BUILDING AN ACTIVITY-BASED MODEL FOR ENVIRONMENTAL FOOTPRINT: A PROOF OF CONCEPT CASE

An ABC model for environmental footprint better informs an organization of the environmental resource intensity of its programs, which facilitates long-term strategic decision-making.

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The Environmental Sustainability Interest Group (ESIG) has operated as an active interest group of the Consortium for Advanced Management–International (CAM-I) since September 2009. Anthony Pember served as chair of the interest group for the first five years of operation, followed by the current chair, Mark Lemon. The CAM-I ESIG seeks to leverage CAM-I's body of knowledge in cost and performance management to develop more effective and efficient management tools and techniques for environmental sustainability initiatives. Management tools and techniques examined by the ESIG include target costing and activity-based costing (ABC).[1] The latter has provided a conceptual framework for its use in the context of environmental footprint.

Following on those projects, the ESIG embarked on a proof of concept, applying ABC management to the physical output of a system rather than its financial dimensions (as in a traditional ABC model). Results of that project are described by Malone.[2] This study reports on ESIG's progress since those earlier projects.

Introduction

This article follows on previous work by moving from a theoretical activity-based output model to a proof of concept project that attempts to allocate physical output to objects in a system. Malone described

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the conceptual use of ABC models to allocate environmental output of business operations to cost objects.[3] Since then, the ESIG has applied those models in a proof of concept study of the physical operations at Weber State University.

Building on the conceptual foundations previously described, the ESIG determined to build a prototype ABC model of an existing system using physical environmental outputs rather than the financial costs typical of such models. ESIG members from Grant Thornton LLP volunteered a programming team from their Advisory Services practice to construct the model. A principal challenge, however, would be to find an operational facility that met numerous criteria (some of which we had not anticipated at the outset of the project). Principal criteria included, among others:

- mature operations (required environmental data were available);
- self-contained operations (limited requirement to collect supplier data);
- moderate size (project could be completed in a reasonable amount of time);
- alternative analytic pathways potential (model results could be used for a variety of objectives);
- existing working relationships with personnel;
- environmentally progressive thinking (facility has a sustainability plan and anticipates benefits from the study); and
- executive support (facility envisions broader application, such as more business units).

One of our members volunteered the possibility of a manufacturing facility that operated in a relatively simple, isolated environment (i.e., few, somewhat heterogeneous products, straightforward energy usage, access to management and data). Unfortunately, while we had an initial positive response from management, as we began to discuss details, the plant manager became more reticent. In this instance, the manufacturing plant's primary objective is execution — moving product out the door every day to help final assembly make its production rate. It accepts the product and manufacturing process design as a given. The process to make changes is initiated in R&D engineering. The result of their work is fed back, in time, to the manufacturing floor. Given that the product and process is fixed in the near term (a minimum of a couple of years), an understanding of the relatively benign environmental impact is of little value. By "relatively benign," the plant manager inevitably will prioritize impact of emissions of different types. For example, greenhouse gas (GhG) emissions will be of lower priority than disposition of toxic chemicals, solvents, degreasers, paints/vapor, etc. Initially, our team sought cooperation with individuals with a higher level of strategic responsibility. Once our requests filtered down to tactical management, there was little interest in committing resources to complete the project.[4]

Following the lack of success in our first attempt, another team member volunteered to approach Weber State University — a university with a relatively aggressive environmental sustainability program — to attempt to build an ABC model for the environmental footprint of its campus.

With a strategic goal of carbon neutrality, Weber State has been a leader among state institutions in pursuing environmental initiatives. Over the past decade, every new building built on the Weber State campus has achieved LEED certification, including four new classroom buildings. There are numerous initiatives on campus that emphasize environmental responsibility and sustainable practices, led by key offices including the Energy and Sustainability Office, the Sustainable Practices and Research Center, the Environmental Issues Committee, and Environmental Ambassadors. These groups, in cooperation with Academic Affairs and Administrative Services, seek to ensure that sustainability is not just an isolated effort on campus, but one that includes as many constituent groups as possible. In other words, this organization would seem to be receptive to trying new methods that may offer insight into how Weber State might achieve its expressed goal of carbon neutrality.

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Key players and access to data

Three organizations were instrumental in executing the project: Weber State University provided the organizational setting of interest. Grant Thornton LLP provided experience in executing ABC models in organizational settings, specifically in university settings. Finally, Pilbara Group provided the programming expertise and proprietary ABC software with which to accomplish the task. Several individuals in each organization were instrumental in providing access to the appropriate data, refining the data, and providing expertise in both bringing ABC to a university environment and modeling the data through proprietary software.

Weber State University. At the outset of the project, and with a member of the ESIG employed by Weber State, the challenge of acquiring the appropriate data for the ABC model began. Initially, the ESIG identified the Office of Institutional Research (IR), under Administrative Services (an office at the vice president level within the university), as a likely source of data. IR's participation, however, proved unlikely due to a series of reservations, including sensitivity of student data (under the Family Educational Rights and Privacy Act [FERPA]), lack of local availability (a sense that the requested data resided in a disparate number of locations), general apathy toward the project, and so on. Discussions to which we were not privileged concluded that the effort would be excessive for the perceived benefit and that there may be issues of confidentiality that could not be overcome. Even though we could assure that other universities had undertaken such projects (using financial rather than environmental data) and that Grant Thornton was in a position to generate and sign all necessary nondisclosure agreements, our request was still rebuffed.

A KEY CHALLENGE TO ABC IS THE AVAILABILITY OF APPROPRIATE SOFTWARE, ADEQUATE PROGRAMMING PERSONNEL, AND ACCESS TO SUFFICIENT DATA FOR THE PROBLEM.

While IR was the most obvious office to begin our search, it was not the only possibility. Because the data needed to complete the project resided primarily in three locations — Academic Affairs, Human Resources, and Physical Plant — we approached each of those divisions with descriptions of our project and the data we would require to build the proposed model.

In the case of Academic Affairs, the Provost's Office fully appreciated the efforts to engage in a project that merged academic and practical goals. They lent their support, subject to the need to preserve privacy of student records.[5] Because Grant Thornton had engaged extensively in building financial ABC models for universities and had necessary mechanisms for executing confidentiality agreements, privacy concerns proved to be an easy obstacle to overcome. Grant Thornton prepared the necessary agreements, which were then reviewed and signed by Weber State's legal department.

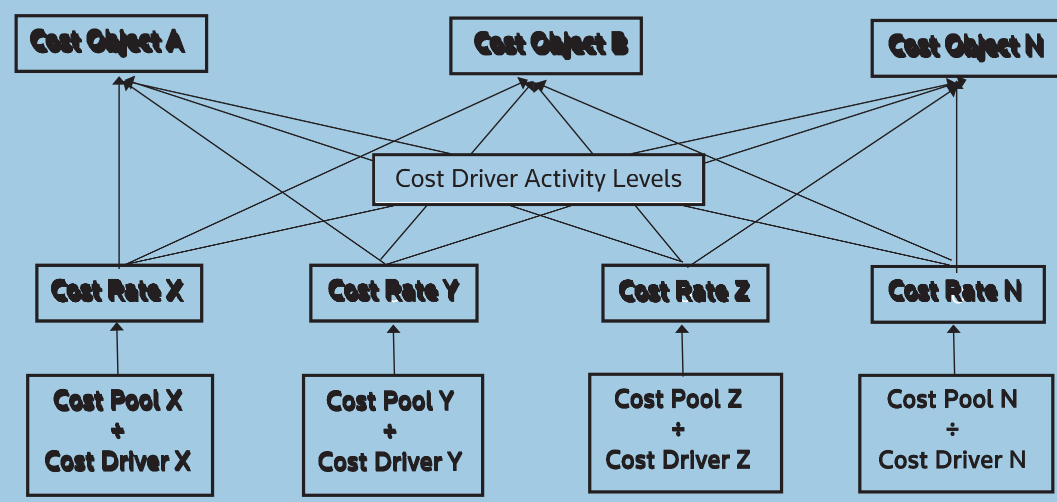
From there, the Provost's Office appointed two key data owners within Academic Affairs to cooperate with the project and provide necessary academic data to populate cost pools and cost driver levels, according to the data to which they had access.

Weber State's Facilities Management division leads the university's efforts to record and evaluate environmental initiatives (as well as implement all physical aspects of those initiatives). As such, they have custody of data that measure the physical emissions of the university. Such measures include GhG emissions, kilowatt hours (kWh), materials waste (e.g., recycled, composted, reused, disposed in a landfill), water use, etc. Because these data were not tied to students and presented no proprietary challenges, Facilities Management personnel became the third party providing the data necessary to build the ABC model.

Grant Thornton. In practice, a key challenge to ABC is the availability of appropriate software, adequate programming personnel, and access to sufficient data for the problem. As described, Weber State provided the data, while Grant Thornton and Pilbara Group provided the software and personnel. With two ESIG members, Grant Thornton, (a member of CAM-I) generously provided ABC model programming expertise. Another CAM-I member, Pilbara Group — a group that specializes in developing software and building cost models for institutions of higher education — provided the software to build the ABC model using data obtained from Weber State.

As previously noted, Grant Thornton and Pilbara have extensive experience working with universities on traditional ABC models. That work has not only familiarized them with the capital and organizational structures, but with the missions and sensitivities of those organizations as well. Thus, Grant Thornton was instrumental in providing the legal path by which we

EXHIBIT 1 Allocating Costs to Cost Objects



acquired access to sensitive data (e.g., student enrollment records) that were necessary to complete the ABC model. Further, programmers at Grant Thornton and Pilbara were able to specify to data owners at the university how they could "sanitize" the data to further ensure compliance with FERPA restrictions.

Defining the scope of the project

Building an ABC model is both capital- and labor-intensive. ABC models, in practice, are built on expensive software platforms that also require high costs to maintain. Additionally, labor to operate these systems (i.e., to program) includes highly skilled, highly compensated positions. Since this project posed challenges to Grant Thornton and Pilbara that would require commitment of both capital and labor, we quickly realized that the scope of the project and defining the environmental footprint would be important and among the most significant challenges of the project. We wanted to provide a proof of concept; however, because important resources of Grant Thornton and Pilbara were to be consumed, the decision was made to limit our scope in a variety of ways.

A significant challenge in comprehensively measuring the environmental footprint of an organization is defining the boundaries of that organization. For example, GhG emissions are generally separated into three categories: Scope 1 emissions occur on site and thus can be attributable directly to the institution. Scope 2 emissions are indirect emissions attributable directly to the operation of the organization, primarily in the form of kWh consumed. Scope 3 emissions include all other emissions that result from activities of the organization but do not occur on site and/or are not controlled by the organization (e.g., air travel of employees, commuting costs).[6] Thus, one limitation that the ESIG addressed was one of depth.

Environmental footprint may be measured across a wide array of outputs. Those include, but are not limited to, GhG emissions (as noted above, and at each level of scope), water consumption, and waste production. Furthermore, an organization can measure these elements in the short term or over a product life cycle. A common comparison, for example, is that of a fuel-efficient conventional gasoline engine to an electric or hybrid vehicle. In the short term, the hybrid vehicle is likely to be more fuel-efficient; however, when expanding the scope of the analysis to include a broader range of environmental footprint and a longer time frame, one must consider the effect of mining

EXHIBIT 2 Summary of Cost Objects and Activities/Activity Drivers (continued on p. 34)

Cost Objects

Primary cost objects (9,638)

1. Courses, broken down by:
   a. college (e.g., Arts and Humanities)
   b. subject (e.g., communication)
   c. course (e.g., COMM 1120)
   d. section, differentiated by campus, term, and modality (e.g., COMM 1120 (20968): HU Principles of Public Speaking, WSU Main, fall term, face-to-face)

Note: Courses are each assigned to programs based on the number of students in each course. For example, English 101 may have students from arts and humanities as well as engineering and nursing. As such, the GhG footprint of the course will be distributed to programs at the three schools based on the number of students in the course enrolled in each program.

2. Research: one research cost object for the entire institution (i.e., no breakdown to a lower level)
3. Auxiliary: three high-level cost objects in this category (one each for Athletics, Health, and Residential)

Secondary cost objects (551)

1. Programs, broken down by:
   a. college
   b. subject
   c. degree
   d. major
2. The same research and auxiliary cost objects as the primary cost objects (to ensure both the primary and secondary cost object modules are fully "costed")

42 building pools used to distribute GhG emissions to the rooms based on square feet

1,302 rooms (or rollup of rooms) that are allocated using a number of different methods

lithium to provide the battery power to those vehicles. In this study, the ESIG assessed the breadth of the project's scope.

In the Weber State project, measurement was limited to the main, Davis, and Morgan campuses. Weber State has two principal campuses with larger scale operations: the main campus located in Ogden, Utah, and the Davis campus located in Layton, Utah (nearer to Salt Lake City and immediately adjacent to the Hill Air Force Base). Also included in the study was a small facility, serving primarily as a testing center, in Morgan, Utah. The university also maintains a smaller campus in Farmington, Utah, with easy access to high-speed rail serving the corridor between Provo and Ogden. The Farmington Station campus was not included in the study, because it was only recently opened.

Ultimately, this project limited the scope to measurement of environmental footprint that included:

- Scope 1 and Scope 2 emissions, translating primarily into kWh; and
- those emissions only consumed on the listed campuses.

Applying an activity-based method

A key value of ABC methodology is that it allows for the attribution of indirect costs (in addition to direct costs) to products and services. In a traditional ABC model, indirect costs are allocated to cost objects. An analysis of the activities establishes a causal relationship between those activities and specific components of the indirect costs (e.g., the number of times a particular activity is performed). Costs are gathered in cost pools associated with the cost drivers to arrive at predetermined rates by which costs can be allocated to cost objects that indirectly consume those resources. This process can be represented as shown in Exhibit 1.

In the following discussion, we provide the specific variables included in the Weber State model.

Cost objects

The objective of ABC is to assign costs to specific cost objects to estimate long-term resource intensity toward the end of making cost-effective resource allocations over time, weighing the relative benefits associated with those cost objects.

Specific objects in this project included the primary products and services at Weber State. The first set of outputs included teaching-related cost objects, such as specific courses and course sections that we then aggregated to specific majors and degrees.

Additionally, research cost objects included faculty, parsed by the proportion of their job description that included research. (Instructors generally were not assigned research costs because their jobs normally do not include a research component. In contrast, tenure-track faculty are nearly always assigned a significant proportion of research responsibility.) Only office space was allocated to personnel on a full-time equivalency (FTE) basis. General space was allocated to all other space (office, teaching, research, etc.) as building overhead. Administrative space (outside of office space) was allocated to the assigned department and the activities performed by that department. It should be noted that space assignment data, the department that "owns" the space, were less than ideal, and many assumptions had to be made.

Finally, self-sustaining activities within the university were assigned as cost objects. These included such groups as athletics, the bookstore, dormitories, food service, etc. Including cost pools, 9,638 primary cost objects were included in the model, broken down by logical academic categories of courses (broken down by college, subject, course, and section), research, and auxiliary services (in the case of Weber State, athletics, health, and residential).

Model values

First, we confined value in the model to metric tons of carbon dioxide equivalent ($MTCO_2e$). $MTCO_2e$ was calculated by converting energy consumption data on campus, captured by Weber State facilities as electricity and natural gas consumption, to emissions based on fixed rates defined by the U.S. Environmental Protection Agency. Data for energy consumption were provided by building by Weber State Facilities Management. The $MTCO_2e$ values originate in the facilities module of the model and "flow" through the model using a number of different assignment and allocation methods.

Model assignments

To allocate building-level energy consumption to the correct activities, products, and services, cost pools were organized by the activity that would serve to drive those costs. These cost pools organize all space at Weber State into the following categories:

1. instructional space (classrooms, teaching services, and labs);
2. office space;
3. auxiliary space (residential, athletic, and other); and
4. other (general space, building services, mechanical, circulation, support, and special use).

Teaching and related services included all space dedicated to extending education services to students — classrooms, student labs, testing centers, tutoring facilities, etc. These spaces were assigned to departments and colleges based on the classes that used the space (e.g., Botany 1403, taught in the Tracy Hall Science Building, was assigned to the botany department). Unused space (i.e., time when a classroom is idle) was allocated to the assigned owner of that space (e.g., the greenhouse on top of the science building was a dedicated facility specific to the botany department).

When possible, office space costs were pooled and assigned to those objects to which they were purposed. For example, room 259 in the Wattis Business Building was assigned to an associate professor of accounting whose job responsibilities were divided among teaching, research, and service. The proportions designated to each

THE OBJECTIVE OF ABC IS TO ASSIGN COSTS TO SPECIFIC COST OBJECTS TO ESTIMATE LONG-TERM RESOURCE INTENSITY.

EXHIBIT 2 Summary of Cost Objects and Activities/Activity Drivers (continued)

Resource (facilities) drivers used	Use
Building services	Drives building service space to all teaching or research space in same building and assigned owner based on square feet. If space is not assigned, then it allocates based on square feet to any teaching or research space in building regardless of the assigned owner. This is essentially treating the space using this driver as overhead for teaching and research space. This driver is used by the following space types: • general use • building services • circulation • mechanical • support
Credit hours	Assigns the resource to destination objects based on the total number of credit hours associated with each destination object. This was used in only two instances as a driver of last option to allocate GhG emissions to courses.
Evenly assigned	Used to assign space where the relationship to the destination object (activity or cost object) was one-to-one. This driver was most often used for research, athletic, or auxiliary space where the room GhG emissions were assigned to a single research, athletic, or auxiliary activity.
Room hours	Allocates teaching and instructional space to classes based on hours scheduled for each class. Excess hours (derived by summing all scheduled hours and subtracting from 1,600, chosen as the maximum number of hours instructional spaces are available) are pooled by assigned owner and distributed to all courses taught by the owner at the same campus based on total credit hours.
Total credit hours matching campus	Drives instructional facilities to courses based on campus and total credit hours. This driver is used to send instructional facilities excess capacity to courses. It is also used as an alternative to “room hours” when instructional space was not scheduled.
Teaching services	Drives teaching service space to teaching space in the same building based on square feet of teaching space.
Total FTE (HR)	Drives office space to personnel in HR module based on total FTE. (Note that due to mismatches in assigned owner data between facilities data and HR data, it was necessary to essentially pool all office space and allocate it to everyone. As such, personnel in departments or organizations that have a large office footprint are receiving less GhG emissions than they should.)

were then used to drive costs to the related cost objects (i.e., teaching-related and research-related cost objects). More specifically, academic GhG footprint was aggregated within teaching departments in three pools: teaching, research, and service. The teaching pool was allocated to all courses taught by the department; research was allocated directly to a research cost object; and service GhG emissions were allocated to both teaching and research cost objects for the department based on the academic FTE directly contributing to the cost objects. In turn, those costs were pushed down to the student level, adding to the environmental footprint incurred to produce a Bachelor of Science in accounting, an accounting minor, a Master

1,839 personnel objects that receive GhG emissions from office space and pass them to activities based on the organization they work for and the role/position of the employee:

Resource (HR) drivers used	Use
Default activity	Used to allocate non-academic personnel to the default activity for the organizational area.
Workload split	Used to split academic time between teaching, research, service, and administration. The model uses a generic profile that can be refined all the way down to the individual. The generic profile currently splits time as follows: • teaching: 60% • research: 20% • service: 20% • administration: 0% The model does not currently differentiate between the workload for lecturers and tenure-track professors, but it can if needed. The reason for this lack of differentiation was a lack of confidence in the source data identifying the different academic types.

Activities

436 activity instances, with 15 unique activities used throughout the model multiple times in different organizational areas. The 15 unique activities are as follows:

Conduct external engagement
Conduct Office of the President activities
Provide academic support
Provide administrative services
Provide athletics support
Provide enrollment/admissions services
Provide financial services
Provide IT support
Provide operations and maintenance services
Provide police/emergency services
Provide research support
Provide student support
Research
Service
Teach

of Taxation, or a Master of Accounting graduate (and, of course, specific coded identification of the students in those classes was achieved via student records provided by Weber State).

Other space not specifically included in teaching or office pools was investigated and assigned to appropriate objects. For example, a lab designated specifically for research and not as a student lab was pushed to the research cost object; weight rooms designated for varsity athletics were pushed to the athletics cost object, and so on.

Unassigned or excess teaching space was assigned to courses taught at the campus based on total credit hours. Unassigned space was pushed to each of the cost objects discussed. A summary of cost objects and

EXHIBIT 2 Summary of Cost Objects and Activities/Activity Drivers (continued)

Activity Drivers

Activity drivers used	Use
Academic FTE	Assigns source activity to destination objects based on the academic FTE on the destination objects (direct academic personnel).
Academic FTE (Davis only)	Assigns source activity to Davis campus destination objects based on the academic FTE on the destination objects (direct academic personnel).
Academic FTE + student FTE	Assigns source activity to destination objects based on the academic FTE and student FTE on the destination objects (direct academic personnel plus student FTE).
Credit hours	Assigns the source activity to destination objects based on the total number of credit hours associated with each destination object.
Evenly assigned	Used to assign activities where the relationship to the destination cost object is one-to-one. Typically, this is used for research and auxiliary activities.
Square feet utilized	Assigns the source activity to destination objects based on the number of square feet of room space directly consumed.
Student FTE	Assigns source activity to destination objects based on the student FTE associated with the destination objects (student FTE is loaded on courses based on enrollment information).
Student FTE (Davis only)	Assigns source activity to destination objects based on the student FTE associated with Davis campus destination objects (student FTE is loaded on courses based on enrollment information).
Total FTE	Assigns source activity to destination objects based on the total FTE on the destination objects (direct academic and non-academic personnel).
Total FTE + student FTE	Assigns source activity to destination objects based on the total FTE and student FTE on the destination objects (direct academic and non-academic personnel plus student FTE).

activities/activity drivers used in the model is provided in Exhibit 2.

Current status

Currently, work continues to be done in the development and refinement of drivers used across different organizational cost objects. For example, as a broad cost pool is established from non-owned resource consumption (as described), drivers and activity levels must be refined in order to push those costs down to specific cost objects: How much environmental footprint of the grounds maintenance department for the main campus should be allocated to an accounting major? What is the driver that best specifies resource consumption by that person? Is it, for example, related to the number of online courses in which that person enrolled during his or her academic career? Or in a semester?

The ESIG currently has a working ABC model for Weber State, constrained as described. Within those constraints, however, there is still a fair amount of work necessary to arrive at a point where that model will be demonstrated for administrators and other concerned parties at the university.

Overall, the Weber State project is essentially complete, with only presentation to the client remaining (at the time of this article's publication). Because the project was offered to Weber State on a volunteer basis, and because of the new terrain the project was exploring, the time frame has been extended to just over a year. Normally, the project team would expect a project of this magnitude to take approximately two to three months.

Conclusions

The ESIG at CAM-I is in the process of developing a working ABC model of environmental emission effects at Weber State University. The most significant challenges encountered were obtaining administrative support, identifying the most relevant cost objects, forming cost pools, and identifying cost drivers most closely aligned with those pools. We also found that because of the complexity of emissions and ancillary emission effects (e.g., students' commuting distances), the scope of the study was necessarily limited to address those constraints. These limitations, most importantly, were $MTCO_2e$ effects of commuting or university-related travel.

Also significant was consistency of data. Because facility data were not provided by Weber State's banner system, many key fields used to link to other sources were not using common data. For example, the "assigned owner" field that designated the department or organizational area to assigned office space did not correlate to the organizational areas captured in the finance and HR systems. Similarly, the teaching departments that were assigned teaching space in the facilities data were not aligned with the teaching departments within the student and timetable systems. These data disconnects required crosswalks to be developed and assumptions to be made.

Excluded, too, were sources of environmental footprint other than $MTCO_2e$, notably waste (short-term, including garbage/trash, and long-term, including life cycle costs, such as the materials used in facilities) and water consumption. In a comprehensive ABC project of this nature, these components of environmental foot-print would comprise an important component of cost pools.

Ultimately, the purpose of building an ABC model as described is to better inform an organization of the environmental resource intensity of its programs. While caution should be used in employing such a model in tactical or short-term decisions, the model significantly informs management for long-term, strategic decisions (e.g., providing "fully burdened" environmental footprint data for facilities and the relationship between that footprint and the cost of offering disparate programs across campus).[7] ■

NOTES

1 Hendricks, J.R., "Managing environmental sustainability using target costing principles," CAM-I (2013) (white paper); Pember, A. and Lemon, M., "Measuring and managing environmental sustainability: Using activity-based costing/management (ABC/M)," CAM-I (2012) (white paper).

2 Malone, D., Cost management tools for the environmentally sustainable firm, *Cost Management* 29, no. 2 (2015): 41–47.

3 *Ibid.*

4 Hendricks, J.R., "Lessons learned: The Boeing Company pilot project to implement environmental activity-based costing/management principles," CAM-I (2016) (white paper).

5 Weber State University assumed responsibility for ensuring all student data were provided with substitute identities to ensure anonymity of the data.

6 For an excellent discussion of the nature of these emissions, see: Bodine, J., "Weber State University climate action plan: Progress report for FY 2016," Weber State University (June 30, 2017). Available at: https://apps.weber.edu/wsuimages/sustainability/Plans%20and%20Reports/FY2016WSUSustainabilityReport.pdf.

7 Key contributors to this article were Mark Lemon (Grant Thornton LLP), Anthony Pember (Grant Thornton LLP), James Hendricks (Boeing), Michael Gerding (Pilbara Group), and Jacob Cain (WSU).