

AAU, NMSU, METEC Systems Engineering Initiative

Phase I Report

September 30, 2013

Acknowledgements

The activity described in this report grew from a team visit in spring 2012 led by Tilahun Adera, dean of NMSU's College of Health and Social Services and native Ethiopian. Adera was accompanied by a team of NMSU researchers that included Ricardo Jacquez, dean of NMSU's College of Engineering; Kathleen Hales, professor in the Southern New Mexico Residency Program; Sam Fernald, professor of animal and range sciences; and Frank Ward, professor of agricultural economics and agricultural business. The purpose of the trip was to form educational partnerships inside and outside of Ethiopia; form research partnerships in water resources, water management and water and health issues; and network with Ethiopian university leaders and other dignitaries to build educational relationships between NMSU and Ethiopia.

As a result of that visit, Ed Pines, head of the NMSU Industrial Engineering Department hosted Daniel Kitaw, chair of the Addis Ababa University Industrial Engineering Department for a sabbatical in fall semester 2012. Discussions between Pines and Kitaw led to a realization that a class in complex systems engineering would be of clear value to both students and professionals in Ethiopia.

I wish to thank Professor Pines for his financial support of this project and for his guidance throughout. Deans Jacquez and Adera were key to making this project a reality with their enthusiastic support and knowledge of the academic landscape in Ethiopia. METEC, under the guidance of Sergeant Tomas Deress, is to be thanked for providing for all of my logistics – including housing, food, and transportation – while in Ethiopia. Finally, Professor Kitaw and Ephrem Giday (PhD Candidate at Addis Ababa Institute of Technology) provided much in the way of intellectual capital in helping make this project a success. Mr. Giday provided an excellent overview of the results of the panel deliberations (see attachment 8).

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Background

The AAU~NMSU~METEC Systems Engineering Initiative (SEI) is directed toward applying advanced systems engineering approaches – via the three academic cornerstones of teaching, research, and service – to help develop and implement resolutions of issues that are vital to the Federal Democratic Republic of Ethiopia (FDRE). This initiative employs a strategic planning tool (the Vital Issues Process) to identify and prioritize the vital issues (see Attachment 1 for an overview of the VIP). Next, a one-week survey class in advanced systems engineering was provided to the METals and Engineering Corporation and other professionals (see Attachment 2 for an outline of this class). The case study that was the focus of the survey class was drawn from the high priority vital issues that were identified via the Vital Issues Process. Finally, an executive level class in advanced systems engineering was offered to senior executives. The executive level class was intended to familiarize senior executives with the methodological approaches associated with advanced systems engineering by way of demonstrating the results of

the Vital Issues Process and the outcomes of the survey class project. The three academic cornerstones are fundamental to this initiative insofar as the *teaching* is accommodated via the two classes, the *service* is addressed by building the class project around issue(s) that are vital to the FDRE, and the *research* dimension will be a natural outcome on the portfolio of options that are identified for resolving the vital issues.

Approach

The modules within Phase I of the AAU~NMSU~METEC SEI were as follows...

Module I: Conduct a Vital Issues Process

Module II: Provide a Survey Class in Advanced Systems Engineering

Module III: Provide an Executive-Level Class in Advanced Systems Engineering

In the spirit of the Systems Engineering (SE) paradigm, the purpose of Module one was to help 'Define the Problem'. Continuing with the SE paradigm, the purpose of the second Module was to help 'Design the System Solution'. Finally, again continuing with the SE paradigm, the purpose of Module three was to help (a) verify requirement inherent in the problem solution and (b) present a preliminary model of the system solution.

Results

The results of Modules I and II are contained in Attachments 3 and 4. The final deliverables for each of the class project teams are contained in Attachment 5. A valuable addition to Module II was the inclusion of a special session on Engineering Ethics. A list of the students completing the SEI training is contained in Appendix 6. The results of the Ethics Session are included in Attachment 7. It is noteworthy that although Module III was offered, the senior executives were unable to attend because of other pressing needs. Finally, in order to help gauge the perceived value of this initiative to the students, an evaluation form was completed by each of the students taking the survey class. The results of the evaluation are contained in Attachment 8.

Recommendations

The value of the AAU~NMSU~METEC Systems Engineering Initiative will be enhanced by documenting the substance in various media. Activities suggested include the creation of Web pages, the presentation of the SEI results at appropriate technical conferences, and the publication of the SEI methodology in relevant technical journals. The SEI Web pages should be accessible via the AAU/AAiT (<http://www.aait.edu.et/>), the NMSU (<http://engr.nmsu.edu/>), and the METEC (<http://www.metec.gov.et/index.php/en/>) home pages and should be designed to provide the SEI substance to potential students, researchers, and other government/corporate partners. Initial discussions with representatives of AAU, NMSU, and METEC have set the stage for implementation of these Web pages. Technical conferences that may be of value for the SEI include those organized by the International Council on Systems Engineering (<http://www.incose.org/symp2013/>), the European Conference on Complex Systems (<http://www.eccs13.eu/>), World Congress on Engineering Education (<http://www.wfeo-ceie.org/wcee.php>). Potential technical journals that may be viable for publication of the SEI activity include Applied Research in Quality of Life (<http://link.springer.com/journal/11482>), Journal of Policy Modeling (<http://www.journals.elsevier.com/journal-of-policy-modeling/>), and

Finally, representatives of both AAiT and METEC highlighted the need for a significant increase in graduate-level ~ in particular, PhD-level ~ engineers throughout Ethiopia. One guesstimate¹ is that Ethiopia will need more than 200 additional PhD-Level engineers over the next 5 to 10 years². Further, these representatives encouraged the involvement of NMSU in helping fill this need. To this end, activities worth consideration include:

- (1) Developing a good understanding of the current and future needs of Ethiopia for PhD-level engineers, and
- (2) Explore the feasibility of helping meet these needs through a Distance Education PhD Program.

Regarding (1) above, one approach is to develop a model of the current and future demand for PhD-level engineers in Ethiopia. The guesstimate of 200 additional PhD-Level engineers was just that. In order to have a credible estimate of the actual numbers of PhDs needed, careful attention to the plethora of details involved in making such a forecast is essential. Clearly, any such model will have elements of dynamics and stochastics while being parameterized by surveys and benchmarking. This is a formidable task and one which should only be undertaken after careful consideration of the costs and benefits of developing such a forecast. Regarding (2), careful attention should be paid to both (a) ensuring quality while (b) managing the quantity. To honor the spirit and intent of ensuring quality in the Distance Education Engineering PhD Program, the institution of PhD Qualifying, Prelim, and Final exams should be carefully managed. Regarding (b), managing the quantity, the initial transients in any Distance Education Engineering PhD Program should be carefully forecast, measured, and controlled to the extent possible. One possible model is for NMSU to initially service the need for engineering PhDs with a manageably small number of students. If the demand is, indeed, of the order of more than 200 engineering PhDs over the next 5 to 10 years then a careful analysis of the costs and benefits of forming a consortium of Universities to service this need. If the analysis yields a conclusion that moving forward with a consortium is warranted, then should NMSU could consider taking the lead in forming such a consortium.

Attachments

Attachment 1: Overview of Vital Issues Process

Attachment 2: Module I Materials

¹ This information was conveyed via a private communication with an AAiT faculty member/administrator and with a METEC representative.

² It is noteworthy that one of the four Vital Issues identified as important for Ethiopia is “Brain Drain”. More specifically, this Vital Issue was defined as “The *Brain Drain* in certain critical areas is too great to support sustainable development.” Clearly, this issue must be addressed in order to help ensure that the net increase in the number of PhD Engineers is sufficient to meet Ethiopian demand.

Attachment 3: Module II Materials

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