								4			
4	Anatomy and physiology of human visual system		1.8									3.8			
5	Photopigments and photorecptors (alpha-opic action spectra)		1.8									4.2			
6	Fundamental seeing factors (i.e., luminance, constrast, size, time, age)			2.8										5.6	
7	Constrast sensitivity		2.2									4.4			
8	Visual acuity		2.4										4.6		
9	Luminance adaptation			2.6									5.2		
10	Chromatic adaptation		2.2										4.6		
11	**Visibilty models (e.g., VL, ESI, RVP)**		1.8								3.3				
12	Historical context for VL, ESI, RVP	1.4									3.2				
13	Research foundations for VL, ESI, RVP		1.8								3.2				

Cognitive | Sorted by Mean



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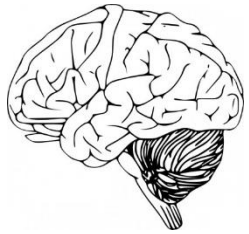
		Non-Lighting AE Students							Lighting AE Students						
		Not Important	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Not Important	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
263	Oral communication skills						6.5	6.5						6.5	6.5
264	Presentation skills						6							6.4	
128	**Computer Calculations and Computing Skills**				4.5	4.5								6.3	
256	**Non-Technical Professional Skills**					5								6.3	
155	Design creativity (divergent thinking skills)			3										6.2	
54	Photometric reports			2.8										6	
147	**Lighting Design Skills**			3.5	3.5									6	
148	Lighting design process			3.3										6	
149	Design criteria development			3										6	
156	Conceptualizaton of luminous compositions			3.2										6	
209	**Color and Colorimetry**			3.5	3.5									6	
211	Spectral power distributions (SPDs)			3.4										6	
258	Written communication skills						6							6	
153	Design criteria prioritization			3.2										5.8	
154	Development of preliminary/schematic design concepts			3										5.8	
162	Hand sketching			3.2										5.8	

Cognitive | Sorted by SD



		COGNITIVE DOMAIN LEARNING LEVEL													
		Non-Lighting AE Students							Lighting AE Students						
		Not Important	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Not Important	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
143	Python								2			1			1
125	Form factors								1	1	1			1	1
126	Interreflected calculations (flux balance models)								1	1	1			1	1
140	Excel								1			2			2
274	Personal financial literacy								2		1			2	
142	Matlab								2		1	1			1
124	Configuration factors								1		2			1	1
122	Point calculations								1		1	1		1	1
115	Connected Lighting									1	1		1		1
272	Time sheets								3		1			1	
164	Working drawings								1		1		1	2	
260	Formal report preparation								1		1		1	2	
123	Radiative transfer								1		1	1		2	

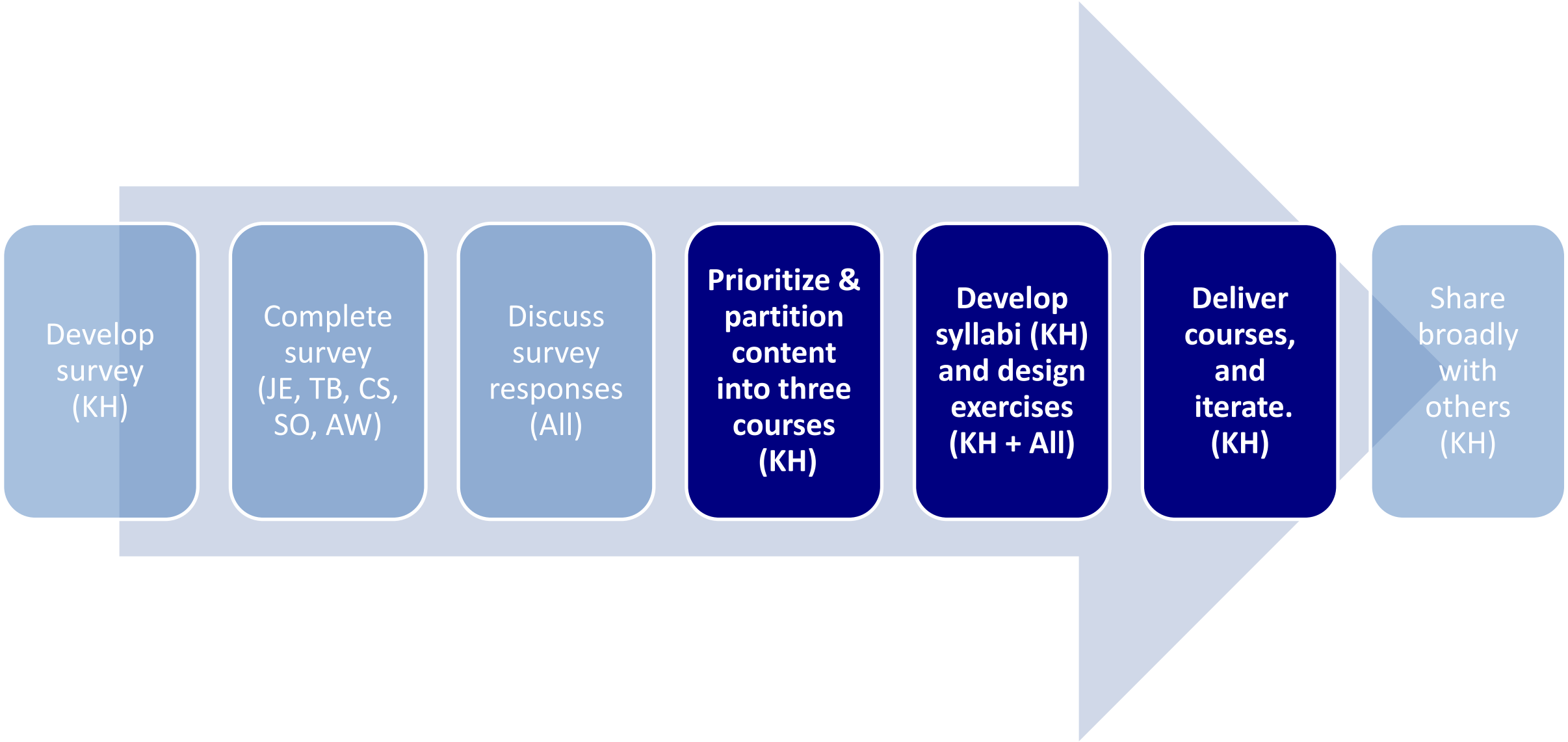
Psychomotor | Unsorted

		PSYCHOMOTOR DOMAIN LEARNING LEVEL											
		Non-Lighting AE Students						Lighting AE Students					
		Not Important	Imitation	Manipulation	Precision	Articulation	Naturalization	Not Important	Imitation	Manipulation	Precision	Articulation	Naturalization
1	**Measurement Techniques**		1.8								3.8		
2	Illuminance measurement		1.8								3.8		
3	Luminance measurement	1.5	1.5								3.8		
4	SPD measurement	1.5	1.5								3.8		
5	Colorimetric measurements	1.3								3.5	3.5		
6	Reflectance measurement	1.5	1.5							3.3			
7	Goniophotometry	1.3								2.8			
8	Integrating sphere photometry		2							3			
9	**Design Communication**			3.3							4		
10	Hand Sketching			3.3							4		
11	Preparing design documents				4						4		
12	**Commissioning of lighting equipment in field settings**		1.8							3			
13	Luminaire aiming		1.8							3.5	3.5		
14	Controls comissioning		1.7							2.8			
15	**Model building / craftsmanship**				4						4		

Affective| Unsorted

		AFFECTIVE DOMAIN LEARNING LEVEL											
		Non-Lighting AE Students						Lighting AE Students					
		Not Important	Receiving	Responding	Valueing	Organizing	Value Complex	Not Important	Receiving	Responding	Valueing	Organizing	Value Complex
1	**Mental Library of Light and Lighting**		2									5	
2	**Artistic and Aesthetic Appreciation**			2.8								4.8	
3	**Profesional Attitude**				4							4.8	
4	**Ability to Find and Use Appropriate Resources**			3							4.3		
5	IES Lighting Library (RPs, TMs, DGs)		2.5	2.5							4.3		
6	CIE Standards		2							3.5	3.5		
7	Web-based resources			3							4.5	4.5	
8	Manufacturer's literature			3							4.5	4.5	
9	**Non-Technical Professional Skills**					5						5	
10	Written communication skills					5.3						5.3	
11	Tone of e-mail communications					5.3						5.3	
12	Manner on phone/video calls					5.3						5.3	
13	**Intrisic Motivation**					5						5.3	
14	**Attitude toward receiving constructive criticism**					4.8						5	

Discussion led to appropriately grounded course development.



Discussion clarified learning outcomes, leading to defensible course and learning exercise development.

ARE 361

By the conclusion of this course, students are expected to be able to:

1. Compute and manipulate photometric quantities such as luminous flux, luminous intensity, illuminance, exitance, and luminance.
2. Analyze lighting design solutions by identifying the components of light (sometimes called “layers of light”, or luminous characteristics) that were employed in design.
3. Explain the basic performance characteristics of light sources that are relevant when matching light sources to end-use application.
4. Identify major families of luminaire types and subtypes.

ARE 461

By the conclusion of this course, students are expected to be able to:

1. Compute photometric quantities using basic radiative transfer situations, including point calculations and computation and implementation of configuration and form factors.
2. Implement the lighting design process for a space of modest complexity where there are multiple and competing design considerations and design criteria.
3. Develop design documentation comprising drawings and a lighting equipment schedule comparable to that expected in a professional context.

ARE 462

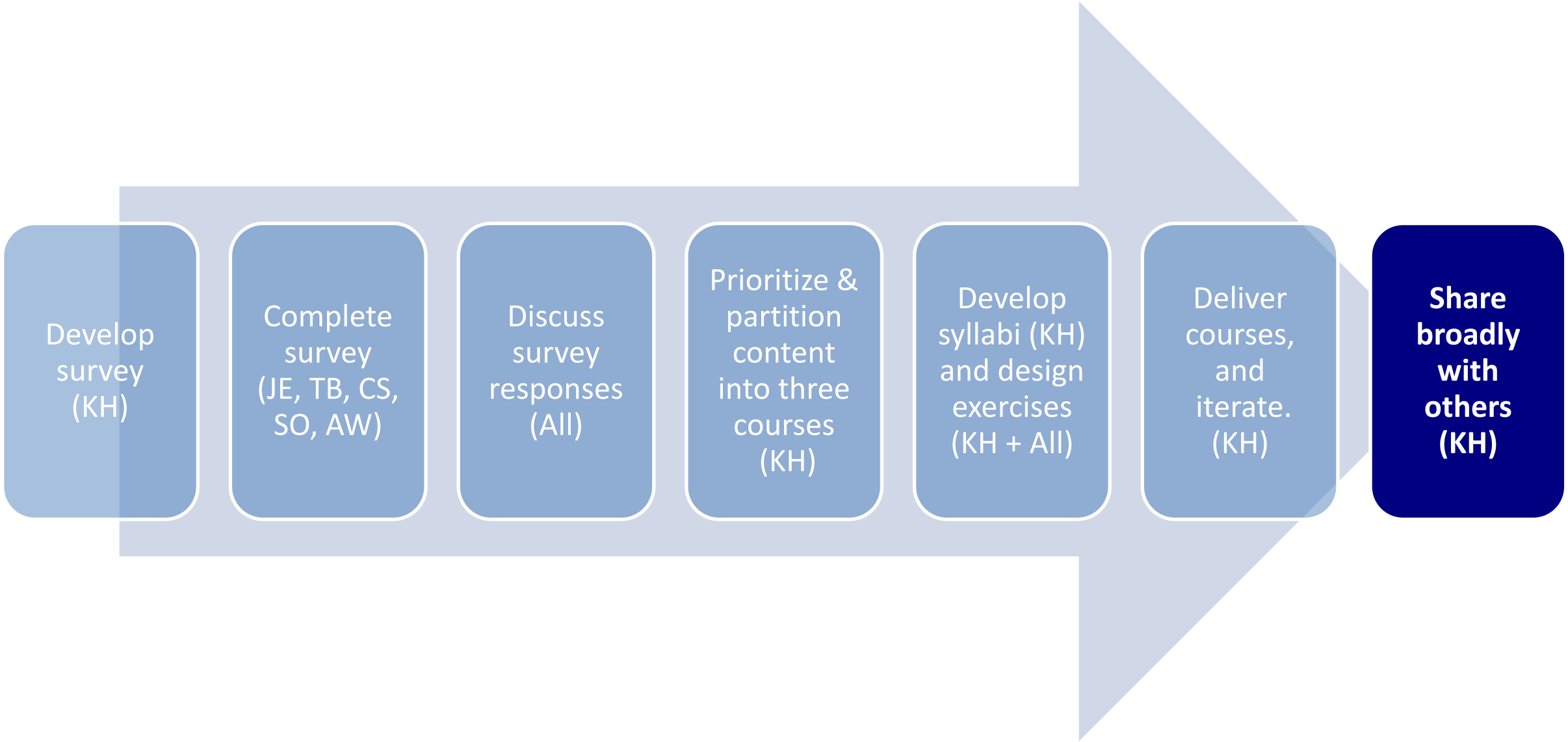
By the conclusion of this course, students are expected to be able to:

1. Compute the major components of a luminaire photometric report (e.g. zonal lumens, luminaire efficiency, coefficient of utilization) from an IES LM-63 format photometry file.
2. Implement the lighting design process for a space of modest complexity where there are multiple and competing design considerations and design criteria.
3. Report the results of your design process orally in the form of a professionally prepared presentation and in writing in the form of a professionally prepared report.
4. Be able to perform a parametric comparison where one lighting variable is systematically varied and a dependent measure is analyzed.

Thoughts for your consideration.

- What is the desired relationship between industry and academia? (e.g., consider how to create a benevolent push and pull).
- Content is a vehicle for developing disciple specific problem-solving skills (e.g., skills in design, communication, computation)
- Cognitive topics tend to receive disproportionate emphasis by some educators. Affective and psychomotor skills matter, too!
- Learn about your student audience my mapping teaching and learning styles—being sure to "teach around the wheel".
- Teaching is supported by textbooks, classroom instruction, and complementary assignments, but learning requires motivation, time, thought, and the doing of the work—invest in developing quality exercises that support learning outcomes.

Enjoy the process and outcomes!



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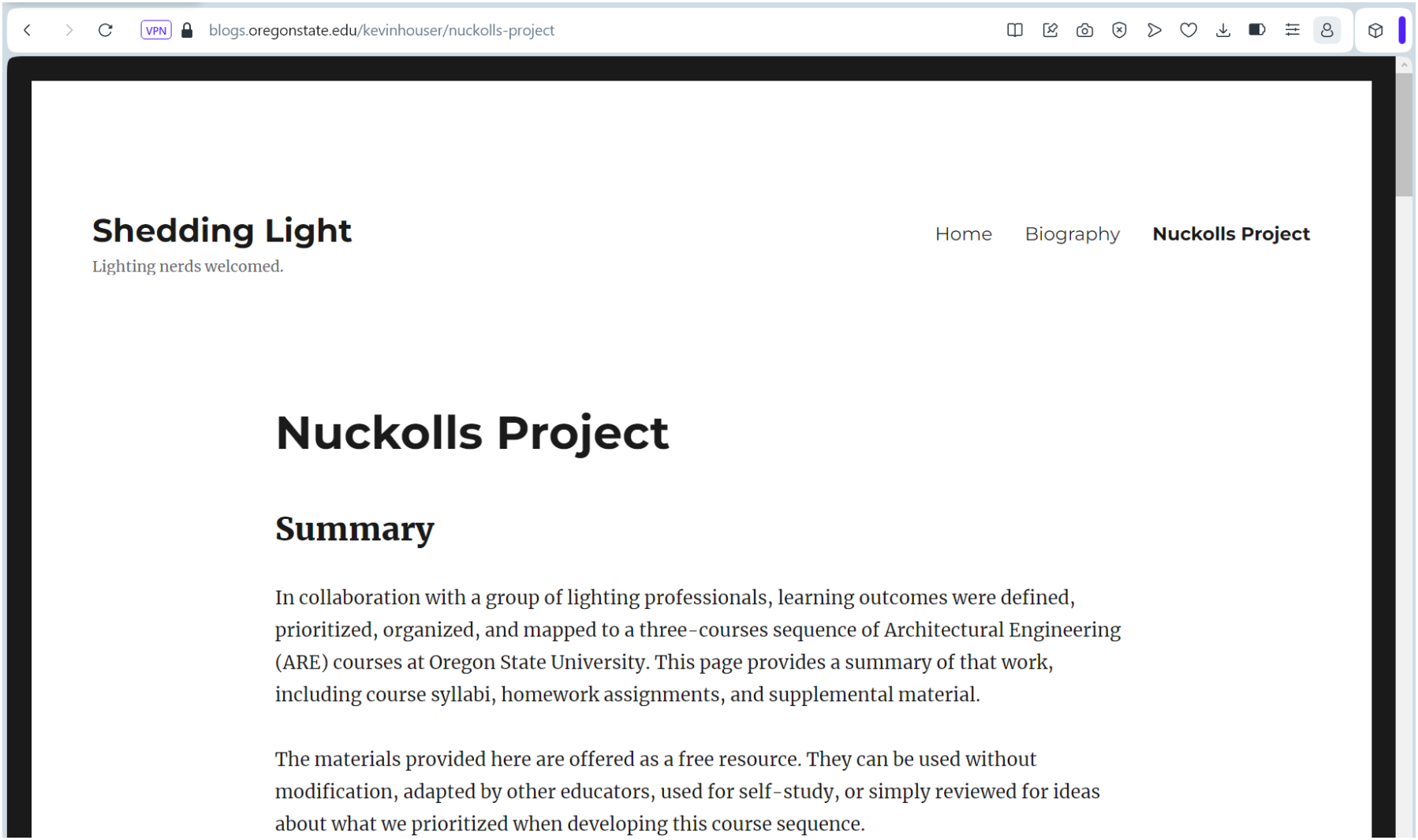

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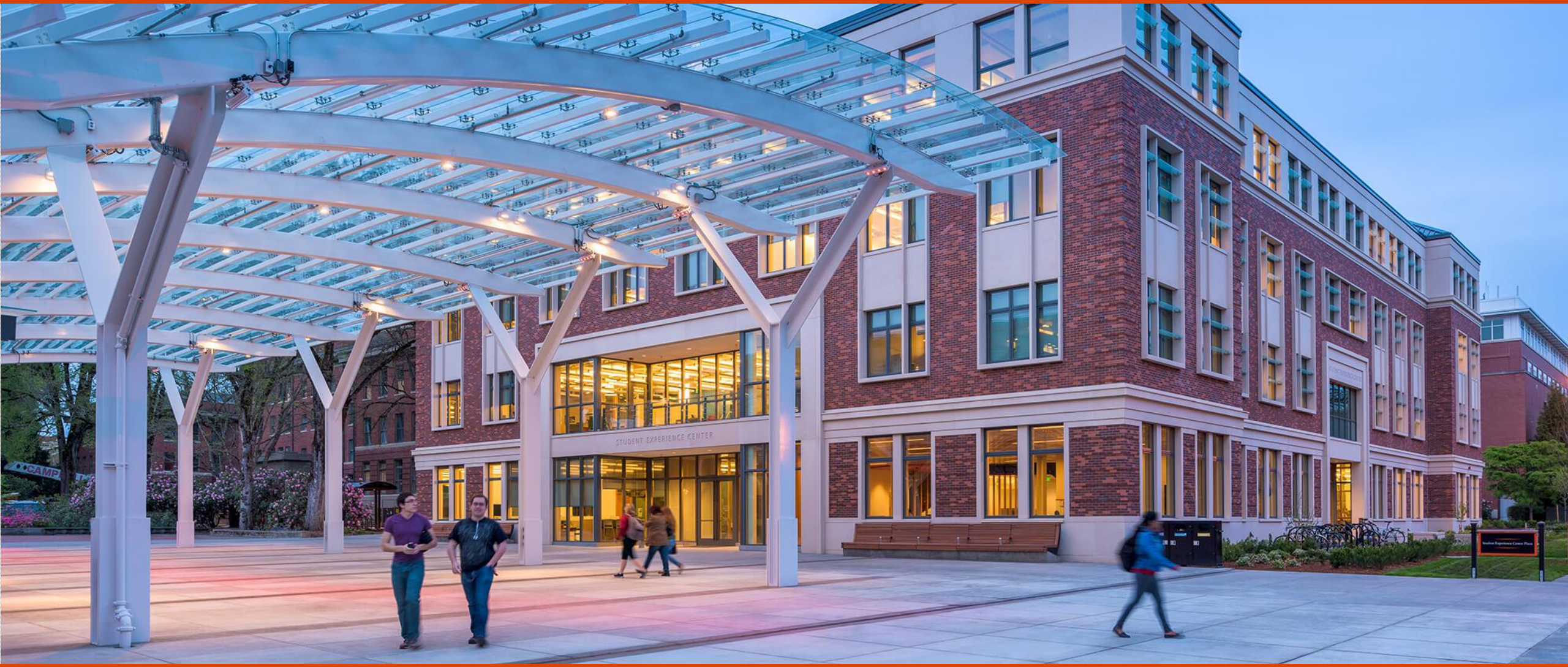

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