An NSF/ATE National Center

DUE 1700705

EVALUATION REPORT
Year One: October 1, 2017 to May 31, 2018

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Acknowledgments

This report would not have been possible without the collaboration of Larry Chang, BEST Center Manager, who met with the external evaluator on a regular basis to develop and implement the evaluation work plan and to review and revise the center’s surveys. He was instrumental in executing the collection of data for the evaluation of the center.

In addition, PI Crabtree and Center Director, Pam Wallace are acknowledged for their support and trust in the Center Manager and evaluator in the implementation of the evaluation for the Center. Finally, Victor Garcia, who took a new position contributed significantly to the data collection and evaluation design for this year.

The BEST team took significant efforts to provide accurate data and produced high-quality documentation to reflect the center’s impact and progress toward goals.

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List of Tables

Table
1. Example of Means/Average Calculation
2. BEST Center Reach, 201-2018
3. Total Attendance for BEST Center Professional Development Activities
4. Student Diversity in BEST Courses Compared with Average for All ATE Centers and Projects
5. Top 5 Frequently Used Resource, by User Group
6. Website Metrics, October 1 to May 31 of Each Year
7. Video Activity, 2016-2018
8. Capacity-Building Activities by BEST Faculty (Source: Follow-Up and Impact Surveys)
9. Impact on Workforce, Student Completion and Workforce Entry

List of Figures

Figure
1. Map of BEST Center College Network (66 members)
2. Racial Diversity of Students in BEST-Informed Courses, 2015-2018 (Source: Follow-Up Survey)
3. Quality of BEST Resources, Year One (Source: Impact & Follow-up Surveys)
4. Quality of BEST Center Institute
5. Use of Center Resource, Impact Survey vs. Follow-Up Survey 2017-18
6. Website Metrics, Current Year vs. Prior Year
7. Video activity 2016-17 vs. 2017-18
8. Top Six Categories from Follow-Up Survey, FY18
9. Impact on Classrooms and Institutions, Follow-Up and Impact Surveys
10. Impact on Students from Impact and Follow-Up Surveys (n=53), 2017-18
## List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AACC</td>
<td>American Association of Community Colleges</td>
</tr>
<tr>
<td>ACE</td>
<td>Architecture, Construction, Engineering</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ATE</td>
<td>Advanced Technological Education</td>
</tr>
<tr>
<td>BAS</td>
<td>Building Automation Systems</td>
</tr>
<tr>
<td>BEST</td>
<td>Building Efficiency for a Sustainable Tomorrow National Center</td>
</tr>
<tr>
<td>BOMA</td>
<td>Building Owners and Managers Association International</td>
</tr>
<tr>
<td>CN</td>
<td>Collaboration Network</td>
</tr>
<tr>
<td>DACUM</td>
<td>Developing A Curriculum</td>
</tr>
<tr>
<td>DOL</td>
<td>Department of Labor</td>
</tr>
<tr>
<td>DUE</td>
<td>Division of Undergraduate Education</td>
</tr>
<tr>
<td>GPTC</td>
<td>Georgia Piedmont Technical College</td>
</tr>
<tr>
<td>HBPOPTM</td>
<td>High Performance Building Operations Professional</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heating, Ventilation and Air Conditioning</td>
</tr>
<tr>
<td>HVACR</td>
<td>Heating, Ventilation, Air Conditioning and Refrigeration</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
</tr>
<tr>
<td>NSF</td>
<td>National Science Foundation</td>
</tr>
<tr>
<td>PI</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Mathematics</td>
</tr>
<tr>
<td>STEAM</td>
<td>Science, Technology, Engineering, Arts and Mathematics</td>
</tr>
<tr>
<td>SVWG</td>
<td>Silicon Valley Working Group</td>
</tr>
<tr>
<td>TAG</td>
<td>The Allison Group</td>
</tr>
<tr>
<td>TBD</td>
<td>To be determined</td>
</tr>
<tr>
<td>WDI</td>
<td>Workforce Development Institute</td>
</tr>
<tr>
<td>YES</td>
<td>Youth for the Environment and Sustainability</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

Executive Summary .................................................................................................................................................. 6

Introduction
  Mission and Goals ................................................................................................................................................. 8
  Purpose and Design of the External Evaluation ............................................................................................... 9

Evaluation Question 1: Reach
  Events ................................................................................................................................................................. 12
  Faculty Reached ............................................................................................................................................... 13
  Industry Reached ............................................................................................................................................ 14
  Students Reached ............................................................................................................................................. 15
  Summary of BEST Center Reach .................................................................................................................. 16

Evaluation Question 2: Quality
  Quality of BEST Center Products and Services ......................................................................................... 17
  Quality of Professional Development ........................................................................................................... 17
  Summary of User Perceptions of BEST Center Quality ............................................................................ 19

Evaluation Question 3: Use of Materials
  Frequency of Use by Stakeholders ................................................................................................................. 19
  Website and You Tube .................................................................................................................................... 20
  Overall Value of Center Products .................................................................................................................. 22
  Summary of Center Materials Use ................................................................................................................ 23

Evaluation Question 4: Capacity Building
  Generation of Knowledge ............................................................................................................................... 24
  Impact on Classroom Practice ...................................................................................................................... 25
  Impact on Students ....................................................................................................................................... 26
  Impact on Programs ..................................................................................................................................... 28
  Summary of Impact of the BEST Center on Capacity to Educate the High Performance Building Operations Technician Workforce .................................................. 29

Conclusions and Recommendations
  Conclusions ....................................................................................................................................................... 30
  Recommendations ........................................................................................................................................... 31

Appendix 1: Approach to Evaluation ............................................................................................................... 33
Appendix 2: Student Success Story .................................................................................................................. 35
The Building Efficiency for a Sustainable Tomorrow (BEST) National Center is funded by the National Science Foundation (NSF) to improve the field of building systems technician education. The center was initially funded by a 4-year grant in 2012 (DUE 1204930). The center was granted a 5-year renewal in 2017 (DUE 1700705). The following evaluation covers the period October 1, 2017, to May 31, 2018.

Year one of the renewal grant saw a continued maturing of the BEST Center, as well as an unwavering commitment to meeting its goals. The center and its partner colleges continue to provide a comprehensive approach to improving building systems technical education through enhanced career awareness and exposure, high-quality curriculum and instruction, and strong educator development. As clear evidence that the center is making a positive impact, survey respondents reported a 10.2% increase in students who remained in programs that incorporated the BEST Center curriculum as well as a 34.0% increase in program participants who found a technician job.

Overall, the BEST Center reached 4,536 educators, students, and representatives of industry and government, nearly 16% more than in the previous year. Events included regional and national conferences, meetings and professional development workshops and webinars. Center staff exhibited regional and national leadership through leading two breakout sessions at HVAC Excellence’s National HVACR Educators and Trainers Conference, leading a session at AACC Workforce Development Institute, and addressing the Youth for the Environment and Sustainability Conference.

User perception of the quality of BEST Center products and services is very high. The top-rated products and services are workshops and materials, faculty network, and mentoring support from center staff. Almost 100% of Institute participants rated the quality of every aspect of the professional development as Excellent or Good.

This perception is affirmed by the consistent growth in use of center resources over the years. The top four BEST Center resources most frequently used by its intended audience were the workshops and materials, sharing of best practices, faculty network and curriculum documentation. While overall traffic to the website was flat this year compared with last year, pageviews, pages per session, and session duration increased and there was a big leap in views of videos. Stakeholders and partners indicated that they derived the most value from learning how to adapt or expand existing courses and add new hands-on lab activities and new equipment to existing labs.

Overall, 85.0% of survey respondents indicated that they took at least one action and 81.1% took more than one action. Survey respondents self-reported that the top ways that they used BEST Center resources to build capacity in their classrooms were to develop presentations or lecture materials for existing or new courses and increase student awareness of educational or career opportunities for building technicians to enhance instructional techniques. In addition, 85% believed that their action had a high or moderate impact on their students. The top two areas of impact were (1) expanded my knowledge of advanced building science and technology and (2) helped me to improve student outcomes.

The center continues to support relationships and collaboration not only with educators but also with government agencies and industry, leading to the following outcomes in the first year of the renewal:

- Conducted task analysis with 13 subject matter experts over 4 days, with the goal of identifying specific knowledge and skills areas that can be formulated into a test for national certification for High Performance Building Operations Professional (HPBOP)™.
- Conducted train-the-trainer sessions for faculty who will teach the State of California Department of General Services (DGS) employees in northern and southern California.
- Developed industry-endorsed curriculum comprised of 12 sessions (96 hours), with professionals from the public and private sector.

Laney College must be acknowledged for its clear commitment to providing state-of-the-art career and technical education to the Oakland community and beyond. In the past year, the college completed construction of the BEST Center building, an active learning laboratory in sustainable building design, construction and operations. The building features two Test Houses (Electrical and Alternate Mechanical Systems) and a Passive House-type Classroom. The classroom is designed to achieve a LEED Platinum certification and is likely to be among the first classrooms in California to meet “Passivhaus” standards for energy efficiency.

The BEST Center provides an excellent example of a high-quality NSF-funded center. The BEST team is to be commended for its commitment and for its impact on the sustainable building technician workforce.
INTRODUCTION

In October 2017, Laney College received a 5-year renewal award ($3.6 million) for the Building Efficiency for a Sustainable Tomorrow (BEST) National Center (DUE 1700705). This follows an initial four-year center award (DUE 1204930) at $3.5 million. Prior to these awards, Laney College received two NSF ATE project grants, “Environmental Control Technology Education for Advanced Building Operation and Management” (2004) and “Educating Technicians for Building Automation and Sustainability” (2008), plus a 1-year no-cost extension in 2011.

This report covers the first year of the center renewal grant, which is the reporting period October 2017 to May 2018. The evaluator attended multiple meetings with BEST leadership by telephone and in person. In addition, the evaluator combined on-site meeting with the NVC with a site visit. The evaluation describes information from those meetings and reports findings from surveys, interviews, center documentation and data analysis. A summary of the approach to the evaluation is in Appendix 1.

BEST is a national center that focuses on improving the field of building systems technician education. To this end, the center

- supports instruction in new technologies that enhance commercial building performance,
- develops and implements leading-edge curriculum based on input from industry partners,
- provides professional development to postsecondary instructors so that their curricula cover current and emerging technologies,
- graduate a diverse population of students in high performance building systems and operations careers.

Peralta Community College District in Oakland, California, is the BEST Center fiscal agent. BEST has three lead college partners and one research partner, each with its own area of expertise:

- Laney College
- Milwaukee Area Technical College
- Georgia Piedmont Technical College
- Lawrence Berkeley National Lab

Commercial HVAC & BAS
Sustainable Facilities Operations
Building Automation Systems
Research in Energy Efficient Buildings

Mission and Goals

The mission for the BEST Center was updated for the renewal grant. The mission is to support the transition to high performance, energy-efficient buildings especially in the commercial building sector by helping to build a national agenda for building efficiency; supporting the development, dissemination, and adoption of exceptional building technician education programs in community colleges nationally; leading the development of ISO/ANSI accredited certification(s) for High Performance Building Operations Technicians targeted to community college graduates and incumbent workers; and supporting the development of certifications for the building automation systems (BAS) sector targeted to community college graduates and incumbent workers.

The goals of the project are the same as the goals for the prior BEST Center grant:

**Goal 1:** Build and transform the instructional capacity of community colleges in the field of high performance building technician education.
**Goal 2:** Engage industry stakeholders in a national collaboration with community colleges to support high quality instructional programs for new and incumbent high performance building technicians.

**Goal 3:** Strengthen the national STEM pipeline for educating building technicians and engineers, starting in high school.

**Purpose and Design of the External Evaluation**

In year one of the renewal, the team and the evaluator developed a revised evaluation plan for the center, keeping in mind the goal to minimize the overlap between the annual report and the evaluation report. This was accomplished by designating the focus of the evaluation report to be outcomes and impacts, and the focus of the annual report to be activities and results. These efforts resulted in the following evaluative questions.

1. To what extent has BEST reached its intended audience?
2. What are users’ perceptions of the quality of the BEST Center?
3. To what extent are BEST materials being used?
4. To what degree was the nation’s building technician education and workforce development capacity expanded, improved, and/or enhanced?

Evaluation in year one of the center’s renewal had three new components:

1. The evaluator and center staff aligned all surveys so that similar questions had the same format to increase the number of responses and to aid in triangulation of evidence to address the evaluative questions.
2. In May, the evaluator, with input from center leadership and staff, updated the student survey for the HBPOPTM (High Performance Building Operations Professional) pilot training 2018 (in preparation for the HPBOP workshop series that will take place in year two).
   - The center gathered data on its webinar on women in the trades.

The 2018 BEST Center Impact Survey was an 11-item instrument and was updated in year one in collaboration with center staff. Last year, the center ensured that there was only one name for each institution on the distribution list. However, upon the advice of the evaluator, this year the survey was sent to all individuals known to the center, and allowed multiple individuals from an institution to respond. This resulted in a jump in the size of the distribution list from 385 last year to 495 this year (an increase of 27.8%). The response rate also increased from 5.4% to 13.9%, producing 69 responses (versus 21 last year).

The 11 questions from the Impact Survey were also embedded into the annual Follow-Up Survey. Additionally, the Follow-Up Survey was updated and conducted in the spring of 2018. The center increased the number of core college recipients of the Follow-Up Survey to 48, up from 35 last year. The number of respondents increased as well, from 27 last year to 35 this year. The response rate was slightly lower, dropping from 79.4% to 72.9%, which is still an outstanding response to the survey.

The reporting period for year five (the final year) of the first center grant extended through September 30, 2017. Consequently, that evaluation report included analysis of two BAS workshops, conducted in June 2016 and June 2017. Because the evaluation reporting period for year one of the renewal ends on May 31, 2018, analysis of the June 2018 BAS workshop will not be included in this report, but will be included in the report for year two.
Sources of Data
The sources used to obtain evidence to address each of the evaluative questions were

Question 1, Reach
- Center attendance records
- Impact Survey
- Follow-Up Survey
- BEST Center Institute Registration Data
- Webinar Attendance (Women in Building Technologies and the Trades)

Question 2, Quality of Products and Services
- Impact Survey
- Follow-Up Survey
- BEST Center Institute Post-Survey
- Webinar Survey (Women in Building Technologies and the Trades)

Question 3, Use of BEST Center Materials
- Impact Survey
- Follow-Up Survey
- Website Analytics
- Evaluation Preparation Questionnaire

Question 4, Capacity Building:
- Impact Survey
- Follow-Up Survey
- BEST Center Institute Post-Survey
- Evaluation Preparation Questionnaire
- Center Records

The platform for collection of survey data was Survey Monkey, and the evaluator exported the Survey Monkey data into Excel format for data analysis.

This year, Center Manager Chang developed a new master reporting document for all partners and co-PIs to use for inputting the data for which they were responsible, using DropBox Paper. The document was intended to help streamline the center’s reporting efforts, with all staff and partners entering their information into a common document. This innovation was successful in collating all the information in one place and worked well for a first-year effort. Some data was not entered prior to the data cutoff date, which means that there is a small amount of information not included in this report. However, the data submitted was sufficient to perform the evaluation of the center, draw conclusions from the data and make recommendations.

Data Analysis Methods
Two methods for calculating means/averages were employed in the data analysis:

1. When the term mean is used in the report, it was calculated by adding the numbers in the array and dividing the sum by the count.
2. When the term weighted average is used in the report it refers to the average value of a set of numbers with different weights. This situation occurs when a rating scale is used with relative values (weights) attached to the quantitative or qualitative attributes in the scale (i.e. agree/disagree, excellence, likely/not likely, etc.). The weighted average is calculated using the formula below, where \( x \) = the # of responses for the attribute and \( w \) = the value assigned to the attribute.

\[
\frac{\sum (x_1w_1 + x_2w_2 + x_3w_3 + x_nw_n)}{\text{Count}}
\]

For example: A scale with weights assigned and # of responses for each item on the scale as follows:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value/Weight (w)</th>
<th># responses (x)</th>
<th>( (x)/(w) )</th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>4</td>
<td>6</td>
<td>24</td>
<td>Sum/Count 64/22</td>
</tr>
<tr>
<td>Good</td>
<td>3</td>
<td>10</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1: Example of Means/Average Calculation**

Standard qualitative analysis methods were used to examine and analyze the data collected from open-ended questions in the surveys. The goal was to identify themes in the responses. The strategy used to identify themes used multiple techniques in a sequential manner:

- Responses were reviewed to identify key words and concepts.
- Key words were grouped.
- Comparisons were made across respondents.
- Word repetitions/key words and concepts were analyzed.

To obtain a version of responses to open-ended questions, please contact The Allison Group at tbailey@theallisongroup.com.

The results of all surveys and the center documentation were compiled, reviewed, and analyzed. The larger themes that emerged are described in the following report.
EVALUATION QUESTION 1: To what extent has BEST reached its intended audience?

The reach of the BEST Center was measured in several ways:

- Individuals reached through outreach events and activities
- Faculty reached through professional development
- Students reached with BEST Center materials

While many stakeholders for building systems technician education and workforce development exist, to target a manageable audience, BEST narrowed the larger audience to its intended audience, which includes individuals associated with technological education and representatives of the sustainable building industry. Specifically, the intended audience includes K-12, 2-year college and university educators and administrators, and employers in the sustainable building industry.

The respondents to the Impact Survey indicate that the center remains focused on its intended audience, with 73% of the respondents self-identifying as being from the intended audience. Additionally, BEST Center documentation indicates that the center had considerable reach to industry, government, universities, other ATE projects and centers and professional associations, as shown in Table 2 below.

<table>
<thead>
<tr>
<th>Event Description</th>
<th>2016-17</th>
<th>2017-18</th>
<th>Overall % Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students impacted by BEST Center Curriculum</td>
<td>1,327</td>
<td>1,747</td>
<td>31.7%</td>
</tr>
<tr>
<td>Number of institutions responding to Annual Follow-Up Survey</td>
<td>27</td>
<td>35</td>
<td>29.6%</td>
</tr>
<tr>
<td>Number of institutions participating in professional development*</td>
<td>50**</td>
<td>41</td>
<td>-18.0%</td>
</tr>
<tr>
<td>Number of educators supported by professional development*</td>
<td>67</td>
<td>62</td>
<td>-7.5%</td>
</tr>
<tr>
<td>Number of educators who participated in the train-the-trainer for HBPOP™</td>
<td>n/a</td>
<td>9</td>
<td>n/a</td>
</tr>
<tr>
<td>Number of participants in outreach conferences</td>
<td>2,530</td>
<td>2,710</td>
<td>7.1%</td>
</tr>
</tbody>
</table>

*Unduplicated headcount
**Includes two BAS workshops not included in 2017-18 due to reporting period requirements
Total attendance at professional development events in year one was 86 (duplicated headcount)

Table 2: BEST Center Reach, 2016-2018

Another measure of reach is the number people who have used at least one of its resources within the past 12 months. With this measure in mind, the use of BEST’s materials by the intended audience appears to be very good. In response to an Impact Survey question about frequency of resource use, at least two-thirds of respondents indicated that they accessed a resource at least once within the previous 12 months. The concept of reach as it is distinguished from frequency is discussed later in the report.

Events
In year one, center staff participated in and disseminated materials at conferences and meetings, conducted workshops and tours with students and community members, and met with staff from more...
than 20 congressional offices. Attendance at these events totaled 2,710 people. The audience type cannot be determined for 930 people (31.4%, all attendees of the AACC Workforce Development Institute and the National Council for Science and the Environment Council). The remaining 1,780 can be categorized as 2-year educators and administrators (49.5%), students (12.2%), K-12 educators (2.9%), industry (2.1%), and government (1.8%).

**Faculty Reached**

Faculty are reached through the center professional development and through the center’s network of colleges with commercial HVAC, energy management, and/or building automation programs. Sixty-six colleges were included in this network at the end of year one.

Professional development activities during year one included the BEST Center Annual Institute on January 3-6, 2018 and a webinar on “Women in Building Technologies and Trades” on April 26, 2018. As mentioned above, the BAS workshop did not occur during this reporting period and as a result, is not included in Table 3 below. However, in year one the center also conducted a train-the-trainer event for HBPOPTM on April 26-27.

<table>
<thead>
<tr>
<th>Activity</th>
<th>2016-17</th>
<th>2017-18</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institute</td>
<td>36</td>
<td>42</td>
<td>+6</td>
</tr>
<tr>
<td>HBPOPTM train-the-trainer</td>
<td>n/a</td>
<td>9</td>
<td>+9</td>
</tr>
<tr>
<td>Webinars &amp; Collaboration Calls</td>
<td>52</td>
<td>35</td>
<td>-17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>88</strong></td>
<td><strong>86</strong></td>
<td><strong>-2</strong></td>
</tr>
</tbody>
</table>

Table 3: Total Attendance for BEST Center Professional Development Activities
The total number of participants in BEST Center professional development events was nearly the same as the previous year. However, the mix shifted with the addition of the train-the-trainer and the diminishment of the collaboration calls. In general, the center continues to hone its focus on professional development activities to those that are most likely to increase the number of colleges offering high performance building operations curricula. The center’s continual innovation is to be commended.

**Industry Reached**

Measures of industry reach were

- Advisory Council membership
- Software or equipment discounts

The center did not conduct HBPOP™ training during the reporting period. However, it continued to deepen its knowledge and expertise in high performance building operations and to lay a sustainable foundation for developing curriculum and a certification for HBPOP™, and to continue to refine the incumbent worker training as a pilot for two-year college curriculum. The center conducted a job task analysis, sought additional funders, and conducted train-the-trainer sessions in preparation for HPBOP incumbent worker training scheduled for early in year two.

Ten high-profile companies and industry organizations are represented on the National Advisory Council:

- Oracle
- Sheraton Hotel
- Facility Engineering Associates
- CBRE (CB Richard Ellis)
- JLL (Jones Lang LaSalle)
- Oracle CEES-Advisors; BOMA Energy Chair
- International Facility Management Association (IFMA)
- Pacific Northwest National Laboratory
- U.S. General Services Administration (GSA)
- Office of Federal High Performance Green Buildings
- U.S. General Services Administration

Additionally, ten companies offer discounted equipment and software discount to colleges in the BEST Center network:

- AutomatedLogic
- Honeywell
- Siemens
- Kele
- Triatek
- EasyIO
- Contemporary Controls
- Control Depot
- Cochrane Supply
- Tridium

Finally, several companies and government agencies are collaborating with the center in developing and delivering the HPBOP training:

- Southern California Edison
- PG&E
- Southern California Gas
- National Science Foundation
- BOMA California
Students Reached
Students reached was measured by the following:

- Estimates by stakeholders who completed the Impact Survey
- Estimates by stakeholders who completed the Follow-Up Survey
- Center documentation on ACE Mentor program participation

A measure of the BEST Center’s reach with respect to students is the number of students that enroll in BEST-supported courses. When asked to estimate the number of students who took courses informed by BEST Center curricula and/or lab development in the 2017-18 academic year, respondents to the Impact and Follow-Up Surveys indicated that 1,747 community college students were reached, representing an almost 24% increase over last year.

Additionally, in year one of its renewal, the BEST Center continued its relationship with ACE Mentor, an afterschool STEM program that mentors high school students and introduces them to architecture, construction, engineering, and the skilled trades. During spring 2018, the center hosted 30 students from the ACE Oakland team who are interested in the building trades and their 20 industry mentors. In addition, in April 2018 the center presented to the first cohort of 20 Miami Lakes BAS students and introduced 55 high school students of the SIMS Career Academy to Building Automation, and throughout the year provided tours of MATC’s ABS labs to a total of 200 high school students.

Student Demographics
Year one saw a slight decrease in enrollment in BEST-informed courses of female students from 8% to 7% of total students. The enrollment of Caucasian students increased by 9.1 percentage points, and the enrollment of Hispanic, African American, and Asian students declined 6.3, 2.2, and 2.5 percentage points, respectively.

![Figure 2: Racial Diversity of Students in BEST-Informed Courses, 2015-2018 (Source: Follow-Up Survey)](image-url)
Summary of BEST Center Reach

Overall, the BEST Center reached 4,536 educators, students, and representatives of industry and government, nearly 16% more than in the previous year. Events included regional and national conferences, meetings and professional development workshops and webinars.

Center staff exhibited regional and national leadership through leading two breakout sessions at HVAC Excellence’s National HVACR Educators and Trainers Conference, leading a session at AACC Workforce Development Institute, and addressing the Youth for the Environment and Sustainability Conference. A sampling of three other centers known to this evaluator shows that the BEST Center’s overall reach is within the range of other centers.

While the student demographics do not compare favorably with all ATE Projects and Centers, the demographics compare very favorably to the HVAC industry, as shown in Table 4.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>BEST</th>
<th>ATE</th>
<th>HVAC Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiracial/Other</td>
<td>8%</td>
<td>2%</td>
<td>--</td>
</tr>
<tr>
<td>Asian</td>
<td>7%</td>
<td>7%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Native American, Hawaiian Native, Pacific Islander</td>
<td>3%</td>
<td>3%</td>
<td>--</td>
</tr>
<tr>
<td>African American</td>
<td>13%</td>
<td>22%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>21%</td>
<td>29%</td>
<td>17.9%</td>
</tr>
<tr>
<td>Caucasian (Non-Hispanic/Latino)</td>
<td>69%</td>
<td>55%</td>
<td>90%</td>
</tr>
<tr>
<td>Female</td>
<td>7%</td>
<td>28%</td>
<td>2%</td>
</tr>
</tbody>
</table>

*BEST data reported by respondents to the Follow-Up Survey
ATE data reported by respondents to the annual NSF ATE survey


Table 4: Student Diversity in BEST Courses Compared with Average for All ATE Centers and Projects

The source of data for the student demographics is the Annual Follow-Up Survey. This is problematic because, while there is a core of colleges that reports each year, the demographic mix might not be the case for all of the colleges across multiple years. This means that percentages reported can change because of the mix of colleges rather than the actual diversity of BEST-impacted students.

The other factor that influences the ability of the BEST Center colleges to recruit a diversity of students is the makeup of the industry. While, for example, the biotechnology industry is primarily female, as shown in Table 4 the HVAC industry is 98% male and 90% Caucasian, which is an indicator of the level of social and cultural barriers to diversity in the industry. Of note, BEST diversity exceeds that of the industry in all categories that were measured, and this means that graduates of BEST-infused programs who enter the field will make a contribution to increasing the diversity of the industry over time.

The center is working with colleges to improve their recruitment efforts in terms of diversity. In year one, the center sponsored a webinar on Women in Building Technologies and the Trades as a way to support its stakeholders in their efforts to recruit and retain female students in their programs. The workshop was attended by individuals from companies as well as colleges, and was well-received.

The center expanded its reach to high school students through its national partnership with the ACE Mentor program, as well as workshops and lab tours.
**EVALUATION QUESTION 2: What are users’ perceptions of the quality of the BEST Center?**

The quality of the BEST Center’s products and services was measured in two ways:

- Ratings of quality by center stakeholders (Follow-Up Survey and Impact Survey)
- Ratings of quality by participants in BEST Center professional development workshops

**Quality of BEST Center Products and Services**

Overall, stakeholders within the target audience perceived the quality and utility of BEST’s resources as high. Respondents to the Follow-Up and Impact Surveys rated the quality of BEST resources using a four-point Likert scale as follows:

- Excellent = 4
- Good = 3
- Fair = 2
- Poor = 1

When asked to rate the overall quality of the BEST resource that they had accessed in the past 12 months, 92.0% of the responses were *Good or Excellent*.

![Quality of BEST Resources, Year One (Source: Impact & Follow-up Surveys)](image)

The weighted average rating for all BEST Center products and services was 3.31 out of a possible 4.00, which indicates the center is producing at a high level of quality (this is slightly lower than 3.46 from the previous year).

**Quality of Professional Development**

When asked about the quality of the professional development, participants gave their experience of the BEST Center Institute high ratings.

Respondents rated the quality of their professional development across multiple dimensions that included...
such items as pre-event communications, presenters’ knowledge, presenters’ delivery, balance between pedagogical and technical content, quality of hands-on exercises, and quality of content organization. The used the following four-point Likert scale:

- Excellent = 4
- Good = 3
- Fair = 2
- Poor = 1

With 99.2% of respondents selecting Excellent or Good, and an overall average rating of 3.80 out of a possible 4.00, the quality of the BEST Center products and services is very high.

Rated highest were the perceived knowledge of the presenters, at 3.89; Information usefulness at 3.87; and Impact and relevance at 3.84. Pre-Institute communications received the lowest rating; however, it should be noted that this rating was in the range for Excellent at 3.72 out of a possible 4.00.

> These institutes seem to get better every year, even though there seems to be little room for improvement. These institutes are a critical and irreplaceable tool for program development and sustainability.—2018 Institute Participant

> Amazing workshop, every talk gave me at least couple ideas on what could be introduced and/or improved in my department's program. I am very grateful to be invited to be here.—2018 Institute Participant

Although qualitative, all webinar participants who completed the survey indicated that the ideas and recommendations would be useful in their work. Several expressed appreciation for the information about attracting younger students, organizations focused on women in trades, and mentoring.
Summary of User Perceptions of BEST Center Quality
User perception of the quality of BEST Center products and services is very high. The top-rated products and services are workshops and materials, faculty network, and mentoring support from center staff. Almost 100% of Institute participants rated the quality of every aspect of the professional development as Excellent or Good.

EVALUATION QUESTION 3: To what extent are BEST Center materials being used?

The three indicators regarding the use of BEST Center materials for 2017-18 were:
- Frequency of use by stakeholders
- Use of professional development materials by faculty
- Website traffic and usage

Frequency of Use by Stakeholders
It is useful to make a distinction between reach, which was addressed in evaluation question #1 and the current evaluative question. Reach refers to the extent to which BEST has touched its intended audience. However, frequency of use refers to how often the materials are used.

Interestingly, there is some overlap for the top five most frequently used resources between the college partners and the general users. This overlap is indicative of the overarching importance placed on quality professional development and relationship building.
<table>
<thead>
<tr>
<th>BEST College Partners</th>
<th>General Center Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Workshop and materials</td>
<td>1  Workshop and materials</td>
</tr>
<tr>
<td>2  Sharing of best practices</td>
<td>2  Curriculum development</td>
</tr>
<tr>
<td>3  Faculty network</td>
<td>3  Faculty network</td>
</tr>
<tr>
<td>4  Support of center staff</td>
<td>4  Sharing of best practices</td>
</tr>
<tr>
<td>5  Marketing and career videos/PPT</td>
<td>5  Other web resources</td>
</tr>
<tr>
<td>presentations (tied)</td>
<td></td>
</tr>
<tr>
<td>Source: Follow-Up Survey (n=35)</td>
<td>Source: Center Impact Survey</td>
</tr>
<tr>
<td></td>
<td>(n=18)</td>
</tr>
</tbody>
</table>

Table 5: Top 5 Frequently Used Resource, by User Group

There was no such overlap for the least used resources, which is to be expected given the more common focus of college partners. For the general users, the least used resources were the lab tours, support from center staff, and PowerPoint presentations. For the college partners, the least used resources were the webinar recordings, other web resources, and research reports. Of a curious note, from year five of the prior grant to year one of the renewal, “other web resources” dropped from the top 5 to the bottom 5 for college partners and jumped from the bottom 5 to the top 5 for general users.

**Website and YouTube**

Website traffic for year one remained essentially flat over the previous year. Several PIs have reported to this evaluator that the use of website platforms in general is declining in the face of the ubiquitous use of social media platforms and YouTube.

Website content was enhanced by center staff through the expertise of Media Specialist Espinas. The center added an impressive set of innovations and improvements this year:

- A new feature that provides Student Job and Career Listing and search for nationwide opportunities was added that is powered by ZipRecruiter. The link to ZipRecruiter is seamless and provides the power of a nationally recognized job search engine with the specialized searches that sustainable building technology students would expect from the BEST Center. It is an inventive solution, and the center may consider sharing it with other center PIs.
- A new webpage was added under Student Resources, *Student Success Stories*, to highlight diverse profiles of college graduates and their career pathways. An example of one of the success stories is found in Appendix 2.
- Materials from BEST workshops (e.g., PowerPoint presentations and video recordings) continued to be archived and available for broad public access at any time.
- A new Industry partner page with equipment discount summaries was added.

The number of sessions on the website increased by 0.48%, and the number of users decreased by only 5.6%, signifying that overall traffic to the website was essentially flat compared to the previous year. The number of new users also showed a small decline; however, *pageviews, pages per session, and session duration* increased, indicating that users are staying longer and using more functions of the website. There was an increase in most metrics this year versus last year.
Figure 6: Website Metrics, Current Year vs. Prior Year

<table>
<thead>
<tr>
<th>Metric</th>
<th>Year 5 2016-17</th>
<th>Year 1 of Renewal 2017-18</th>
<th>Difference Year 5 vs. Year 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users</td>
<td>2034</td>
<td>1919</td>
<td>-115</td>
</tr>
<tr>
<td>Sessions</td>
<td>2933</td>
<td>2947</td>
<td>14</td>
</tr>
<tr>
<td>Pages per Session</td>
<td>2.66</td>
<td>2.85</td>
<td>0.19</td>
</tr>
<tr>
<td># New Users</td>
<td>1990</td>
<td>1880</td>
<td>-110</td>
</tr>
<tr>
<td># Returning Users</td>
<td>283</td>
<td>290</td>
<td>7</td>
</tr>
<tr>
<td>Retention*</td>
<td>798</td>
<td>963</td>
<td>165</td>
</tr>
</tbody>
</table>

*Visits which lasted more than 1 page

Table 6: Website Metrics, October 1 to May 31 of Each Year

The top webpages accessed (not including the home page) were approximately the same with the exception of videos making the top five list for last year and BAS IV Controls and Lab Development in the top five for this year.

<table>
<thead>
<tr>
<th>Year 5 (prior grant)</th>
<th>Year 1 (renewal grant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. About</td>
<td>1. Institute</td>
</tr>
<tr>
<td>2. Videos</td>
<td>2. About</td>
</tr>
<tr>
<td>3. Courses and Programs</td>
<td>3. Courses and Programs</td>
</tr>
<tr>
<td>4. Labs</td>
<td>4. BAS IV Controls &amp; Lab Development</td>
</tr>
<tr>
<td>5. Institute</td>
<td>5. Labs</td>
</tr>
</tbody>
</table>

**Videos**

The growing popularity of videos is evident in the metrics for the BEST Center for this reporting period. The center capitalized on this trend by adding 11 new videos to YouTube and the website.

<table>
<thead>
<tr>
<th>Metric</th>
<th>2016-17</th>
<th>2017-18</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Views</td>
<td>1836</td>
<td>2948</td>
<td>60.6%</td>
</tr>
<tr>
<td>Watch Time</td>
<td>7254</td>
<td>9580</td>
<td>32.1%</td>
</tr>
<tr>
<td>Likes</td>
<td>21</td>
<td>19</td>
<td>-9.5%</td>
</tr>
<tr>
<td>Shares</td>
<td>40</td>
<td>30</td>
<td>-25.0%</td>
</tr>
</tbody>
</table>

Table 7: Video Activity, 2016-2018

The top webpages accessed (not including the home page) were approximately the same with the exception of videos making the top five list for last year and BAS IV Controls and Lab Development in the top five for this year.

<table>
<thead>
<tr>
<th>Year 5 (prior grant)</th>
<th>Year 1 (renewal grant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. About</td>
<td>1. Institute</td>
</tr>
<tr>
<td>2. Videos</td>
<td>2. About</td>
</tr>
<tr>
<td>3. Courses and Programs</td>
<td>3. Courses and Programs</td>
</tr>
<tr>
<td>4. Labs</td>
<td>4. BAS IV Controls &amp; Lab Development</td>
</tr>
<tr>
<td>5. Institute</td>
<td>5. Labs</td>
</tr>
</tbody>
</table>
The largest change was the increase in views of videos, which is depicted in Figure 7 below.

![Figure 7: Video activity 2016-17 vs. 2017-18](image)

The three most-watched videos were *GPTC Lab Video*, Jessica Granderson’s 2016 presentation on *Fault Detection*, and the *College of DuPage Lab Video*. All of the top three videos were on technical topics as opposed to more broad topics such as career awareness. This speaks to the depth of the usage of the BEST Center curriculum and to the success of the technical support in helping colleges establish programs in sustainable building technology.

The social media analytics were not available this year and will hopefully be captured for next year’s report.

**Overall Value of Center Products**

Survey respondents were asked their opinions regarding the value of the BEST Center and the nature of its contributions, through open-ended questions. A qualitative analysis of the responses was conducted. Thirteen categories of responses were revealed, and the top six are represented in the chart below.

![Figure 8: Top Six Categories from Follow-Up Survey, FY18](image)
“BEST Centers faculty, staff, and network are excellent. They are always willing to share information, ideas, and experience. At this time, many of the materials are used for inspiration or justification for developing materials that are specific to our program.”—Follow-up Survey Respondent

“As a regional program manager, all of the work and support by the BEST Center is a model program for aligning community college energy efficiency programs to meet the sector workforce needs and employer expectations.”—Annual Impact Survey Respondent

Summary of Center Materials Use
Use of BEST Center resources has consistently grown over the years. The top four BEST Center resources most frequently used by its intended audience were the workshops and materials, sharing of best practices, faculty network and curriculum documentation. While overall traffic to the website remained flat in year one, pageviews, pages per session, and session duration increased. Stakeholders and partners indicated that they derived the most value from learning how to adapt or expand existing courses and add new hands-on lab activities and new equipment to existing labs.

EVALUATION QUESTION 4: To what degree was the nation’s building technician education and workforce development capacity expanded, improved, and/or enhanced?

The overarching purpose of most, if not all, of the activities of the BEST Center is to increase the capacity of the U.S. to meet the need for high performance building operations technicians across the country. The center’s initiatives to increase capacity are:

- Professional development for post-secondary educators on high performance building operations through workshops (BAS) and the annual Best Center Institute.
- Partnerships between industry and education
- Partnerships with STEM/STEAM organizations

The reach, quality, utility, and extent of use resulting from these initiatives have already been detailed in this report. The evaluative question on capacity will be addressed below.

In collaboration with the center leadership, the evaluator identified four indicators for the extent to which the BEST Center increased capacity to deliver technical education in high performance building operations in 2016-17:

- Generation of knowledge:
  - Faculty learning as a result of BEST Center professional development
  - Studies on the knowledge, skills and abilities required for the occupation of the High Performance Building Operations Professional
- Changes in classroom practice as a result of implementing BEST Center materials
- Impact of changes in classroom practice on students and the national workforce
- Impact on programs
Generation of Knowledge

Faculty Learning
Consistent with the BEST Center logic model, it is theorized that an outcome of their work is an increase in knowledge and understanding of high performance building operations careers, education and workforce development. The Center Impact and Follow-Up Surveys asked participants to rate the degree to which they agreed with the statement that information they received from the BEST Center expanded their knowledge of advanced building science and technology. They used a five-point Likert scale for their ratings:

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

There were a total of 48 respondents to this question, and 44 (91.7%) strongly agreed or agreed that the center expanded their knowledge of advanced building science and technology. In addition to the questions asked in the current Institute survey, it is recommended that the center gather data on pre-vs.-post levels of knowledge of building automation systems and high performance building operations.

> All of my courses have benefitted from the inclusion of material that is a direct result of information obtained from discussions and presentations through the BEST Center.—2018 Institute Participant

Task Analysis
Leveraging PI Crabtree’s national leadership in prior years, the BEST Center built on its research on knowledge and skills required for the HPBOP. In 2016 the center sponsored a professionally facilitated DACUM (Developing a Curriculum) focus group to identify critical skills for HPBOPs and key elements of high performance building operations. In early 2017 the BEST Center sponsored a study to validate the eight duties and 116 tasks identified in the DACUM. Surveys were sent to BOMA (Building Owners and Managers Association International) members, and 256 responded with ratings on the following areas with respect to the tasks:

- **Importance (overall building performance):** How important is this task for overall building performance? None / Minor / Moderate / Major / Critical
- **Task Performance:** Who performs this task? I perform / I direct others / I provide input
- **Learning Difficulty:** How difficult is it to learn this task to a proficient standard? Very Easy / Easy / Difficult / Very Difficult

This year, the center focused on converting the tasks that were identified and verified through the DACUM process into a task analysis. Fourteen subject matter experts (SMEs) from diverse regions in the United States, including a few from the original DACUM and some representing unions, convened at the College of DuPage for 4 days under the direction of Ohio State University facilitation experts in task analysis. The SMEs broke down each task into the steps that are required to perform the task and the performance standards used by industry to know when someone has performed each step correctly. In addition, the SMEs provided information on the knowledge and skills that are required for successful task completion, tools/equipment used, and the decisions that a person performing each step needs to make.
The information from the task analysis produced a rich data set on the high performance building operations professional and confirmed the core elements of the pilot HBPOP\textsuperscript{TM} incumbent worker training. In addition, the information will be used to accomplish three key results of the center:

- Develop a national certification for HPBOP
- Create a 2-year AS degree curriculum aligned with national certification.
- Develop a condensed program for incumbent building technician training

The completion of the task analysis is a major step forward for the center in producing those key results.

**Impact on Classroom Practice**

The Follow-Up and Impact Surveys asked participants to share their actions regarding classroom practice and support of students after attending the institute. All of the actions increase the capacity to engage and educate students in high performance building operations classrooms. Overall, 85.0% of respondents indicated that they took at least one action and 81.1% took more than one action. Actions taken are shown in the following table:

<table>
<thead>
<tr>
<th>% of Respondents who Selected Each Option; Multiple Selections were Allowed</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016-17 n=39</td>
</tr>
<tr>
<td>Presentations or lecture materials for existing or new courses</td>
<td>69%</td>
</tr>
<tr>
<td>Enhanced instructional techniques</td>
<td>54%</td>
</tr>
<tr>
<td>Student awareness of educational or career opportunities for building technicians</td>
<td>46%</td>
</tr>
<tr>
<td>Written materials</td>
<td>41%</td>
</tr>
<tr>
<td>Connections to guest speakers from industry</td>
<td>26%</td>
</tr>
<tr>
<td>Modules</td>
<td>13%</td>
</tr>
</tbody>
</table>

Table 8: Capacity-Building Activities by BEST Faculty (Source: Follow-Up and Impact Surveys)

Educators also reported on the manner in which BEST Center resources were used in classrooms. Respondents reported their level of agreement with a series of statements, using a five-point Likert scale:

- Strongly Agree = 5
- Agree = 4
- Neutral = 3
- Disagree = 2
- Strongly Disagree =1

The top two areas of impact were (1) expanded my knowledge of advanced building science and technology and (2) helped me to improve student outcomes.
Impact on Students
The Follow-Up and Impact Surveys asked respondents to estimate the level of impact that BEST materials had on their students, as well as how the students were impacted. Of respondents who believed the question applied to them, 85% reported that the changes made in the classroom had a high or moderate impact on students. Instructors reported an increase in hands-on labs and increased exposure to high performance building operations.
Another measure of the BEST Center’s impact on students is the number of students who complete building technician certificates and degrees supported by the center. BEST building technician certificates and degrees include Associate of Applied Science in such areas as building automation systems, commercial HVAC systems, and energy management. Examples of certificates include electrical systems technology, building-related environmental control, and sustainable technologies.

Below is comparison of data on student completions and placements, using the average of the last three years of the prior grant and year one of the current grant. These numbers reflect the students in programs or courses that incorporated BEST Center curriculum as reported in the Follow-Up Survey and do not reflect the total number of students impacted by BEST Center resources. However, these data indicate trends.

<table>
<thead>
<tr>
<th></th>
<th>Average 2014-17 (n=30)</th>
<th>2017-18 (n=31)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students impacted by BEST Center Curriculum</td>
<td>1,110</td>
<td>1,747</td>
<td>+637</td>
</tr>
<tr>
<td>Completed the program</td>
<td>405</td>
<td>540</td>
<td>+135</td>
</tr>
<tr>
<td>Left program to take a job</td>
<td>181</td>
<td>204</td>
<td>+23</td>
</tr>
<tr>
<td>Remained in the program</td>
<td>524</td>
<td>1003</td>
<td>+479</td>
</tr>
<tr>
<td>Graduates who found technician jobs</td>
<td>182</td>
<td>426</td>
<td>+244</td>
</tr>
</tbody>
</table>

Table 9: Impact on Workforce, Student Completion and Workforce Entry

In year one, compared to the average of the past three years, a higher number of students completed the program, although this represents a smaller percentage of total students in the program. Of note, there was an increase of 479 students (10.2%) remaining in the program, and an increase of 244 graduates who found technician jobs, which is an impressive percentage change of 34.0%.

Below is a sampling of the employers who have supported internships or hired BEST Network graduates:

- **Building Operations**: Able Engineering, Siemens Building Technologies
- **HVAC Companies**: Berkshire HVAC, Climate HVAC, Radiant Heating and Air Conditioning
- **Health Care**: Children’s Hospital at Oakland
- **Manufacturing**: Carrier, Johnson Controls, Siemens, Trane Company, Triatek, Bimbo Bakeries
- **Public Agencies**: City of Sacramento, City of Seattle, State of California
- **Research Labs**: Sandia National Lab
- **Universities**: UC Berkeley, Univ. of Cincinnati, Seattle Colleges

**Ace Mentor Program**
In year five of the prior grant, the BEST Center began a partnership with ACE Mentor, an after-school program which brings students together with design and construction industry companies and professionals. Students receive hands-on instruction from college professors and local construction industry guest speakers and mentors. The BEST Center is providing ACE Mentor its network of colleges with the intention of adding high performance building operations to the ACE Mentor capabilities.

Last year, 33 students completed the ACE program, 13 of whom enrolled in 55 or more classes and Laney College and other Peralta colleges during the summer and fall terms. In addition, in spring 2018, Laney College hosted the ACE Oakland team for the second year in a row. This year, students worked with mentors on short, hands-on exercises, visited the Laney Carpentry, Electrical, and Environmental Control
Technology departments, and were introduced to building automation concepts through an activity using electronic kits. For the final project, students designed a public park and pavilion by using SketchUp and other skills developed during the 16-week program.

ACE Regional Directors plan to continue the expansion of connections with ACE teams in the Northeast, Midwest, and West Coast. An Atlanta, GA, team visited with a GA Piedmont instructor who introduced the BAS program and other trades-related educational/career pathways.

HBPOPTM Training

The goal of the HBPOPTM project is to improve the skills of technicians managing commercial buildings. The center did not conduct HBPOPTM training during the reporting period. However, center staff engaged in several significant activities to enhance the project and prepare for the two trainings scheduled for June and September 2018:

- Conducted task analysis with 13 subject matter experts over 4 days. This group fleshed out the duties and tasks identified in the DACUM for HPBOP, with the goal of identifying specific knowledge and skills areas that can be formulated into 2-year college curriculum and a test for national certification.
- Conducted train-the-trainer sessions for faculty to teach Department of General Services employees in northern and southern California.
- Developed industry-endorsed curriculum for 12 sessions, with professionals from the public and private sector. The content areas are Information Technology, Energy Literacy, Building Systems, Whole Systems Analytics, Systems Manuals, Building Automation Control Systems (BAS), Energy Conservation, Commissioning (Cx) and Continuous Quality Improvement.

Impact on Programs

In year one, the center continued to scale up its support to colleges. The quality of its products and services and its increasing reach are two primary factors contributing to its ability to do so. A key center activity is the provision of technical assistance to individual colleges, led by Co-PI Lovell. This past year, Co-PI Lovell worked with an impressive 17 colleges in 13 states, and continued prior support of 20 colleges in 14 states from last year.

Observed trends for year one can be summarized as the following:
- Increased interest in building automation programs;
- More advanced and frequent requests for technical assistance, including for NSF ATE grant submissions, curriculum review, leadership/stakeholder meetings, and equipment and lab design requests; and
- Increased communication between BEST Center schools.

Silicon Valley Working Group (SVWG)

The SVWG consists of nine companies that meet monthly to collaborate on workforce development issues. Facilitated by Director Wallace, the SVWG identifies HVAC and sustainable building workforce challenges and works together to meet those challenges. The companies are: C & W Services, Impec Group, Enovity, Therma, Slatter Construction Inc., Alexandria Real Estate, Western Allied Mechanical, GSH Group, Able Engineering.
BEST Center Building
This year, Laney College completed construction of the BEST Center building, an active learning laboratory in sustainable building design, construction and operations. The building features two Test Houses (Electrical and Alternate Mechanical Systems) and a Passive House-type Classroom. The classroom is designed to achieve a LEED Platinum certification and is likely to be among the first classrooms in California to meet “Passivhaus” standards. This building is a testament to the college’s commitment to state-of-the-art sustainable building technology education programs.

National and Regional Leadership

Center documentation provided three examples of BEST’s leadership role in the region and across the U.S.

First, the center was selected to lead two different breakout sessions at HVAC Excellence’s National HVACR Educators and Trainers Conference (750 attendees total), Mar. 26-28, 2018, Las Vegas, NV. There were 140 attendees total between the two sessions, which are described below:

- **The ABCs of BAS (Building Automation Systems)** – Presentation by Larry Chang, Bob Clark, and Jeryll McWhorter. The session highlighted the importance of BAS in modern commercial buildings, career pathways, samples of BAS curricula at 2-year colleges, and how to start a BAS course or program.
- **Current Developments in HVAC Instructional Lab Designs** – Presentation by Larry Chang, Bob Clark, and Jeryll McWhorter. The session reviewed instructional lab designs at College of DuPage, GA Piedmont Technical College, and Laney College. Attendees learned about commercial lab development, sources of discounted equipment, and potential Living Lab applications.

In addition, PI Crabtree led a session at the American Association of Community Colleges Workforce Development Institute, which had a total of 670 attendees. This year's theme is “Exploring Intersections,” and he highlighted the ways in which the work in BEST's professional communities intersects with industry, employers, federal, and foundation partners.

Finally, PI Crabtree addressed the YES (Youth for the Environment and Sustainability) Conference, Feb. 24, 2018, held at Laney College. This regional event was attended by 400 high school students from the nine Bay area counties.

Summary of Impact of the BEST Center on Capacity to Educate the Building Technician Workforce

The BEST Center impacted capacity to educate the high performance building operations workforce in a number of ways:

- Generation of knowledge: Faculty learning as a result of BEST Center professional development
- Changes in classroom practice as a result of implementing BEST Center materials
- Impact of changes in classroom practice on students and the national workforce
- National and regional leadership

Survey respondents self-reported that the top ways that they used BEST Center resources to build capacity in their classrooms were to a) develop presentations or lecture materials for existing or new
Courses, b) increase student awareness of educational or career opportunities for building technicians and c) to enhance instructional techniques.

Overall, 85.0% of respondents indicated that they took at least one action and 81.1% took more than one action. In addition, 85% believed that their action had a high or moderate impact on their students. The top two areas of impact were (1) expanded my knowledge of advanced building science and technology and (2) helped me to improve student outcomes.

Regarding student completion and workforce entry, respondents reported a 10.2% increase in students who remained in programs that incorporated the BEST Center curriculum as well as a 34.0% increase in program participants who found a technician job.

The center reported its ongoing role as a regional and national leader by presenting at multiple conferences. The center is also acknowledged for the important work that the center is doing to develop curriculum and certification for the emerging job role of high performance building operations professional.

In year one, the BEST Center expanded its partnership with ACE Mentors and laid the foundation to enhance the HBPOP™ project and training.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions
Year one of the renewal grant saw a continued maturing of the BEST Center, as well as an unwavering commitment to high-quality curriculum and resources, professional development, and technical assistance.

BEST’s efforts to expand and deepen its network and to serve colleges, students and the building technology workforce have been successful on all fronts. Its engagement with industry and institutions continues to offer new opportunities to increase student pathway programs and improve cooperation among all stakeholders. The center added an impressive set of innovations and improvements to its website this year. Of particular note is the link to ZipRecruiter which provides students with a seamless access to the national job market through the BEST website.

BEST gathered evidence of its impact on the technician network in terms of the number and quality of applicants for entry-level positions. There is clear evidence from summative data that the center has made a positive impact on building operations curriculum, classroom results, and student entry into the workforce.

The center continues to make progress in developing and improving high performance building operations technician education for community college students as well as training for incumbent workers. Its work to identify the knowledge and skills required for national certification represents a significant contribution to the field.

The center’s regional and national leadership is supported by its increased presence at conferences; more-advanced and frequent requests for technical assistance from other community colleges; collaborations with new organizations; and co-authoring of a white paper, “Development and Training of Knowledge-
The center’s strategic directions for the coming year include the following:

- continue program implementation through model curriculum, professional development, and technical assistance
- stimulate industry partnerships through HBPOP™ training, lab design, endorsement, and job opportunities for graduates
- track program implementation at partner colleges, as well as student participation
- add content to the website, along with implementing targeted social media tactics
- complete development of national certification
- pursue strategies to engage high school students

In terms of sustainability, the center is exploring establishment of a nonprofit organization to continue operations beyond the NSF funding cycle.

Through its professional development, curriculum development, website content, and strategic relationships, the center has enhanced understanding by educators, students, and families about the relevancy and importance of careers in the high performance building operations industry.

**Recommendations**

The first recommendation is to continue the high-quality work with the workforce and education systems. Additional recommendations as are follows.

1. Obtaining data from partners is a challenge for all centers known to this evaluator. Building on the Reporting Document developed using DropBox Paper by Center Manager Chang this year, it is recommended that the center incorporates reminders and prompts for the partners and co-PIs to fill in the document as the year progresses rather than waiting until April to upload the data. It may also want to start including the external evaluator in the partner/co-PI phone conference meetings to instill the importance and value of evaluation as a way to be more timely with data collection and further institutionalize the data collection process. Finally, the PI could consider requiring partners/co-PIs to insert their data into the Reporting Document on a quarterly basis.

2. It may be productive for the center to work with the external evaluator to develop a methodology to project the number of students reached for the entire population of BEST Center users, including those that did not respond to the survey.

3. The center is encouraged to work with the external evaluator to fine tune the systematic data plan and evaluation checklist at the beginning of each year. These tools assist in the selection of indicators of success and will allow the center to document more fully its evidence of progress toward completion of goals and long-term, sustainable impacts.

4. The center may want to consider adding a question to the Institute application regarding knowledge of specific topics that will be covered in the Institute, and asking the identical question on the post-survey to strengthen its measurement of faculty learning.

5. The center might consider sharing with other PIs in the ATE community and with the college network its innovation to seamlessly link its website jobs page to ZipRecruiter.
6. The center could work with its college partners and continue to explore ways to recruit and retain female students into building systems programs of study that lead to high-demand careers that offer family-sustaining wages.

Finally, if the center decides to pursue a next round of funding, a Collaboration Network (CN) grant from NSF ATE might be worth consideration given the strength of the center’s existing network. If the CN is a possibility, the center could use the next two years to explore the types of network activities, identify measurable outcomes, and develop evidence of success to highlight the value of a CN in high performance building operations education and careers.

The BEST Center provides an excellent example of a high-quality NSF-funded center making an impact on students, faculty, institutions and the workforce. The BEST team is to be commended for its commitment and for its impact on the sustainable building technician workforce.
APPENDIX 1
APPROACH TO EVALUATION
Approach to Evaluation

The evaluation of SCME is primarily based on adaption of the Context-Input-Process-Product evaluation model developed by the Evaluation Center at Western Michigan University, under the direction of Arlen Gullickson, PhD and Daniel Stufflebeam PhD\(^1\). The year’s activities were evaluated following Gullickson’s four essential elements:

1. The degree to which the project is achieving its goals.
2. The level of impact, and the degree to which the project is reaching intended individuals or groups.
3. The effectiveness of the products and services delivered to constituents.
4. Ways in which the project can be significantly improved.

The investigative approaches recommended by the Evaluation Center at Western Michigan University were utilized to produce a theoretically based, complete and comprehensive review of the Center:

- **Objective Orientation**: How closely the products and services meet the stated goals and objectives as stated in the grant proposal.
- **Teaching/Learning Process Orientation**: Based on the perspective of teachers, how the Center activities are assisting or facilitating teaching and learning.
- **Customer Orientation**: From the perspective of students, how the Center activities are improving learning, comprehension and retention.
- **Faculty and Institutional Support**: The degree to which the Center’s efforts are integrated and accepted, and the positive changes resulting from the efforts.
- **Business and Industry Support**: The level of acceptance and support for the Center’s efforts by business and industry, especially those which hire graduates and utilize the technician workforce.
- **Management**: The degree to which processes are in place or under development that leverage the effort with the goal of building on the Center’s activities, products and services after the funding period comes to an end.

Each item in the evaluation plan was considered from one or more of the approaches listed above. The following methods were used to develop the data necessary to cover the topics in the evaluation plan:

- Interviews with Principal Investigator, Center staff, partners and faculty.
- Determination of impacts and influences on technician level education.
- Analysis of documents.
- Analysis of applicable survey and other data gathered to date.

Project data-gathering activities and subsequent data analysis were guided by standards developed by the Joint committee on Educational Standards and Evaluation. All active and passive data gathering activities involving human subjects were approved by the appropriate institutions’ IRB (Institutional Review Board).

APPENDIX 2
STUDENT SUCCESS STORY
The Automated Building Systems (ABS) industry encompasses a broad range of emerging and current technologies.

POSSIBLE CAREERS

• Application Engineer
• Building Automation Systems Specialist, Integrator or Technician
• Control Systems Designer
• Control Systems Installer
• Controls Technician (Field-Based)
• Energy Management Technician
• HVAC Controls Technician
• Systems Technician
• Systems Specialist

RELATED MATC PROGRAMS

• Air Conditioning and Refrigeration Technology
• Power Engineering and Boiler Operator
• Refrigeration, Air Conditioning and Heating Service Technician
• Apprenticeships including Refrigeration and Air Conditioning, Environmental Service Technician, and Industrial Manufacturing Technician

Learn more about MATC's Automated Building Systems technical diploma program:
tinyurl.com/MATCabsdiploma

Return to School Allows Engineer to Build New ABS Career

Few occasions in life can inspire simultaneous terror and exhilaration. Skydiving, roller coasters, public speaking – certainly these fit. Unexpected job loss also ranks high on the list.

Stephen Ferns had worked his entire career as an engineer. A few years ago, this 63-year-old was laid off. Instead of feeling sidelined, he viewed it as a springboard to a whole new career.

With a bachelor’s degree in resource development and a master’s in agricultural engineering, Ferns knew he was employable. Why not head in a new, and possibly more challenging, direction? Additional training would be in order. Ferns checked out Milwaukee Area Technical College. He was drawn to the Automated Building Systems (ABS) technical diploma program.

“I was attracted to energy conservation and renewables, and working with complex controls for water treatment,” Ferns said. “MATC’s program allowed me to pull together some of my heating, ventilation and air conditioning (HVAC) experience and building systems background, and get some good training in the area of controls, how to work with them, set them up, program them and make them work.”

MATC PREPARES PROFESSIONALS TO BUILD THE FUTURE

The push to create more energy-efficient buildings is in full swing, in the U.S. and in other countries. Businesses and other organizations are looking at how they build, while actively seeking ways to:

• Save energy
• Decrease production costs

Due to these objectives, structures outfitted with automated systems are gaining popularity. They are becoming even more necessary as “green,” energy-saving regulations increase. As a result, substantial employment possibilities exist.

To prepare workers with the needed skills, MATC’s Automated Building Systems 25-credit technical diploma program can be completed in two semesters of full-time study. Courses are held in MATC’s new ABS Lab at the Oak Creek Campus, in the Center for Energy Conservation and Advanced Manufacturing (ECAM). Ted Wilinski teaches in the ABS program.
He understands the long-term value these courses have in today’s changing world.

“The graying of America is placing incredible stress on employers looking for new employees,” Wilinski said. “It is estimated that over half the workforce is going to retire in the next five to 10 years. Nationally and locally, the demand for control technicians and associate positions far outstrips the pool of available people. With the announcement of Foxconn and all the supporting industry, demand for workers will be even higher, especially in the technical trades, such as building automation.”

Lighting, mechanical, fire protection, security systems – the shift is on from old technologies to newer, digital controls. Trained and skilled technicians are needed for design, installation, servicing and day-to-day operations.

“Obtaining this diploma provides a basis for being able to change jobs well into the future,” Wilinski said. “With current starting wages between $40,000 and $50,000 a year, before overtime, after just two semesters of schooling, ABS promises to be more than just an incredibly interesting career that combines hands-on with computers and the environment.

There will be opportunities to move around to different positions and industries. Discussions with area technicians suggest that wages up to $90,000 are not unreasonable.”

IN DEMAND – AUTOMATED BUILDING SYSTEMS CREDENTIALS

Ferns recognized the myriad of possibilities. “The program met a lot of the things I was interested in,” he said. “And, I knew it would help me find a job in that field.”

While he attended full-time classes, Ferns worked part time. He admits it was a challenge, especially studying new technical terms and ideas. Having the right attitude was key.

“You have to be able to handle new things, new ways of doing things, if you want something different,” he said. He was especially impressed by his instructors.

“My MATC instructors had so much experience in various aspects,” Ferns said. “They were able to show us several different sides of the industry, which was incredibly helpful.”

Shortly before graduation in May 2017, Ferns started sending out résumés and talking to local employers about openings in the ABS field. It didn’t take long for him to find exactly the type of position he had imagined. He currently works as a building applications systems designer with CBRE.

“The day I got a job offer, I had a request to interview with another firm,” Ferns said. “There is a lot of opportunity out there.”