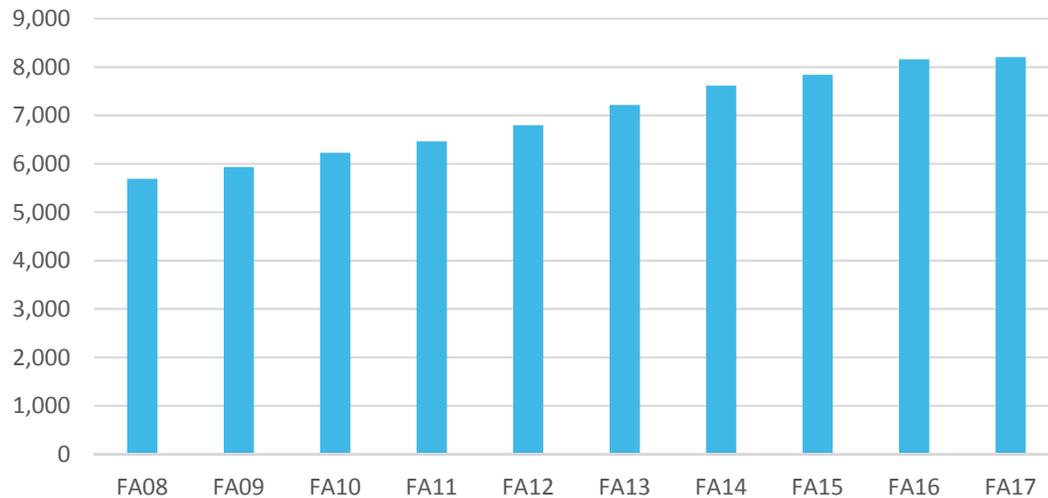


GROWTH PROJECTIONS

3

COE UNDERGRADUATE POPULATION 2008-2018



NEED

HISTORIC GROWTH

Since 2008, the College of Engineering's (COE) undergraduate population has increased by 43%, and the graduate population increased by 7%. During this period, the tenure track faculty have grown by 10%, with more growth this year, bringing the faculty growth to 20%. The COE has not added any space to their inventory during this period of rapid growth.

PROJECTED NEED

In the next ten years, the College of Engineering foresees 26% anticipated growth in FTE population, with an increased degree production of 700 undergraduate and 1,500 graduate degrees. The COE is also welcoming a new policy of direct freshman admissions, which implies not only an emphasis on a freshman and sophomore College of Engineering experience, but also commensurate increases in tenure track faculty, administrators and space.

Since 2008, the College of Engineering's undergraduate population has increased by 43%, and the graduate population increased by 7%.

* Source: iTwo Official Student Enrollment; includes AE, AEROSP, AGBE, BME, BIO-E, CEE, CH-E, CSE, ESC&M, ENGR & AE PRE-MAJOR, I &ME, ME, NUC-E

REBALANCING GROWTH

This projected growth is a result of the College of Engineering's desire to rebalance the faculty to undergraduate student ratio, and the graduate student to faculty ratio, to be commensurate with its peers. The College is aiming for an 8:1 ratio of faculty to graduate students overall, and a 6:1 grad to faculty ratio in labs. Rebalancing these ratios will enhance the ranking of the Institution, which is a key goal of the COE.

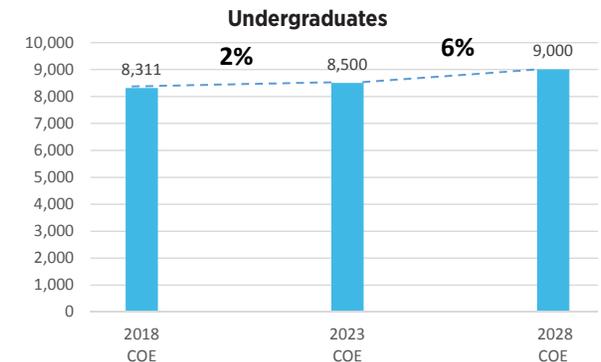
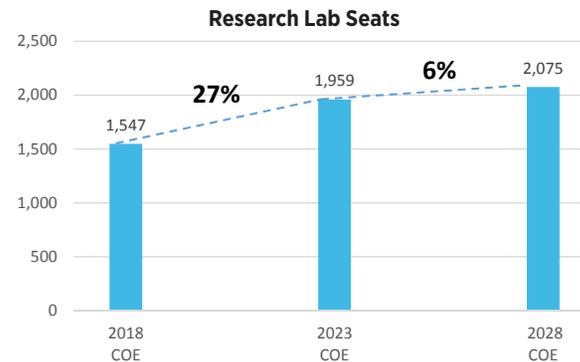
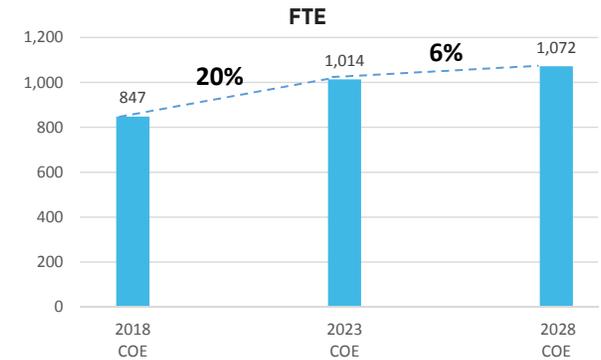
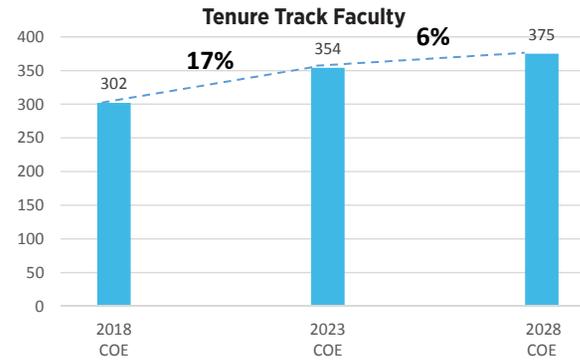
COE Projections: 2018-2028*

	2018 COE	2023 COE	2028 COE
TTF Faculty	302	354	375
All Faculty	410	497	520
FTE	847	1,014	1,072
Graduate Students (MX + PhD)	1,547	2,903	3,075
Lab Seats	1,547	1,959	2,075
Undergraduate Students	8,311	8,500	9,000

This growth in the headcounts, both historic and projected, creates a demand for growth in physical space to support the goals of the College.

Currently the COE occupies approximately 715,000 assignable square feet in more than 31 buildings across and off the University Park campus. Apart from a new building opening in January 2019 that will house the departments of Chemical Engineering and Biomedical Engineering, the most recent engineering-only building was completed in 2000, and the most recent shared building was completed in 2004.

10 YEAR GROWTH PROJECTIONS



*Source: College of Engineering

APPROACH

The programmatic goal of this study was to determine the amount and type of space that the College of Engineering should occupy to meet specific growth targets. The outlook captures the need for space projected for the next 10 years.

The Executive Committee used the following process to establish consensus data for current and future COE space:

- Understand current COE population and space allocations (2018)
- Determine projected headcounts for the COE for 2023 and 2028
- Determine mutually agreed upon metrics for space allocations
- Determine current space deficiencies by applying these metrics to current headcounts to calculate “right-sized” space allocations
- Determine future growth space needs based on the projected headcounts and metrics
- Establish a master plan for new space based on the projected space needs

Once future space needs were determined, a ten-year master plan was developed in two five-year phases outlining how the COE and Penn State can meet the space demand on both the Engineering Core Campus and the West Campus. This plan is outlined in Chapter 5 of this report.

Needs beyond the ten-year horizon can be extrapolated based on a percentage growth rate but are not tied to specific faculty count or other targets.

DEFINITION OF TERMS:

ASF: Assignable Square Feet—Usable space assigned for departmental use

GSF: Gross Square Feet—Total area of structures including walls and mechanical space

ASF/GSF RATIO: Percentage of space within a building that is assignable—for this study, a ratio of 57% is assumed for new engineering buildings, exceptions are noted where they occur

TTF: Tenured or Tenure Track Faculty

“RIGHT-SIZED” SPACE: Idealized space allocation based on current headcounts and accepted metrics

PROJECTED GROWTH SPACE: Idealized space allocations based on projected headcounts

CONSOLIDATION: Spaces identified by the COE as important to move back to the Engineering Core and the West Campus

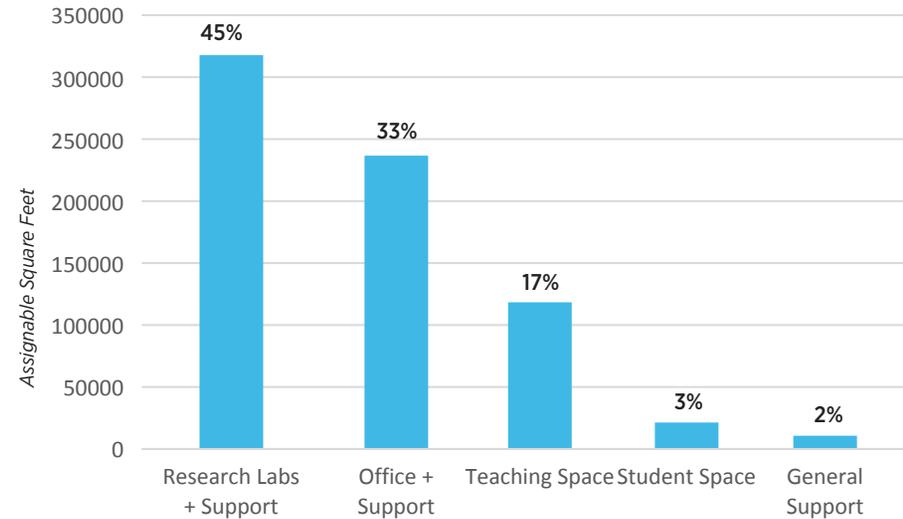
METHODOLOGY

To determine the amount of space (ASF) required to support growth in the faculty, staff and student headcounts, program space was divided into categories by space type, and a unique metric was determined for each space type in collaboration with OPP and the COE. Space type allocation metrics were determined by the following methods:

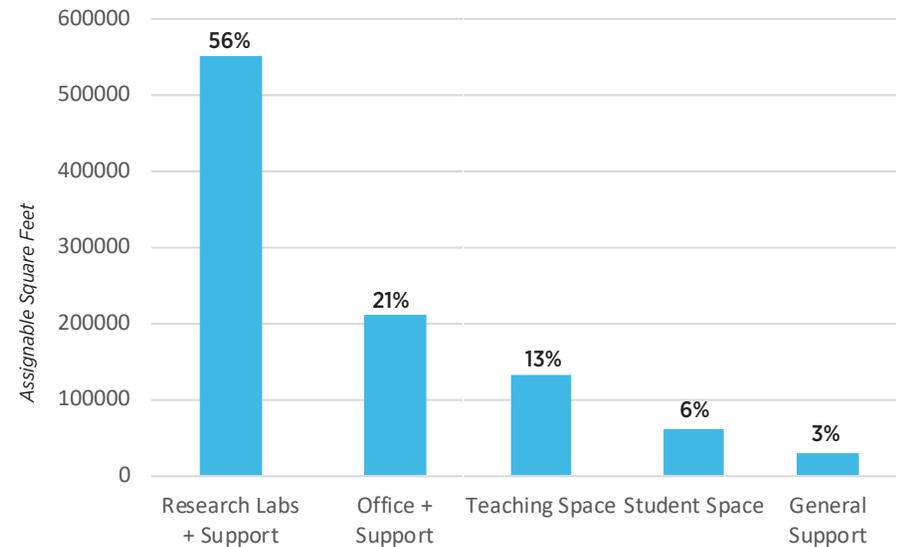
- Mutually agreed upon metrics were applied by space type per head count
- Growth targets, vetted by COE and OPP, were applied to the existing allocation when a head count metric was not applicable
- Allocations for special spaces, such as the Learning Factory and the Office of Digital Learning, were determined by conversations with group representatives
- Metrics to determine allocations for building support space, strategic vacancy, and strategic research cores were mutually agreed upon by Payette, COE and OPP

This method developed a means to calculate targeted space allocations and allowed the development of “right-sized” space allocations and growth space allocations for the COE.

SPACE TYPOLOGY OF EXISTING COE SPACE (2018 ASF)



SPACE TYPOLOGY OF PROJECTED COE SPACE (2028 ASF)



BENCHMARKING AND METRICS

Benchmark data from research institutions similar to Penn State per the Carnegie Classification was used to determine metrics for the study.

These metrics included: allocations of ASF space per faculty, sizes of individual space types such as research labs, teaching labs, classrooms, office support spaces, and graduate student workstations. Penn State space standards were used to inform individual office allocations per the current Penn State standard.

Detailed discussion of the development of these metrics follows later in this chapter. The table “Metrics and Assumptions” lists the ASF metrics used in this study to calculate targeted space allocations for the program.

METRICS + ASSUMPTIONS: *			
Classrooms	30	asf / seat	asf/student = exist. avg. 20 asf/student = exist. avg.
Computer Classrooms	30	asf / seat	
Studio	10%	growth assumption	
Teaching Labs	10%	growth assumption	
Library		no change	
Student Space	4	asf / undergrad (avg. in ME space)	
Research Labs		varies by type (see below)	
Research Group Size		(PhD + 1/3 Masters)/(TTF)	
<i>Wet Bench</i>	170	asf/ grad student (Wet Bench)	(6 student typ. 1,020 asf)
<i>Computational</i>	60	asf/ grad student (Computational)	(6 student typ. 360 asf)
<i>Small Equipment</i>	170	asf/ grad student (Small Equipment)	(6 student typ. 1,020 asf)
<i>Large Equipment</i>	10%	growth assumption	
<i>Large Equipment Write-Up Space</i>	40	asf / grad student	
<i>Experimental Write-Up Space</i>	~	Included in allocations for experimental labs	
<i>Research Faculty Lab (non-TT)</i>	60	asf/ grad student	(6 student typ. 360 asf)
Offices			
<i>Department Head</i>	350	asf / dept chair	1 per dept
<i>Faculty w/ Endowed Chairs</i>	220	asf / faculty	6% of faculty
<i>Faculty Office (TTF, Research, Teaching)</i>	150	asf / faculty	
<i>P/T Faculty Office</i>	75	asf / faculty	
<i>Post Doc Office</i>	120	asf / post-doc	
<i>Tech Staff</i>	60	asf / staff	
<i>Administrative Staff</i>	120	asf / staff	
<i>Administrative Director</i>	175	asf / staff	
<i>Administrative Manager</i>	150	asf / staff	
<i>Department Reception</i>	0	asf	
<i>Kitchenette, Work Room, Storage, Reception</i>	20	asf / faculty & staff	
<i>Conference</i>	30	asf / faculty & staff	
Cores	~	varies	
Shop	0	no change	
General Use	0	no change	

*This item was revised in the detailed programming phase undertaken subsequent to the master planning process. For more detail please reference the April 2019, Phase 1 Programming Report.

CURRENT AND PROJECTED SPACE NEEDS

An overview of COE space by department is included in the "COE Right-Sizing and Growth Projections" table showing right-sized 2018 values and projected values for 2023 and 2028. These values were produced by applying the accepted metrics and assumptions to the head counts provided by the COE.

In 2018 the space occupied by the COE was 714,781 ASF. The right-sized space, using the agreed metrics, yields a need for 808,575 ASF of idealized space based on the current headcounts indicating that the COE currently does not have sufficient space and should grow by approximately 95,000 ASF. In 2023 that idealized need increases to 919,754 ASF based on the projected growth in headcounts. In 2028, the projected need will be 958,717 ASF.

The spaces planned for the new CBEB Building (anticipated in 2019) are included in the Right-sized 2018 figure. For the purpose of this study, it is assumed that the CBEB Building provides the needed growth through 2028 for the Chemical Engineering and Bioengineering Departments.

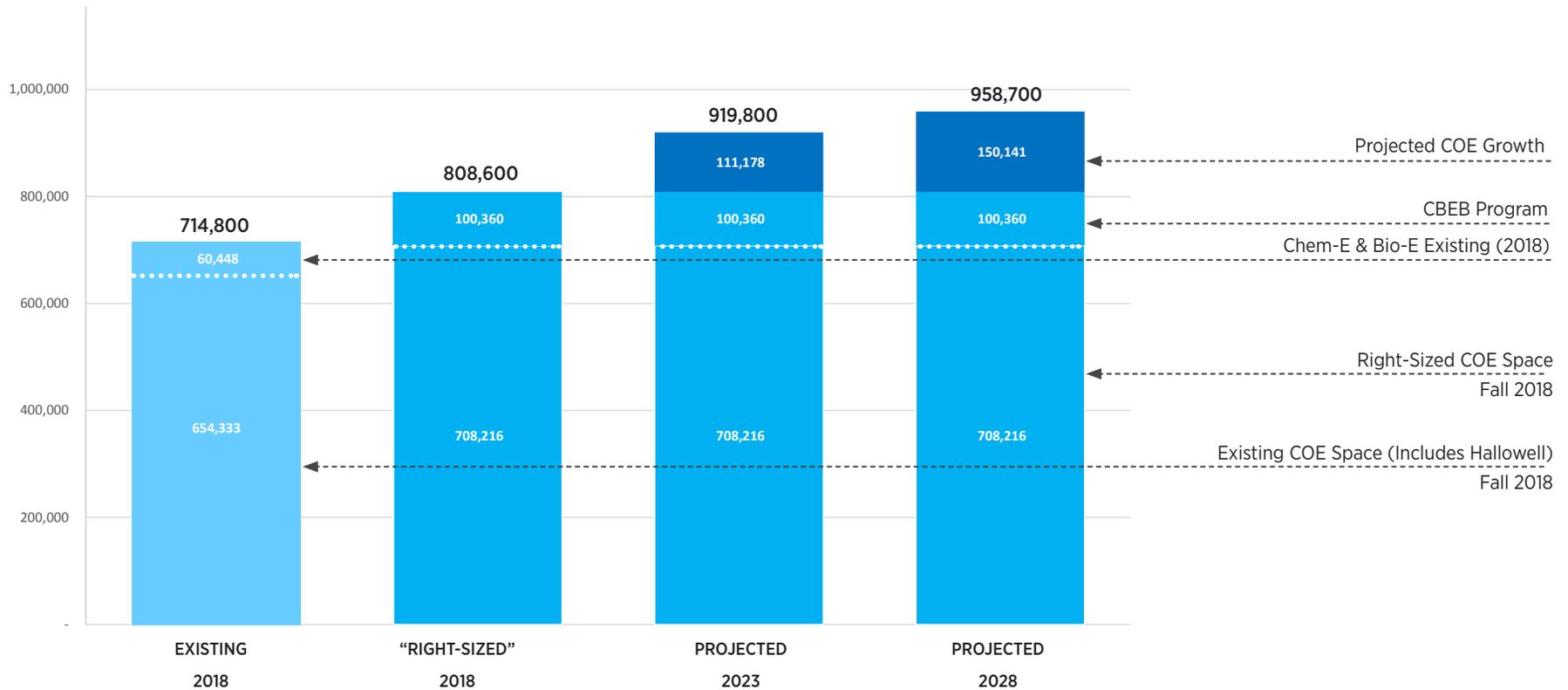
Space allocations for Agricultural and Biological Engineering are excluded from this study per COE request.

Following COE recommendations, growth and right-sizing were not considered for the FEI, the RSEC, and LTI. The COE recommendation was based on the assumption that these areas are not projected to have substantial growth in the next 10 years and they are self-contained enterprises.

COE "RIGHT-SIZING" AND GROWTH PROJECTIONS 2018-2028 TABLE

	2018 ASF	"Right- Sized" 2018 ASF	2023 ASF	2028 ASF	TOTAL Δ	Notes
Acoustics	4,400	8,898	8,918	10,485	6,085	Growth includes 4,498 ASF in ASB
Aerospace Engineering	43,199	47,492	57,454	61,211	18,012	
Architectural Engineering	44,555	51,515	57,214	60,198	15,643	
Civil & Environmental Engineering	86,596	75,442	82,604	85,093	-1,503	
Electrical Engineering / Computer Science	111,863	110,733	119,949	125,168	13,305	
Engineering Science & Mechanics	55,303	47,546	65,890	66,446	11,143	
Industrial & Manufacturing Engineering	41,628	45,698	40,694	43,467	1,839	
Mechanical Engineering	102,193	110,705	129,499	137,391	35,198	
Nuclear Engineering	9,520	10,618	22,990	24,670	15,150	
SEDAPP	24,837	41,093	42,891	49,502	24,665	
	524,094	549,739	628,102	663,630	139,536	
Building Support	0	12,800	15,200	15,600	15,600	2% total ASF
Strategic Vacancy	0	12,606	15,221	15,856	15,856	5% total research
New Strategic Research Cores	0	0	2,354	2,354	2,354	5% research cores
Strategic Space	0	25,406	32,775	33,810	33,810	
Administration	35,532	30,807	34,267	36,667	1,135	20 new offices;
Student Organizations	0	0	4,000	4,000	4,000	.5 asf/undergraduate
Student Commons Space	[10,315]	[35,000]	[~34,000]	[~36,000]	[~26,000]	In depts.
Learning Factory	7,257	14,514	30,000	30,000	22,743	
Engineering Shops	7,691	7,691	7,691	7,691	0	
Office of Digital Learning	1,534	1,834	4,334	4,334	2,800	2 Dist. Lrning (50 seat) + Rec. Studio
	52,014	54,846	80,292	82,692	30,678	
Other COE Departments						
Biomedical Engineering	17,162	42,740	42,740	42,740	25,578	CBEB Program
Chemical Engineering	43,286	57,620	57,620	57,620	14,334	CBEB Program
Facilities Engineering Institute	6,390	6,390	6,390	6,390	0	
Radiation Science & Engineering Center	25,889	25,889	25,889	25,889	0	(1 new faculty)
Larson Transportation Institute	45,946	45,946	45,946	45,946	0	(1 new faculty)
Other COE ASF	138,673	178,585	178,585	178,585	39,912	
TOTAL COE ASF:	714,781	808,575	919,754	958,717	243,936	

COE RIGHT-SIZING AND GROWTH PROJECTIONS TABLE



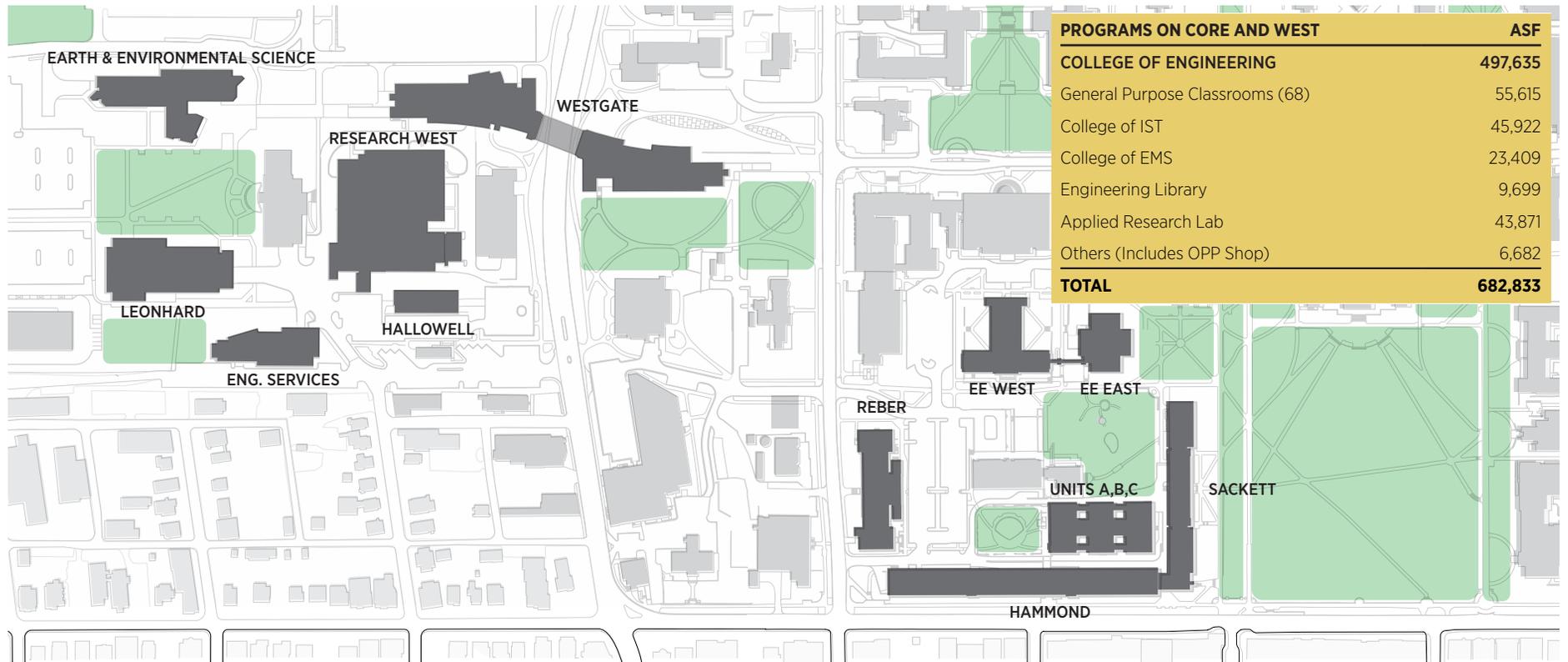
COMMENTS

The right-sized 2018 allocation indicates that the existing space occupied by the COE is approximately 95,000 ASF smaller than an idealized allocation for the same number and type of occupants.

The program model suggests that in 2023, the anticipated growth of the COE would create a need for an additional 205,000 ASF.

These projections suggest a total idealized need for the COE in 2028 of approximately 960,000 ASF based on the projected growth provided by the COE; yielding a need to add about 250,000 ASF to the COE space inventory.

COE OCCUPIED BUILDINGS ON THE ENGINEERING CORE CAMPUS AND THE WEST CAMPUS



GROWTH ON THE CORE AND WEST CAMPUS

The focus of this study was to understand the need for growth for the College of Engineering in the context of the 14 COE occupied buildings on the Engineering Core and the West Campus. These buildings comprise 682,833 ASF; 497,635 ASF of which is assigned to the COE (all other space is assigned to other occupants).

The non-COE occupants of the 14 engineering occupied buildings on Core and West campus are:

- General Purpose Classrooms (68)
- College of IST
- College of EMS
- Engineering Library
- Applied Research Lab
- OPP Shop
- Others

Guidance was provided by OPP as to whether growth should be considered for each of these occupants for the purposes of this study. OPP advised that growth should be considered only for the College of Engineering and the general purpose classrooms.

It was determined that the OPP Shop, currently located in Engineering Unit B, will find a home in the steam plant expansion currently under construction, and would not need replacement or growth space as part of this plan.

CONSOLIDATION REQUESTS

A key area of concern for the COE was to consolidate some of the geographically isolated departmental spaces. The COE outlined approximately ~66,000 ASF of departmental space that is desired to be returned to the Engineering Core and West Campus and brought “home” to the various departments.

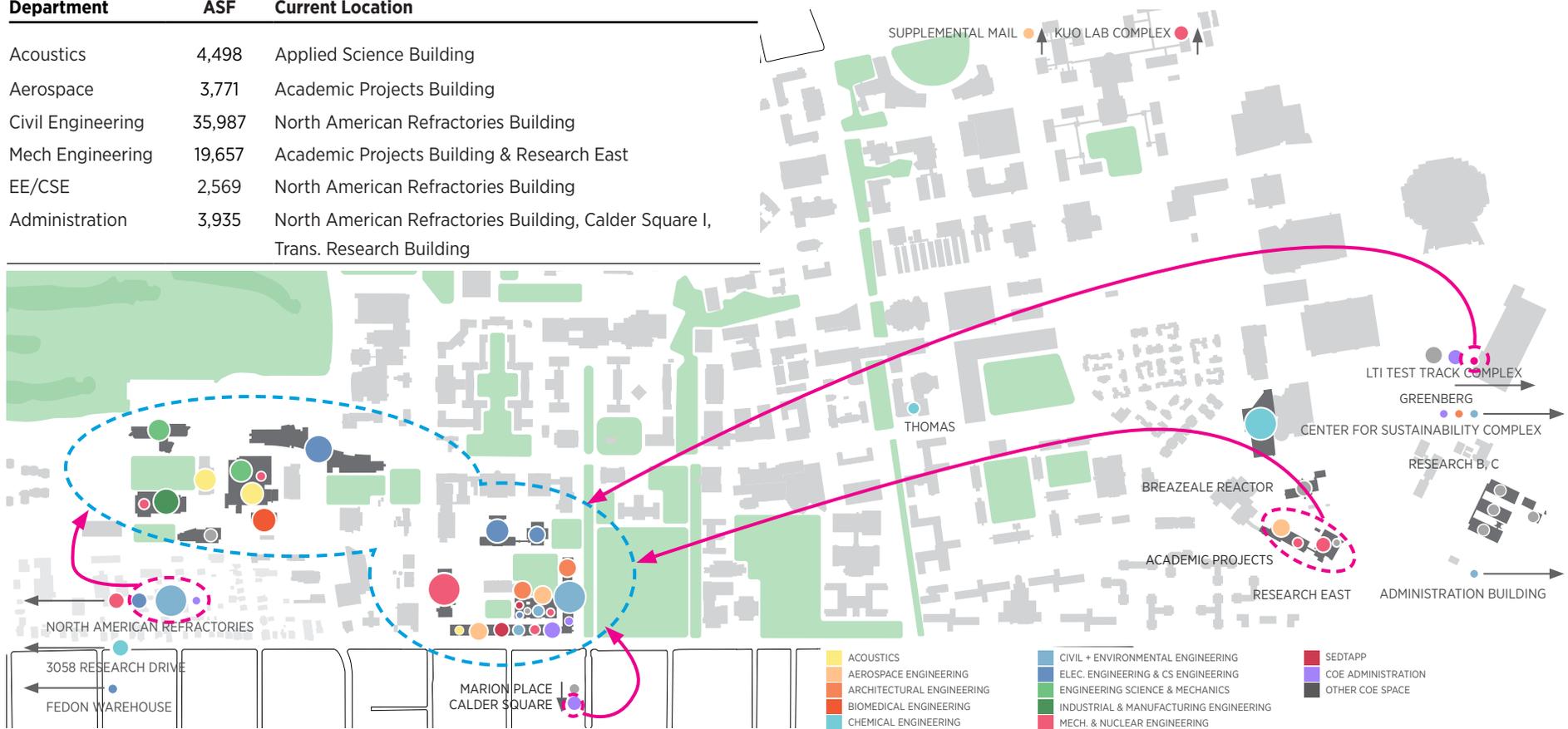
Most of the consolidation consists of requests to consolidate research spaces that has been built outside of the Core and West Campus because of space constraints. Departments would like to bring this space, and the associated researchers back “home” to their departments. Some specialized spaces: the nuclear reactor, the aero flight facility, labs associated with the Test Track, are not requested to consolidate back to the Engineering Core Campus and West Campus.

The largest single consolidation request is the request to consolidate Civil Engineering space from the North American Refractories Building.

** See Next Page for more Information Regarding Consolidation Requests*

COE CONSOLIDATION REQUESTS

Department	ASF	Current Location
Acoustics	4,498	Applied Science Building
Aerospace	3,771	Academic Projects Building
Civil Engineering	35,987	North American Refractories Building
Mech Engineering	19,657	Academic Projects Building & Research East
EE/CSE	2,569	North American Refractories Building
Administration	3,935	North American Refractories Building, Calder Square I, Trans. Research Building



All other occupants were determined to be held in a steady state with no growth for the purposes of this Master Plan including (IST, EMS, Engineering Library, and ARL).

The growth in the general purpose classrooms was advised to reflect a right-sizing from 20 ASF per seat to 30 ASF per seat for 50% of the 68 general purpose classrooms to accommodate the integration of active learning pedagogy.

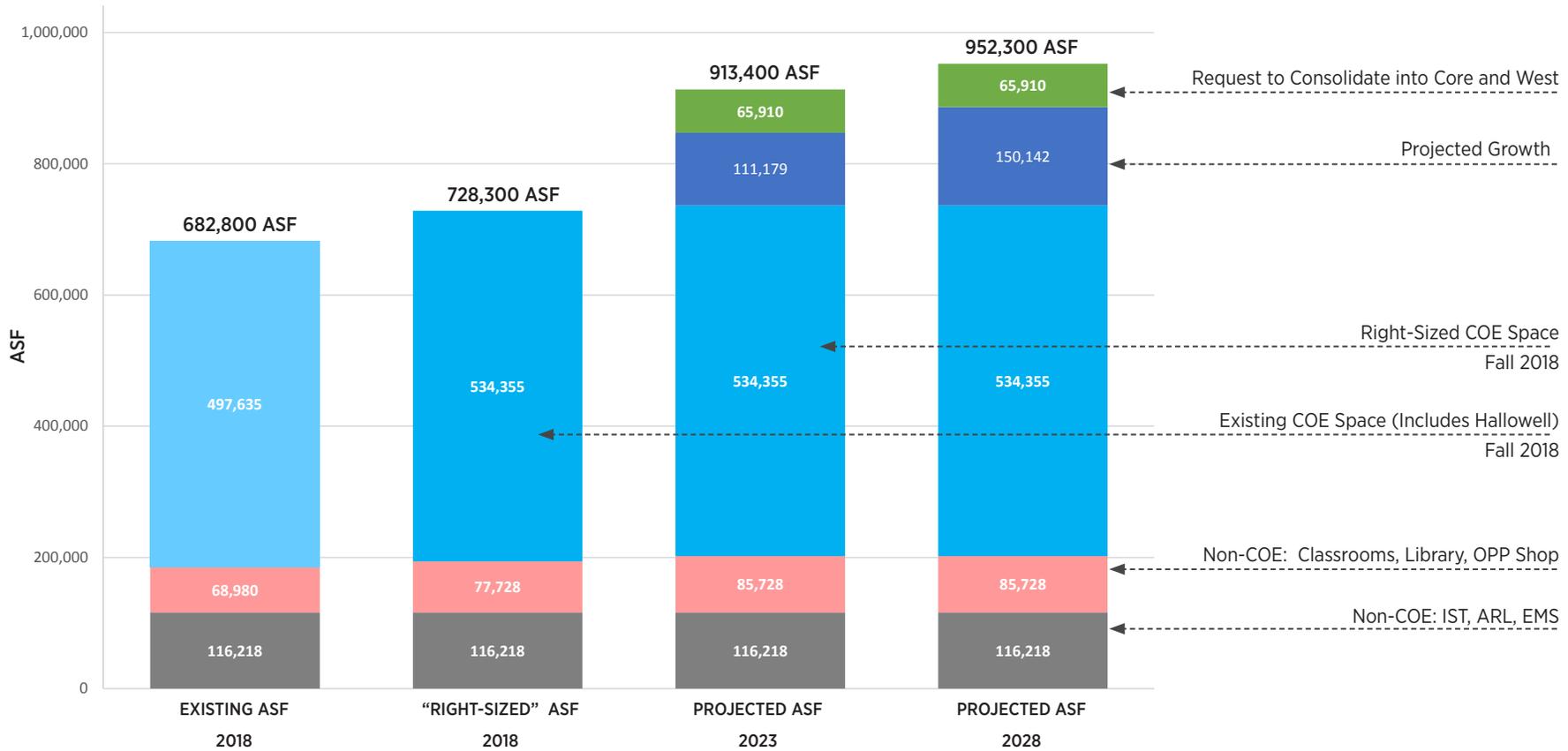
RIGHT-SIZING AND ASF GROWTH ON THE ENGINEERING CORE CAMPUS AND THE WEST CAMPUS

Department	2018	2018	2018	2018	"Right-Sized" 2018	"Right-Sized" 2018	Remain	2023-	2023	Request to	2028 -	2028	Remain
	ASF	West	Core	Other	Δ	West + Core + Δ	Outside West/Core	2018 Δ	West + Core + Δ	Consolidate	2023 Δ	West + Core + Δ + Consolidation	Outside West/Core
Acoustics	4,400	4,400	0	0	4,498	8,898	0	4,518	8,918	0	1,567	10,485	0
Aerospace Engineering	43,199	734	33,957	8,508	4,293	38,984	4,737	14,255	48,946	3,771	3,756	56,474	4,737
Architectural Engineering	44,555	0	43,246	1,309	6,960	50,206	1,309	12,659	55,905	0	2,984	58,889	1,309
Civil & Environmental Engineering	86,596	0	49,221	37,375	-11,155	38,067	1,397	-3,992	45,229	35,978	2,489	83,696	1,397
Electrical Engineering / Computer Science	111,863	35,292	69,528	7,043	-1,131	103,690	4,474	8,086	112,906	2,569	5,220	120,694	4,474
Engineering Science & Mechanics	55,303	55,303	0	0	-7,757	47,546	0	10,587	65,890	0	556	66,446	0
Industrial & Manufacturing Engineering	41,628	41,628	0	0	4,070	45,698	0	-935	40,694	0	2,774	43,467	0
Mechanical Engineering	102,193	12,044	55,962	34,187	8,512	76,518	14,530	27,306	95,312	19,657	7,892	122,861	14,530
Nuclear Engineering	9,520	7,843	0	1,677	1,098	8,941	1,677	13,470	21,313	0	1,679	22,993	1,677
SEDTAPP	24,837	0	23,236	1,601	16,256	39,492	1,601	18,054	41,290	0	6,612	47,901	1,601
	524,094	157,244	275,150	91,700	25,645	458,039	29,725	104,008	536,402	61,975	35,528	633,905	29,725
		432,394											
Building Support	0	0	0	0	12,800	12,800	0	15,200	15,200	0	400	15,600	0
Strategic Vacancy	0	0	0	0	12,606	12,606	0	15,221	15,221	0	635	15,856	0
New Strategic Research Cores	0	0	0	0	0	0	0	2,354	2,354	0	0	2,354	0
Strategic Space	0	0	0	0	25,406	25,406	0	32,775	32,775	0	1,035	33,810	0
Administration	35,532	0	31,597	3,935	-4,725	26,872	3,935	-1,265	30,332	3,935	2,400	36,667	0
Student Organizations	0	0	0	0	0	0	0	4,000	4,000	0	0	4,000	0
Student Commons Space	[10,315]	0	0	0	[25,315]	[25,315]	0	0	0	0	[-2,000]	0	0
Learning Factory	7,257	7,257	0	0	7,257	14,514	0	22,743	30,000	0	0	30,000	0
Engineering Shops	7,691	7,691	0	0	0	7,691	0	0	7,691	0	0	7,691	0
Office of Digital Learning	1,534	0	1,534	0	300	1,834	0	2,800	4,334	0	0	4,334	0
	52,014	14,948	33,131	3,935	2,832	50,911	3,935	28,278	76,357	3,935	2,400	82,692	0
		48,079											
Biomedical Engineering	17,162	17,162	0	0	0	0	0	-17,162	0	0	0	0	42,740
Chemical Engineering	43,286	0	0	43,286	0	0	43,286	0	0	0	0	0	57,620
Facilities Engineering Institute	6,390	0	0	6,390	0	0	6,390	0	0	0	0	0	6,390
Radiation Science & Engineering Center	25,889	0	0	25,889	0	0	25,889	0	0	0	0	0	25,889
Larson Transportation Institute	45,946	0	0	45,946	0	0	45,946	0	0	0	0	0	45,946
Other COE ASF	138,673	17,162	0	121,511	0	0	121,511	-17,162	0	0	0	0	178,585
		17,162											
TOTAL COE ASF:	714,781	497,635		217,146	53,882	534,355	155,171	147,899	645,534	65,910	38,963	750,407	208,310
GPC Classroom Replacement (68)	55,615	21,098	34,517	0	12,414	68,029	0	12,414	68,029	0	0	68,029	0
GPC New Lecture	0	0	0	0	0	0	0	8,000	8,000	0	0	8,000	0
Engineering Library	9,699	0	9,699	0	0	9,699	0	0	9,699	0	0	9,699	0
OPP Shop	0	0	3,666	0	-3,666	0	0	-3,666	0	0	0	0	0
Related Spaces	65,314	21,098	47,882	0	8,748	77,728	0	16,748	85,728	0	0	85,728	0
		68,980											
Other Departments in COE Shared													
Buildings:*	116,218	116,218	0	0	0	116,218	0	0	116,218	0	0	116,218	0

*Includes: Earth + Mineral Sciences, College of IST, ARL (in R. West)

West + Core	Other	2018 West + Core + Δ	Remain Outside West/Core	2023 West + Core + Δ	Request to Consolidate	2028 - 2023 Δ	"Combined" Need in West/Core	Remain Outside West/Core
682,833	0	217,146	155,171	728,301	65,910	847,480	952,353	208,310

PROJECTED SPACE NEED ON THE ENGINEERING CORE CAMPUS AND THE WEST CAMPUS



COMMENTS

To meet the 2028 space needs for the COE growth, requested consolidation, and growth in general purpose classrooms, about 270,000 ASF needs to be added to the inventory of space on the Core and West Campus.

Using a grossing factor of 57% (the agreed upon benchmark for typical engineering buildings), we find a need for 472,000 GSF of new building space while retaining the current inventory of existing buildings to meet the 2028 need.

This new space would accommodate the requested head count growth for the COE, the requested consolidation of space from the isolated areas of campus and the increase in ASF for the general purpose classrooms to accommodate project-based learning.

The next chapters outline how this growth can be accommodated on the Engineering Core and West Campus.

PROGRAM TYPES

The following section gives a detailed breakdown of the metrics used to develop the space projections—both right-sizing and idealized growth for this study, as well as the sources of these metrics and assumptions. Each metric was discussed and developed in detail through conversations with the Penn State College of Engineering and the Penn State Office of Physical Plant.

Space types are divided into the following categories:

- Research
- Core Labs
- Teaching
- Office & Administration
- Student and Library
- Non-COE Space

RESEARCH METHODOLOGY

In order to determine an approximate research lab space need, four general lab types were identified, each with a specific space metric (ASF/lab-based student): computational, wet bench, small equipment, and large equipment.

The metric assigned to each of the types was then applied to average headcounts per department. Write-up/collaboration space is included within the allocations of space for computational, wet, and small equipment bench labs. For large equipment labs, the write-up allocation was calculated separately.

The COE provided the quantities of each type of lab currently and projected estimates of the future needs, as associated with the research programs of the tenure track faculty and research faculty members.

The future lab totals are therefore based on the quantities of lab types as aligned with the faculty growth model.



Computational Lab



Wet Bench Lab



Large Equipment Lab



Small Equipment Lab



Research Lab	Metric (ASF/ Lab Student)	Notes
Computational	60	Benchmarked metric (same as CBEB)
Wet Bench	170	Includes write-up space, based on Payette benchmarking
Small Equipment	170	Includes write-up space, based on Payette benchmarking
Large Equipment	10% increase from existing	COE recommendation, write-up outside of R-lab
Research Faculty Labs	60	COE recommendation, write-up outside of R-lab
Write-up (Large Equipment)	40	Desk space for students

DEFINITION OF TERMS

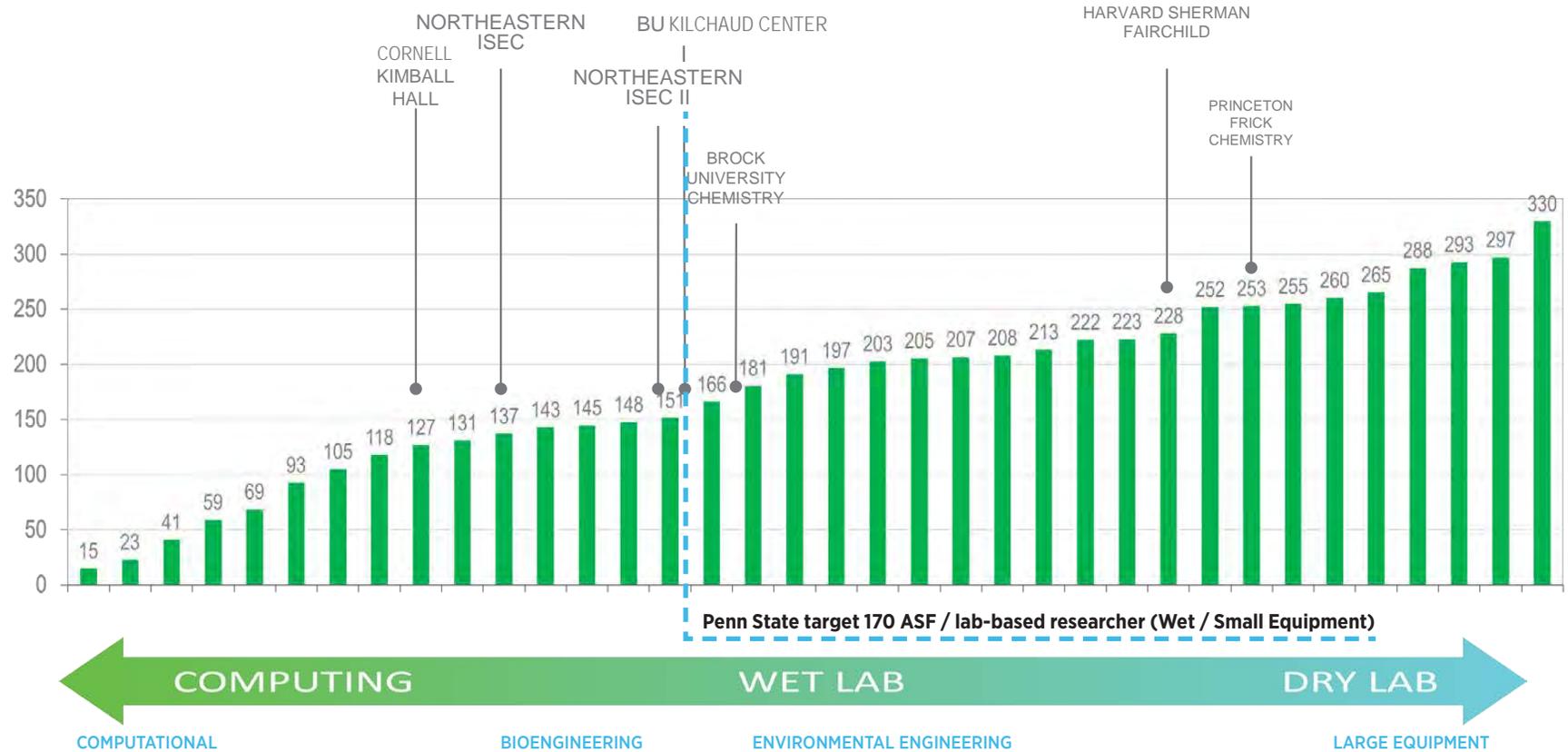
Computational Labs: Office type environments with support rooms for computer work and equipment.

Wet Bench Labs: Traditional wet bench arrangements with support rooms for specialized equipment and write-up space.

Small Equipment / Electronics Labs: Electronics bench arrangements or instrumentation focused spaces that use roughly the same area per researcher as wet labs.

Large Equipment Labs: House equipment or apparatus set-ups that occupy a central open area of the lab and often require generous ceiling clearance.

BENCHMARKING: RESEARCH ALLOCATIONS



For computational labs, a standard metric of 60 ASF/ lab based student was used, which is the same metric as Penn State used in the CBEB Building.

Payette provided guidance on typical research allocations from a range of institutions, and guided COE to use 170 ASF/ lab-based researcher as the metric for the wet bench and small equipment laboratories. This metric will create adequate research space for both types of research, while also allowing for flexibility between the two types of research labs.

For large equipment and core labs, the lab size is determined by the kind of equipment the lab needs to hold, so in those cases, the COE advised that some amount of growth was needed, therefore, 10% growth was assumed for the large equipment labs.

FACULTY HEAD COUNT BY RESEARCH TYPE*

Department Name		TTF	Research Faculty	Computational	Wet Bench	Small Equipment	Large Equipment
Acoustics	2018	4	1	0	1	2	1
	2023	4	1	0	2	1	1
	2028	6	1	0	3	2	1
Aerospace Engineering	2018	20	5	10	1	2	7
	2023	24	7	12	1	3	8
	2028	26	7	12	1	5	8
Architectural Engineering	2018	17	0	10	0	1	6
	2023	21	2	11	0	3	7
	2028	22	2	11	0	4	7
Civil & Environmental Engineering	2018	29	1	20	4	1	4
	2023	30	4	19	6	1	4
	2028	31	4	20	6	1	4
EE_CSE	2018	65	5	39	4	17	5
	2023	72	5	41	9	17	5
	2028	80	5	45	6	24	5
Engineering Science & Mechanics	2018	32	3	9	11	6	6
	2023	33	4	9	11	7	6
	2028	33	4	9	11	7	6
Industrial & Manufacturing Engineering	2018	25	1	17	0	8	0
	2023	27	1	17	0	5	5
	2028	27	1	17	0	5	5
Mechanical Engineering	2018	52	10	7	15	15	15
	2023	58	13	9	16	17	16
	2028	62	13	9	20	17	16
Nuclear Engineering	2018	8	0	3	0	2	3
	2023	15	4	5	1	6	3
	2028	16	4	5	1	7	3
SEDTAPP	2018	10	0	6	0	3	1
	2023	12	1	6	0	6	0
	2028	14	1	6	0	8	0

* Source: Existing and 2023 values: College of Engineering; 2028 values extrapolated by Payette based on overall values for 2028

For each department, the COE provided a breakdown of the Tenure Track Faculty into the research categories provided by Payette. The COE provided the headcounts by research type for existing faculty, as well as projections for future faculty in 2023. Using the overall head count values for 2028, Payette extrapolated the proportion of TTF that would be in each research category.

These assumptions were understood to be rough order of magnitude distributions to allow the calculation of projected and right-sized space. The COE departments did not verify these head count allocations; further study is needed in a detailed programming process to parse the space needed at a finer grain.

CORE LABS

For the core labs, Payette toured many of the existing core labs with associated department faculty and representatives from COE, and created allocations based on COE identified need.

These allocations were used to understand overall magnitude of need, and were vetted through a detailed programming process as if the spaces were to be designed in a new facility. For the purposes of the Master Plan, these values were deemed sufficient to understand big picture space needs.



Specialty Shared Facility

Large Central Equipment / Testing

Large / Heavy Machinery

High Clearance

Core Labs	Department	Existing ASF	Proposed ASF	Notes
CAV (Anechoic Chambers, Struct. Acoustics)	Aero / Acoustics	2,649	5,000	High Fl. to Fl.
Indoor Flight Facility	Aero	1,663	4,000	High Bay
Flight Simulator	Aero	541	1,500	
Wind Tunnel (Research)	Aero	3,862	5,000	High Bay
Greenhouse	A/E	1,309	1,309	
Structures Lab (Façade Testing)	A/E	3,462	6,000	High Bay
IAC / Energy Lab	A/E	3,332	5,000	
Structures Lab (Cato)	Civil	9,000	6,000	High Fl. to Fl.
Structures Lab (Beams/Concrete Printing)	Civil	2,862	4,000	High Fl. to Fl.
Wave Tank (50')	Civil	1,547	3,000	
Clean Room	EE	5,243	5,243	
Nano Facility	ESM	1,835	1,835	
UAV (Rovers and Drones)	MNE	1,378	3,000	High Bay
Fluid Mechanics	MNE	1,423	1,500	

TEACHING



Teaching Space Types	Metric	Notes
General Purpose Classrooms	30 ASF / seat	support project based learning (for 50% of rooms)
COE Dept. Classrooms	30 ASF / seat	support project based learning
COE Computer Labs	30 ASF / seat	support project based learning
COE Studios	10% increase from current	per COE request
COE Teaching Labs	10% increase from current	per COE request
Distance Learning Classrooms	(2) 50 seat @ 1250 ASF	per ODL request

The COE currently has significant teaching space that is outside of the general purpose classrooms. These teaching spaces include departmental classrooms, computer labs and classrooms, studio space, and teaching labs.

In general, the departmental classrooms provide specialized space for project based learning. An allocation of 30 ASF/ student was determined to be an appropriate general metric to support project-based learning in these rooms.

DEFINITION OF TERMS

Departmental Classrooms: Classrooms controlled by departments—often used for specialized instruction, project-based learning or to support lab-based learning

Computer Labs: Classrooms for computer-based instruction or open labs to support access to software for students

Studios: Specialized teaching space to support design-based curriculum

Teaching Labs: Specialized instructional space for teaching lab-based courses, individual rooms have unique requirements

The COE advised that the studio space and the teaching lab spaces should grow by 10% to relieve some of the overcrowding that has resulted from the 40% growth in the undergraduate population. The requested addition of two distance learning classrooms was from the Office of Digital Learning and reflects the fact that many departments would like to increase their distance learning programs both for undergraduate and graduate programs.

OFFICE & ADMINISTRATION



Office & Admin. Space Types	Metric (ASF/person)	Notes
Department Head	350	Penn State Standard - 1 per department
Faculty w/ Endowed Chairs	220	Penn State Standard - 6% dept (per COE)
Faculty Office (TTF, Research, Teaching)	150	Penn State Standard
P/T Faculty Office	75	Penn State Standard - 2 per standard office
Post Doc Office	120	Penn State Standard
Tech Staff	60	Penn State Standard - 2 per PD Office
Admin. Staff	120	Penn State Standard
Admin. Director	175	Penn State Standard
Admin. Manager	150	Penn State Standard
Kitchen, Work Room & Stor., Reception	20	Per COE; based on similar institutions and CBEB
Conference	30	Per COE; based on similar institutions and CBEB

Penn State is in the process of revising allocation for offices spaces on the campus. The University advised Payette to use the current standards for space allocations with the understanding that these may soon change—reducing the need for office space.

A key item to reduce space use at the College of Engineering is to reduce duplication of offices across the campus. Penn State suggested using a office hoteling strategy when faculty offices are needed in a remote location from the faculty member's primary office.

To determine the office support metrics, which are not included in the Penn State metrics for office allocations, Payette provided a series of comparisons with other similar institutions, as well as comparisons to the allocation provided in the CBEB Building (see table above).

BENCHMARKING: OFFICE ALLOCATIONS

	CORNELL		PURDUE			UVM			PSU - CBEB			PSU Standard		
Position Type	Office ASF	Support + Conference ASF	Office ASF	Support ² ASF	Conference ASF	Office ASF	Support ² ASF	Conference ASF	Office ASF	Support ² ASF	Conference ASF	Office ASF	Support ² ASF	Conference ASF
Senior Administrative and Academic Leadership	280	400	300	30	60	280	30	50				400		
Executive Administrative, Senior Director, Director (Large Unit), Department Head	200	40	150-180	30	60	180	30	30	350			350		
Endowed Chair					60				220			220		
Endowed Professor												185		
Director (Small Unit), Associate Chair, Associate and Assistant Director	160	48			60	180	30	30				175		
Faculty	160	48	130	30	60	140	30	15	150			150		
Visiting / Student Professional Societies			7% total above											
Professional (architect, engineer)						140	30	15	120			120		
Professional, Visiting or Part time Faculty, Lecturer, Instructor, Sr. Research Associate, Sr. Extension Association	120	42	120	30		120	30	15	120			120		
Professor Emeritus	80	20				120	30	15	75			75		
Technical	80	20	120	0		120	30	5	120			120		
Research Associate, Extension Associate, Post-Doc	80	12	120	30		60	30	5	120			120		
Secretarial & Clerical	80	12	120	30		100	30	3	120			100		
Teaching Assistant, Research Assistant, Grad Assistant	40	0	40	30		60	0	5	50-90			50-90		
Staff Assistant									100					
Student Worker (office space required)	30	0	0			30	0	0						
Trades, Crafts, Service, Maintenance	20	0				30	0	0						
Combined Support									22		31			

²Support space includes reception space, and office service space (mail, break areas, photocopying, supplies, student desks, etc.). This space is summed across all individuals and roles in the unit to create a total square footage that is then allocated according to functional needs.

Institutions similar to Penn State have a range of conference and support space. Blending the numbers, institutions range from 15-80 combined support and conference space. The recently designed CBEB Building has a metric of 22 ASF/person for office support and 31 ASF/person for conference rooms.

Penn State determined that a similar metric should be used for the Master Plan; 20 ASF/person for Office Support and 30 ASF/person for conference Rooms.

STUDENT

For the study, student space was understood as falling into the following categories:

- Collaboration Space
- Club Space
- Learning Factory

Collaboration Space: Currently the COE has about 20,000 ASF dedicated to student space controlled by COE departments and the COE Administration. With 8,113 undergraduates, this ratio is about 2.5 ASF/student. The COE reports that there is a high demand for student collaboration space, and that the current space allocations are not sufficient to support the students.

The Reber E-Learning Commons was developed by the Mechanical Engineering Department to provide collaboration space for MNE students, and also the greater COE population. The MNE space to student ratio is about 4 ASF/student using the MNE student headcounts.

The COE and Payette agree that increasing the ASF per student across the COE from 2.5 ASF per student to 4 ASF per student would yield an appropriate amount of space per student.

Club Space: Understood to be a part of the collaboration space yield mainly comprising storage and project space for club projects.

Learning Factory: Existing maker space located in the Engineering Services Building that currently comprises about 7,000 ASF. The COE advised that they would like to significantly grow this resource to 30,000 ASF in the next 5-10 years to support students cornerstone and capstone design projects.



Tufts University—Student Commons



Georgetown University—Student Commons



Penn State—Reber Building —E-Learning Commons



Columbia University—Student Commons & Cafe

COE HEADCOUNTS (DETAIL)

The following pages detail the COE headcounts for the faculty, staff, graduate students, and undergraduate students for 2018 and projections for 2023 and 2028.

These headcounts are the foundation for the space need projections included in this chapter. The headcounts were developed by the COE as a rough indication of the administrations ideas for where and which kind of growth they are anticipating in the next ten years. However, it is understood that actual growth may vary from these projections.

2018 EXISTING HEADCOUNTS (COE)

 Estimated Headcounts Fall 2018 (REVISED 7-17-18)	Faculty					Full Time Staff	Tech Service	Graduate Students		Undergraduate Enrollment (Fall 2017 actual)
	Tenured/ Tenure Track	Non-TT Teaching	Non-TT Research	Post-Doc	Part time teaching			Masters	PhD	
Graduate Program in Acoustics	4	1	1			3		19	29	0
Aerospace Engineering	20	1	5			14		62	53	301
Architectural Engineering	16	3			8	8	3	88	26	290
Biomedical Engineering	19	1	1	10		8		7	57	240
Civil & Environmental Engineering (excluding LTI)	29	3	1	8	1	18		52	67	398
Larson Transportation Institute			6			24	16			-
Chemical Engineering	22	2	1	16	1	10		10	101	526
Engineering Science and Mechanics	32	4	3	7		14		22	62	76
School of Electrical Engineering & Computer Science	65	14	5	9	1	35		160	273	1221
Industrial & Manufacturing Engineering	25	3	1	1		11	1	107	82	422
Mechanical Engineering	53	2	10	10		21	1	60	154	933
Nuclear Engineering	8	Included in ME				in ME		17	27	144
SEDTAPP (including Learning Factory)	9	15			11	10		12	0	3760
Administration (including Student Services)						140	8			
Breezeale Reactor	in NE	3				9	2			
Facilities Engineering Institute						31				
TOTALS	302	52	34	61	22	356	31	616	931	8311

2023 PROJECTED HEADCOUNTS (COE)

 PennState College of Engineering Projected Headcounts Fall 2023 (REVISED 7-17-18)	Faculty					Full Time Staff	Tech Service	Graduate Students			Undergraduate Enrollment (with end of first year ETM)
	Tenured/ Tenure Track	Non-TT Teaching	Non-TT Research	Post-Doc	Part time teaching			Masters	PhD	Grad Seats needed	
Graduate Program in Acoustics	5	1	1			4		20	21	28	
Aerospace Engineering	24	2	6			17		96	101	133	399
Architectural Engineering	21	5	1	1	9	11	3	84	88	116	376
Biomedical Engineering	24	1	2	12		12		96	101	133	308
Civil & Environmental Engineering (excluding LTI)	30	3	3	9	1	19		120	126	166	561
Larson Transportation Institute			6			25	16				
Chemical Engineering	28	3	2	18	1	14		112	118	155	747
Engineering Science and Mechanics	33	6	4	10		15		132	139	183	115
School of Electrical Engineering & Computer Science	77	17	6	10	1	40		308	323	426	1,695
Industrial & Manufacturing Engineering	27	4	1	1		12	1	108	113	149	585
Mechanical Engineering	58	4	17	13		22	1	232	244	321	1,367
Nuclear Engineering	15	3	3	4		5		60	63	83	204
SEDTAPP (Freshman UG enrollment)	12	15	1	1	11	13		48	50	66	2,143
Administration (excluding Student Services)	in Depts					108	10				
Student Services	in Depts					52					
Breazeale Reactor	in NE	3				12	2				
Facilities Engineering Institute						35					
TOTALS	354	67	53	79	23	416	33	1,416	1,487	1,959	8,500

2028 PROJECTED HEADCOUNTS (COE)

 PennState College of Engineering Projected Headcounts Fall 2028 (REVISED 7-17-18)	Faculty					Full Time Staff	Tech Service	Graduate Students			Undergraduate Enrollment
	Tenured/ Tenure Track	Non-TT Teaching	Non-TT Research	Post-Doc	Part time teaching			Masters	PhD	Grad Seats needed	
Graduate Program in Acoustics	6	1	1			5		24	25	33	
Aerospace Engineering	26	2	7			18		104	109	144	424
Architectural Engineering	22	5	2	1	9	12	3	88	92	122	399
Biomedical Engineering	28	1	3	14		13		112	118	155	327
Civil & Environmental Engineering (excluding LTI)	31	3	4	9	1	20		124	130	172	596
Larson Transportation Institute			6			26	16				
Chemical Engineering	30	3	4	18	1	15		120	126	166	794
Engineering Science and Mechanics	33	6	4	10		16		132	139	183	122
School of Electrical Engineering & Computer Science	80	16	5	10	1	42		320	336	443	1,801
Industrial & Manufacturing Engineering	27	4	1	1		13	1	108	113	149	621
Mechanical Engineering	62	4	13	11		23	1	248	260	343	1,452
Nuclear Engineering	16	3	4	4		6		64	67	89	217
SEDTAPP	14	16	1	1	11	13		56	59	77	2,247
Administration (excluding Student Services)						120	10				
Student Servies						60					
Breazeale Reactor	in NE	3				12	2				
Facilities Engineering Institute						37					
TOTALS	375	67	55	79	23	451	33	1,500	1,575	2,075	9,000

NON-COE SPACE PROJECTIONS

GPC CLASSROOMS & LECTURE REQUESTS

The existing classrooms have an average ASF/seat of 20 ASF. As the University moves toward integrating more active learning pedagogies, they would like to move to large classrooms spaces, that can accommodate project based learning. A metric of 30 ASF/seat was agreed upon with the understanding that this metric would be applied to 50% of the classrooms anticipating that 50% of the classrooms will be replaced through the Master Plan.

Additionally 2 lecture halls were proposed to be added to the inventory @ 20 ASF; 1 @ 150 students, 1 @ 250 students for a total of 8,000 ASF to support the request from COE faculty that more large lecture spaces are needed to support their courses.

ENGINEERING LIBRARY

The Engineering Library provides additional student collaboration space. The allocation for the library remained unchanged in this process, but it is assumed that the library space will replace a large portion of the stack areas with student study space.

OPP AREA 3 SHOPS

The OPP Area 3 Shop space currently located in Engineering Unit B will be replaced by the new Steam Services Building. Payette was advised by OPP that replacement space would not be needed for the existing OPP Area 3 Shop space.

OTHER OCCUPANTS

The COE occupied buildings on the Core and West Campus have other occupants that require space. These occupants are:

- IST
- EMS

For the purposes of this study, Penn State advised Payette to keep the space allocations steady, and consider no growth for these occupants.

APPLIED RESEARCH LAB (ARL)

The ARL occupies four buildings on the Core and West Campus:

- Applied Science Building (ASB)
- Applied Research Lab (ARL)
- Garfield Thomas Water Tunnel
- Research West

The ARL performs classified research for the government and its research spaces and buildings have restricted access.

Currently the ARL is considering building a new building off-campus and vacating one or more of its properties, if the ARL vacated one of its holdings, the building would then revert to Penn State control, and could be available for use by the COE or other Penn State Colleges. This study did not consider the growth of the ARL program on the Core and West Campus.

NEW CHILLER PLANT

A New Chiller Plant is currently being planned to enhance the capacity of both the West Campus and the Engineering Core Campus. During the course of this study, the opportunity of building the new chiller plant on the Core Campus was considered.

There were several factors that made the placement of a new infrastructure building on the Core Campus unattractive to the University including:

- The highest and best use of the limited space on the Core Campus is program space for classrooms, research labs, offices, and student space
- Tall, loud, and potentially noxious vent stacks would have a negative impact on the overall environment of the Core Campus
- Other sites are available for the Chiller Plant outside of the Core