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# Engineering the UN Post-2015 Sustainable Development Goals

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He has also been actively involved the American Society of Civil Engineers, serving on the Educational Activities and Continuing Education committees as well as the Technical Council for Computing and Information Technology. He is active in the Transportation Research Board serving on Properties of Concrete and Design of Pavements committees.

Dr. Mohsen was named Engineer of the Year in Education by the Kentucky Section of ASCE in1999 and 2007. He received the University of Louisville Distinguished Service to the Profession Award in 1999 and 2009. He received the Distinguished Teaching Professor Award in 2003. He is a Fellow of ASCE as well as ASEE.

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# The UN 2015-2030 Sustainable Development Goals: The Role of Civil Engineering

## Introduction

The United Nations (UN) Post 2015 Sustainable Development Goals(SDGs) were approved at the end of September 2015 and became effective January 1, 2016. There are 17 goals and 169 targets and they replace 8 Millennium Development goals with 18 targets.[1] The new goals will guide UN sustainable development activities over the next 15 years. The UN has been a major driver of sustainable development beginning with the 1987 Brundtland Report, followed by numerous summits, agreements, and the Millennium Development Goals.

Table 1 - UN Sustainable Development Goals

| |
|---|
| 1. End poverty in all its forms everywhere |
| 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture |
| 3. Ensure healthy lives and promote well-being for all at all ages |
| 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all |
| 5. Achieve gender equality and empower all women and girls |
| 6. Ensure availability and sustainable management of water and sanitation for all |
| 7. Ensure access to affordable, reliable, sustainable and modern energy for all |
| 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all |
| 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation |
| 10. Reduce inequality within and among countries |
| 11. Make cities and human settlements inclusive, safe, resilient and sustainable |
| 12. Ensure sustainable consumption and production patterns |
| 13. Take urgent action to combat climate change and its impacts |
| 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development |
| 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss |
| 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all |
| 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development |

These goals will provide many challenges and opportunities for engineers worldwide. The World Federation of Engineering Organizations (WFEO) provided input to the UN goal setting process.[2] The WFEO represents the global engineering community at the UN and engineering societies based in the United States participate in WFEO through the American Association of Engineering Societies (AAES) International Activities Work Group Task Committee on WFEO.[3]

So what are the implications for civil engineering and how can they be implemented in higher education? Under Goal 4, one of the targets is "by 2030 to ensure that all learners acquire the knowledge and skills needed to promote sustainable development." Engineering graduates will need to have a deeper knowledge and understanding of sustainable development and their overall university education needs to provide context particularly in the social aspects of sustainable development. It seem likely that many universities will try to address sustainable development broadly and engineering students should benefit.

A number of the goals e.g. Goal 6 - water & sanitation, Goal 7 - sustainable energy, Goal 9- resilient infrastructure, and Goal 11 - resilient and sustainable cities are heavily dependent on civil engineering. However, an examination of the targets for even these goals that are heavily engineering should make it clear that achieving sustainable development as defined in the Goals will require a transdisciplinary approach.

The American Society of Civil Engineers (ASCE) has been very involved in developing sustainability targets and transformative policies in recent decades. Canon 1 of the ASCE Code of Ethics states

> *Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.*

ASCE defines sustainable development as

*"... the process of applying natural, human, and economic resources to enhance the safety, welfare, and quality of life for all of the society while maintaining the availability of the remaining natural resources."*[4]

In addition to the Code of Ethics, a number of ASCE policies deal with sustainable development and can be related to specific SDGs. Policy 418 outlines the role of the civil engineer in sustainable development.[5] Policy 517 supports the Millennium Development Goals and will soon be replaced by a policy on the Sustainable Development Goals although the main thrust of the current Policy 517 on poverty fits very well with the SDGs.

SDG 6 - "Ensure availability and sustainable management of water and sanitation for all" cuts across several areas of civil engineering and there are relevant policy statements. Under each of the SDGs there are specific targets and for Goal 6 there are six targets.[6] The UN and its member states are developing metrics for assessing progress in meeting all the goals. For the Water Goal,

UN Water is taking the lead.[7] UN-Water is the United Nations inter-agency coordinator for all freshwater related issues, including sanitation.[8] Freshwater availability is a critical issue in many areas of the world including the U.S. as the current drought in California is demonstrating. Target 6.4 is to

> *By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity*

The UN is only in the first year of implementation of the new goals but there are already many opportunities for faculty members and students to engage and there will be more in the future. Civil engineering educators can play an important role in ensuring that higher education provides all graduates with an appropriate working knowledge and understanding of sustainable development. The purpose of this paper is to outline the role civil engineers can play and some opportunities for faculty members to contribute to achieving the goals as engineering educators - preparing the next generation of civil engineers - and as engineering professionals.

## Civil Engineering Higher Education Curriculum Opportunities

ASCE has a Committee on Sustainability and one of its subcommittees deals with formal engineering (university-based) education. The Formal Engineering Education Committee (FEE) believes that education on sustainability should be integrated throughout a program with both breadth and depth. The following sections provide a number of suggestions for providing breadth starting in the first year and then throughout the curriculum. This is followed by ideas for deepening and applying the sustainability knowledge base with respect to civil and environmental engineering in the curriculum.

### *Beginning*

A good way to start would be to include a discussion of the SDGs in an introduction to civil engineering or introduction to engineering course. This would serve several purposes. First for ABET it would be a start in satisfying the current general criteria especially the following Criterion 3 outcomes:

> (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
> (i) a recognition of the need for, and an ability to engage in lifelong learning
> (j) a knowledge of contemporary issues

and the Criterion 5 curriculum requirement

> (c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

Equally important for civil engineering programs, this could be part of a strategy to address the new ABET civil engineering program requirement.

Washington State University is already starting; first year students interested in engineering take a class titled Introduction to Engineering. There are between 350 and 400 students who take this course annually with sections offered in both the fall and spring semesters.

In the spring of 2016 as part of a series of class activities to introduce the students to sustainability students will do the following:

1. Before the class, individual students will review the list of the UN Goals for Sustainable Development and prepare a notebook entry of the following:

- *Identify* one of the goals on the list that was "unexpected" to you. *Add two or more sentences discussing*; Why this goal was unexpected? AND Why you think it might have been included in the list?
- *Identify* one of the goals that you would like to be involved in. *Add two or more sentences* discussing; Why is this goal interesting to you? AND How do you feel this goal would be connected to your choice of engineering discipline or career?

2. During the class:

- Students will share their selected UN Goals and reasoning with a group for comparison and discussion (Note that the students will also be doing other sustainability activities before the class and will also discuss those activities in this group, including the definition of sustainability.)

3. The following week, students will take a short participation quiz that will include an open response question asking students to recall two UN goals.

Note that the students will only get the goals list, not the whole document. This exercise will provide some data on what engineering students know about the goals and what interests or potentially inspires them.

*Broadening*

For ABET outcome 3(h), students could be motivated with their advisors to plan the general education component of their programs to provide the background to understand sustainable development holistically.[9]

New ABET general engineering criteria are under consideration but a discussion of the SDGs in an introduction to civil engineering would still work. Relevant proposed outcomes are:

> 5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
>
> 6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.[10]

And for the proposed curriculum requirement

> (c) a broad education component that includes humanities and social sciences, complements the technical content of the curriculum, and is consistent with the program educational objectives.

With the proposed broad education requirement, it would help if programs could identify appropriate humanities and social science courses that address sustainable development. Some universities have lists of courses with sustainability or sustainable development content and there will probably be more; see for example Boston University.[11] Some schools have or will be developing minors in sustainable development. The Johns Hopkins School of Engineering has a minor in sustainable development that is open to all engineering majors and students in Arts & Sciences with permission of the program director.[12] Although not completely up to date, a good place to look for information on what universities are doing is the University Leaders for a Sustainable Future website.[13] A role for civil engineering faculty members mentioned earlier is working with colleagues across their campus to ensure all students have a knowledge of sustainable development.

*Deepening*

Looking in more detail at the SDGs, specific goals and targets could be addressed in introductory upper division courses. This would be one way again to address the new civil engineering program criterion. This is also the time to explore with students the important role sustainable infrastructure in the different sectors conceived, designed, constructed, and managed by civil engineers can play in meeting the Goals.

Programs could also address issues raised in the ASCE Body of Knowledge (ASCE BOK2) that are not addressed in criteria.[14] Outcomes in the BOK2 go well beyond current ABET general criteria and the new program criterion; the new program criterion partially addresses BOK2 outcome ten - Sustainable Development. Sustainable development could be embedded in discussions of leadership, project management, business, policy, and ethics and other professional practice topics.

Table 2 Opportunities in Upper Division Civil Engineering Courses

| UN Sustainable Development Goal | Courses |
|---|---|
| **Goal 6** Ensure availability and sustainable management of water and sanitation for all | Introductory Courses in Water Resources and Wastewater Treatment |
| **Goal 11** Make cities and human settlements inclusive, safe, resilient and sustainable | Introductory Courses in any field of civil engineering |
| **Goal 15** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss | Introductory Course in Environmental Engineering |

*Applying*

There are many co-curricular and professional opportunities for applying the goals.

Engineers for a Sustainable World (ESW) is primarily a student organization with chapters on more than 50 campuses.[15] ESW has ongoing and completed projects that would fit under the SDG on water.[16]

Engineers Without Borders (EWB) is directly working on SDGs e.g. water - match countries with least water; countries where EWB is working.[17] Kumar provided a young engineer's perspective on the SDGs at the finance meeting in Ethiopia.[18] Kapanzhi et al describe the use of the Envision rating system for assessing social sustainability for a EWB project in Togo.[19] Recent posts on the EWB Blog highlight some of the opportunities the SDGs present including opportunities in water, sanitation, and healthcare.[20]

There are many examples, of civil engineering students participating in local and national ASCE sustainability activities including workshops and conferences. Going forward, ASCE Student Chapters could have speakers on the SDGs.

In addition, faculty members can contribute to professional activities supporting the SDGs at the local, national, and international levels. Think global and act local; sustainable development opportunities at the local level include serving on planning and zoning committees and sharing their civil engineering expertise. There may be opportunities to talk about the SDGs and how they relate or could relate to local infrastructure needs.

Civil Engineering Professional Opportunities

And of course, practitioners can contribute to the SDGs in their practice and also in professional society activities. ASCE has local and national committees working on sustainability and sustainable development. For example, the ASCE National Capital Section (NCS) has a sustainability committee.[21] The NCS committee supports the annual USEPA $P^3$ competition and makes an award for a sustainable project of the year.

At the national level, there is the ASCE Committee on Sustainability that has already been mentioned.[22] Some of the ASCE Institutes have sustainability committees; for example, the Structural Engineering Institute (SEI).[23] The ASCE Official Register that is available for free download provides information on how to become active in ASCE committee work.[24] Becoming a corresponding member of a committee is an excellent way to get involved. Corresponding members can not vote but they can attend committee meetings and receive all correspondence. Committee vacancies are often filled by corresponding members.

There are a number of non ASCE profesional opportunities with ASTM and TRB being just two examples where civil engineers are very active. The ASTM International E60 Committee deals with standards affecting sustainability broadly.[24] The Transportation Research Board (TRB) has committees that deal with sustainability; see e.g. Transportation and Sustainability.[25]

The World Federation of Engineering Organizations (WFEO) represents the engineering profession at the United Nations.[26] WFEO interacts with the UN through its WFEO UN Relations Committee (WURC) and WFEO does its work through ten standing technical committees. The input provided to the UN connected the 17 goals to the work of the WFEO standing committees including the Standing Committee on Engineering Education.

U.S. engineering societies participate in WFEO through the American Association of Engineering Societies (AAES) that is the U.S, national member of WFEO. AAES works though its International Activities Committee (IntAC) and its WFEO Task Group.[27] ASCE is a member of IntAC and the WFEO Task Group. Faculty can volunteer through their professional societies for WFEO standing Committees.

As mentioned earlier, the WURC provided input to the UN on the SDGs on behalf of the global engineering community. An AAES task force on sustainability supported this effort and will continue to support implementation of the SDGs going forward.

What Else Can You Do?

The FEE is committed to supporting implementation of the UN SDGs and is initiating the following actions and invites your support and participation:

- A module for introduction to civil engineering courses on the Sustainable Development Goals
- A webinar on ways to engage in SDGs activities.
- A list of university sustainable development education resources to be available on the web

The UN is encouraging stakeholder involvement and one of the ways it is doing this is by encouraging stakeholder partnerships though their sustainable development knowledge platform.[28] On the Beta site, partnerships can be searched by goal. Goal 4 is the education goal and can be searched to see what is going on in education but more importantly to learn about and participate in global networks to share and enable the best ways to educate students about sustainable development.

## Summary

The new UN Sustainable Goals extend until 2030 and there will be many opportunities for faculty members and students to be involved.[29] Take advantage of technology to find out how the goals are being implemented around the world and to share and enable some of the initiatives your program or university is taking. In addition, consider implementing educational interventions for both breadth and depth of knowledge in the curriculum. With breadth provided in both engineering and other university classes, while depth in engineering knowledge is given in both the upper level engineering classes and with applications to practice. Finally, networking within the engineering professional community, with and beyond the university setting will aid in furthering these future sustainability goals in the next two decades.

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