PLANNING FOR SUCCESS
STEM Facilities
AGENDA

1. Understanding the issues
2. Planning & Programming Process
3. Trends
1. Understanding the issues
Aging Higher Education Facilities

Public Average

<table>
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<tr>
<th>Year</th>
<th>Under 10</th>
<th>10 to 25</th>
<th>25 to 50</th>
<th>Over 50</th>
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<td>2014</td>
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Private Average

<table>
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<tr>
<th>Year</th>
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<th>25 to 50</th>
<th>Over 50</th>
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<tr>
<td>2014</td>
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<td>25%</td>
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</tr>
</tbody>
</table>

Source: Sightlines: STATE OF FACILITIES IN HIGHER EDUCATION – 2015 Benchmarks, Best Practices & Trends
Most states provide less money per student now than before the last recession.

Source: https://gbpi.org/2017/georgias-education-cuts-a-growing-burden-for-low-income-students/
Georgia’s amended budgets 2001-2017; 2018 budget (HB44), as signed by governor; University System of Georgia, fall semester enrollment reports 2001-2016, GBPI estimates of fall enrollment 2017 and 2018; adjusted for inflation; student is full-time equivalent.
Enrollment trends

May 2009 – May 2015
18.9%
Increase in STEM jobs in Georgia

High school graduates:
2005: 2,799,250
2018: 3,323,656

College STEM graduates:
2011: 166,530
2024: 173,622

National STEM pipeline:
524,406 (18%)

7,092 (4%)
STEM interest: 2012-2016

Students have changed...

“It’s called ‘reading’. It’s how people install new software into their brains”
Students are more diverse

- **1970’s**: 53% Non college bound high school graduates, 47% College bound high school graduates
- **2000’s**: 30% Non college bound high school graduates, 70% College bound high school graduates
- **2010’s**: 22.7% Non college bound high school graduates, 77.3% College bound high school graduates
College readiness

Percentage of 2013 U.S. high school graduates ready for college-level courses.

- Math: 44% ready
- Science: 36% ready

Stem Education & Workforce
January 13th, 2014
Education demands

In 2020, 47% of all jobs require Associate’s Degree or higher.
Top 10 skills and qualities for college graduates sought by employers

1. Leadership
2. Teamwork skills
3. Communication skills (written)
4. Problems-solving skills
5. Strong work ethic
6. Analytical skills
7. Technical skills
8. Communication skills (verbal)
9. Initiative
10. Computer skills
How much has the way students learn, the way we teach, and the spaces we use for education, changed over time?
Replication has been the typical path forward....
Facilities and design solutions are not keeping up.
“Higher education is a thousand years of tradition wrapped in a hundred years of bureaucracy.”

Moe, 1994
Twitter
email
Leaving early
FB check
Paying attention
Twitter
email
FB check
email
email
Not paying attention
What are we thinking?!

Anyone, anyone?
So, what should we be thinking about?

- All spaces are **academic opportunities**
- Learning spaces are also **social meeting places**
- **Flexible, blended** learning environments
- **Students as designers** of their environments
So, what should we be thinking about?

- Studio-based **team learning**
- Ready **access to resources**
- Spaces for **reflection and creativity**
- Design based on **pedagogy**
- Creative **classroom management techniques**
- **Undergraduate research opportunities**
We cannot solve our problems with the same thinking we used when we created them.

-Albert Einstein
2. Planning and Programming process
What is a program?

Our take:
The most important stage in a project

Planning a project without a program is like planning a trip where you know the beginning and the end, but have no idea what happens along the way.
Living roadmap to a successful project

- Defines the **problem** & provides the framework to **solve** it
- Clearly expresses the **needs**
- Establishes the **dreams, goals** and **objectives**
- Identifies the **processes**
- Defines the **spaces**
- Establishes/validates the project **budget**
- Sets the project **schedule**
- Is completed in a timely manner
Based on simple philosophies:

- No single use can be planned in isolation
- No two projects are the same
- Programmers are facilitators, not dictators
Students, stakeholders and user groups

Facilities Planning and Design

University Administrators

Student, stakeholders and user groups

University Partners

Collaborative Team

Planners, Architects, Engineers, Cost Consultant

Maintenance Personnel

Physical Plant
• **Work collaboratively on site** so that all team members are accessible and connected

• **Engage all team members** in discussions about project goals, objectives and constraints

• **Listen intently** and collaborate on all programming elements

• **Learn** about programs and people

• **Share perspective** about past experiences and current industry trends

• **Respond** with a comprehensive programming and project definition document
Define needs based on:

- Existing deficiencies
- Change in programs
- New programs
- Growth
- Accreditation
- Institutional mandates
- Changes to mission, vision and goals
- Strategic plan modifications
- Future
Establish dreams, goals and objectives

• **ORGANIZATIONAL:** owner’s big picture
• **FORM & IMAGE:** aesthetics
• **FUNCTIONAL:** activities, occupancy & interaction
• **ECONOMIC:** budget + operating and maintenance costs
• **TIME:** short-term & long-term plans
ORGANIZATIONAL: Owner’s big picture

- Dream BIG
- Don’t be constrained by what you know now and what you have now
- Challenge all preconceptions
FORM AND IMAGE: Aesthetics

- Master plan compliance
- Design standards
- Connection to adjacent buildings
- Campus gateways
- Science on display
FUNCTIONAL: Activities, occupancy & Interaction

- People
- Equipment
- Supplies
- Activities
- Function
Define all assignable, useable spaces:

- Core facilities
- Offices
- Research labs
- Instructional labs
- Project spaces
- Classrooms
- Support spaces
- Student success spaces
- Collaborative spaces
- Other assignable spaces
## Program Summary

<table>
<thead>
<tr>
<th>SPACE TYPES</th>
<th>PHASE 1</th>
<th></th>
<th>PHASE 2</th>
<th></th>
<th>PHASE 3</th>
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<th>NOTES</th>
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### Programming Document

18

### CVEG - Research & Education Center at University of Arkansas
## Program Model - Analysis

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<tr>
<th>Department</th>
<th>ANSF</th>
<th>Efficiency</th>
<th>GSF</th>
<th>Grossing</th>
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<td>Administrative</td>
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<td>14,487</td>
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<tr>
<td>Research</td>
<td>12,418</td>
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<td>22,578</td>
<td>10,160</td>
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<td>Instructional Laboratories</td>
<td>35,753</td>
<td>55.0%</td>
<td>65,005</td>
<td>29,252</td>
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<tr>
<td>Collaborative Learning Spaces</td>
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<td>65.0%</td>
<td>10,605</td>
<td>3,712</td>
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<td>5,747</td>
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</table>

**Grossing - Typical (includes building support spaces)**

- **58,305**

**Total**

<table>
<thead>
<tr>
<th>ANSF</th>
<th>Efficiency</th>
<th>GSF</th>
<th>Grossing</th>
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<tbody>
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<td>59.6%</td>
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### Efficiency

<table>
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<tr>
<th>Type of facility</th>
<th>Low end efficiency</th>
<th>High end efficiency</th>
<th>Average efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional</td>
<td>62%</td>
<td>68%</td>
<td>65%</td>
</tr>
<tr>
<td>Research</td>
<td>56%</td>
<td>64%</td>
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<tr>
<td>Animal Research</td>
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<td>60%</td>
<td>45%</td>
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<tr>
<td>Bio-Containment</td>
<td>30%</td>
<td>50%</td>
<td>40%</td>
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</table>
## Example STEM Research Facility

<table>
<thead>
<tr>
<th>Programmed lab and lab support spaces</th>
<th>38,500 NSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmed office/conference/support spaces</td>
<td>16,500 NSF</td>
</tr>
<tr>
<td><strong>Total programmed space:</strong></td>
<td><strong>55,000 NSF</strong></td>
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</tbody>
</table>

### Estimated efficiency at program stage:

<table>
<thead>
<tr>
<th>Total GSF at program stage</th>
<th>85,938 GSF</th>
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<tbody>
<tr>
<td>Estimated construction cost of facility ($400/GSF):</td>
<td>$34,375,200</td>
</tr>
<tr>
<td>Estimated total project cost ($520/GSF):</td>
<td>$44,687,760</td>
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### Actual Efficiency:

<table>
<thead>
<tr>
<th>Actual GSF of Facility:</th>
<th>91,667 SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Construction Cost of Facility ($400/GSF):</td>
<td>$36,666,800</td>
</tr>
<tr>
<td>Difference Between Program and Actual:</td>
<td>$2,291,600</td>
</tr>
<tr>
<td>Actual Total Project Cost ($520/GSF):</td>
<td>$47,666,840</td>
</tr>
<tr>
<td>Difference Between Program and Actual:</td>
<td>$2,979,080*</td>
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</table>
### Example STEM Research Facility

<table>
<thead>
<tr>
<th>Programmed lab and lab support spaces</th>
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</tr>
<tr>
<td>Total programmed space:</td>
<td>55,000 NSF</td>
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</tbody>
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#### Estimated efficiency at program stage:

| Total GSF at program stage | 85,938 GSF |
| Estimated construction cost of facility ($400/GSF): | $34,375,200 |
| Estimated total project cost ($520/GSF): | $44,687,760 |

#### Actual Efficiency:

| Actual GSF of Facility: | 91,667 SF |
| Estimated Construction Cost of Facility ($400/GSF): | $36,666,800 |
| Difference Between Program and Actual: | $2,291,600 |
| Actual Total Project Cost ($520/GSF): | $47,666,840 |
| Difference Between Program and Actual: | $2,979,080* |

To maintain the project budget established at the program stage, a **3,437 NSF reduction of programmed space** is required.
**ECONOMIC:** budget + operating and maintenance costs

- Establish/confirm budget
- Identify philosophies and constraints: initial cost vs. long range costs
- Balance budget and schedule
- Determine sustainability goals and requirements
- Life cycle costing
- Deferred maintenance
TIME: short-term & long-term plans

- Complete program in a timely manner
- Phasing
- Revenue resources
- Anticipated long term changes
- Current and future market conditions
- Project delivery method
- Commissioning
- Move in
Tools we use

- Transparent communication
- Modular planning
- Information gathering
- Perspective
MODULAR PLANNING

- Organizational tool to define individual spaces & layout
- Not the final floor plan
- Improves efficiencies of building systems and structure
MULTI-DIRECTIONAL MODULES
As security goes up... ...access goes down

PUBLIC
Classrooms, informal spaces

SEMI-PRIVATE
Instructional laboratories

PRIVATE
Research laboratories

CLOSED OPEN LOW

HIGH Security Access

LOW Security Access
### General
- Type of space
- Area / sq ft
- Activities/users
- Special requirements (vibration, acoustics, etc…)

### Functional Relationships
- Adjacencies
- Separations
- Hazards
Building Systems

- Temperature
- Humidity
- Air pressurization
- Power requirements
- Light levels
- Communication and Technology
Major equipment impact:

- Physical space (size)
- Adjacent areas (location)
- Building systems
- Vibration – producing or sensitive
- EMI – producing or sensitive
Backfill space

AVAILABLE SF
Basement Floor: 5,444 ft²
First Floor: 5,133 ft²
Second Floor: 1,072 ft²
Third Floor: 7,900 ft²
Fourth Floor: 9,713 ft²
TOTAL SF: 29,262 ft²
Classrooms with tablet arm chairs:
- KI: 16 to 19 sq ft / student
- Steelcase: 17 sq ft / student
- Our team: 16 to 20 sq ft / student

Classrooms with continuous tables & chairs:
- KI: 17 to 22 sq ft / student
- Steelcase: 16 to 27 sq ft / student
- Our team: 20 to 25 sq ft / student
Active learning environments with moveable furniture

- KI: 22 to 32 sq ft / student
- Steelcase: 24 to 31 sq ft / student
- Our team: 24 to 30 sq ft / student
Classroom utilization

• Usually based on 40 to 50 hour weeks

• Typical range 50 to 80%

• Average occupancy 60 to 80%

• Cost of classrooms outfitted with technology $350-$450 / sf
Instructional laboratory utilization

- Usually based on **40 to 50 hour weeks**
- Typical range **25 to 55%**
- Average occupancy **30 to 80%**
- Cost of instructional laboratory outfitted with technology **$500-$650 / sf**
Individual Class Labs:

- Biomedical Engineering, Mechanics of Materials, Hydrology, Fluid Mechanics, Thermodynamics, Automation and Controls, Robotics, HVAC, Lighting, Electronics, Environmental…

- General Biology, Molecular Biology, Microbiology, Genetics, Marine Biology, Plant Biology, Cell Biology, Physiology and Anatomy, Ecology, Histology and Cytology, Neurobiology…

- General Chemistry, Organic Chemistry, Biochemistry, Analytical Chemistry, Physical Chemistry, Inorganic Chemistry…
3. Trends
Instructional Laboratories
Research Laboratories & Core Facilities
ADC -- Multiple Samples Exercise

- Design a function to collect multiple sample forests.
- Write guidance on how to do that for test purposes.
- Write a function to capture.
- Insert a similar function, and collect multiple sample outputs.
- Collect with samples, and test with EnvironForest.
- Add comments to the function.
Collaboration & Informal Learning Spaces
## Take-aways

<table>
<thead>
<tr>
<th>Project planning and programming is the first, and most important step in the design process</th>
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<tbody>
<tr>
<td>Programming is a collaborative process that translates stakeholder wants and needs into a useable facility</td>
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<tr>
<td>Design professionals are not dictators but facilitators; they use tools, strategies and trends to inform and guide</td>
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</tbody>
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