



SEPTEMBER 6, 2021

Submitted in Support of: Auburn University System Engineering Technician
(SET) Program Development and Application (CS-20-1601)

PHASE 1 FINAL REPORT

SYSTEMS ENGINEERING TECHNICIAN PROGRAM

AUBURN UNIVERSITY
INSTITUTE FOR DIGITAL ENTERPRISE ADVANCEMENT (IDEA)
VICTORY SOLUTIONS
CALHOUN COMMUNITY COLLEGE

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1 SET Objective

The overall objective of this effort is to advance training in digital engineering and manufacturing methods and processes through the creation of a 2-year degree in Systems Engineering Technology (SET). SET is a curriculum specifically created for the community college student. We have chosen to develop SET as a concentration in the existing Computer Information Systems (CIS) degree program. The ideal SET student has computer skills, an interest in how things work, and a desire to pursue a career in an engineering field.

SET will enable and accelerate the incorporation of Digital Engineering and Manufacturing into the workplace through education and partnership. It is our vision to provide a National collaborative center for identifying, sharing, and recommending best practices and solutions in Digital Engineering and Manufacturing. We initially implement SET through a community college or 2-year curriculum vehicle which should appeal to incoming freshmen and career transitioning professionals including returning veterans.

The SET program has been structured as a concentration under the umbrella of the existing CIS Associate in Applied Science (AAS) degree program. This strategy provided a time and cost advantage over creating an entirely new AAS degree and minimizes procedural risks. The program will require 64 semester credit hours to complete and can be completed by a full-time student in two years. Currently, many CIS majors attend part-time, with the median time to completion for recent graduates being three years. We anticipate SET students will behave similarly.

2 Phase 1 Metrics for Success

Metrics for successful prototype completion were specified in the Cornerstone OTA agreement. Sections of this report that describe how each of the metrics have been met are in parentheses for each metric restated below.

- A. Metrics associated with the statement of work (SOW)
 - i. With Calhoun Community College (CCC) support, develop/implement a SET curriculum as modification to Computer Information Science (CIS) Associate Degree. **(Section 3)**
 - 1. Course requirements established
 - 2. Curriculum developer lead identified and development underway
 - 3. Curriculum materials available for draft review

4. Curriculum materials ready for final review
5. Curriculum materials approved
- ii. Develop/implement marketing and/or recruiting mechanism and campaigns to raise SET/MBSE awareness for post-secondary students, entry-level career workers, and returning veterans. **(Section 4)**
 1. Strategy for recruitment developed and approved
 2. Materials and information for marketing/recruitment campaign created and approved
 3. Number of students interested in the program
- iii. Develop and assess a sustainable strategy for creating the SET concentration and/or stand-alone degree and determine a viable path for sustaining the launch locally and across the country to potential nodes of educational/industry/government partners. **(Section 5)**
 1. Develop the local sustainment strategy
 2. Develop a draft launch program to take the program nationally
- iv. Develop and assess a viable strategy for identifying potential regional nodes for SET, advocating for expansion, and the processes for replicating SET in new locations. **(Section 6)**
 1. Identify potential nodes regionally
 2. Develop partnerships for expansion
- B. Metrics associated with the Establishment of the Organization **(Section 7)**
 - i. Formally create the Institute for Digital Engineering Advancement (IDEA)
 - ii. Formally establish the Board of Directors
 - iii. All necessary partnership agreements are in place

3 SET Curriculum

Metrics A.i (1-5) as stated in section 2 above have been successfully met during SET Phase 1. A SET curriculum has been established at Calhoun Community College and the first class is currently being taught. Course requirements for all six new courses have been outlined. We established a committee of experienced systems engineers to review the materials and advise the course developers from a Subject Matter Expert (SME) perspective. SYS 101—Introduction to Systems Engineering, the first course in sequence, is completely built out including all instructional texts, reference text for the students, homework assignments and tests. The remaining five courses have been outlined and will be built out as funds become available. Plans for developing SYS 231—Systems Modeling I are in work. All materials have been reviewed in both draft and final

form by the SME advisory group and have been approved by the Alabama Community College System for instruction. The SET Program Curriculum was submitted as a milestone deliverable on June 16, 2021. The SET specific curriculum is shown in Figure 1. The SET curriculum will prepare students for professional certification by Object Management Group, the non-profit Standards Development Organization for SysML, at the 3rd of 4 levels—Model Builder-Intermediate.

SET Program: 6-Course Overview					
Fully Developed	In Development				
SYS 101: Introduction to Systems Engineering	SYS 231: Systems Modeling I	SYS 221: Database Management for Systems Engineering	SYS 232: Systems Modeling II	SYS 233: Systems Modeling III	SYS 241: Dynamic Data Visualization Applications
Yr1 Sem1: Fall 2021	Yr1 Sem2: Spring 2022	Yr2 Sem1: Fall 2022	Yr2 Sem1: Fall 2022	Yr2 Sem2: Spring 2023	Yr2 Sem2: Spring 2023
Module 1: Systems Thinking	Module 1: Understanding a Model	Module 1: Essential Database Management Concepts	Module 1 Organizing a Model Using Basic SysML Constructs	Module 1 Building a Package Diagram Using a Full Set of SysML Constructs	Module 1 Role of Data Visualization in a Model Manipulation and Communication
Module 2: The product and product life cycle	Module 2: Building a MBSE model	Module 2: Database Analysis and Design	Module 2 Building a Structural Model	Module 2 Building a Requirements and Use Case Diagram Using a Full Set of SysML Constructs	Module 2 Use Data Visualization Tools
Module 3: Engineering a System	Module 3: SysML Diagram Types	Module 3: Database Implementation	Module 3 Building a Parametric Model	Module 3 Building a Block Definition and Internal Block Diagram Using a Full Set of SysML Constructs	Module 3 Use Various Data Visualization, SysML Programming, and Web Development Tools to Store and Visualize Data and Views and Manage Models
Module 4: Systems engineering in the product life cycle	Module 4: Requirement Development	Module 4: Designing and Building a simple Database suitable for MBSE	Module 4 Building a Behavioral Model	Module 5 Defining and Using Constraints on Diagrams	Module 4 Build an Interactive Website Suitable for the Interchange of Data in an MBSE Context
Module 5: Systems engineering and the SET in the life cycle			Module 5 Customizing a Model and Understanding Allocation Relationships	Module 5 Building an Activity, Sequence and State Machine Diagram Using a Full Set of SysML Constructs	

Figure 1. SET Course Overview

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4 Marketing/Recruiting

Metrics A.ii (1-3) as stated in section 3 above have been successfully met during SET Phase 1. The strategy for marketing and recruiting was created to reach a broad

audience in a short amount of time. Marketing began in earnest in April 2021. Unfortunately, we missed the window to reach high school students in the classroom due to both our late start and the Covid-19 pandemic which forced most schools to distance learning. However, our strategy to reach our target audience proved to be successful with 35 students registering for the very first cohort in August 2021, exceeding our expectations of 10-12 and our goal of 25 students. Our strategy is shown below:

The Phase I marketing campaign launched on Thursday, April 1, 2021 and concluded Friday, August 20, 2021 so as to impact the Fall 2021 semester. The planned stages in the campaign were:

- April 1: SET page on the Calhoun website went live at calhoun.edu/SET. This page will be modified regularly as needed.
- April 5 through May 14: Recruiting visits to local high schools
The Dean of the Business & CIS Division and personnel from the college's Office of Recruiting made contact with guidance counselors and teachers at high schools in the Calhoun service area to promote the SET program. Calhoun encouraged graduating seniors with an interest in technical careers about the field and Calhoun's program. They also encouraged students among next year's senior class to take the introductory course (SYS 101) on a dual-enrollment basis during their senior year. At least six students are currently enrolled. The program rack card to be used for this (and other) recruiting efforts is shown by Figure 2. Follow-on brochures tailored to specific target audiences will be developed from this as well.



SYSTEMS ENGINEERING TECHNOLOGY

*Looking for a **fast track** to a **career** in the field of **engineering**?*

ENGINEERING TECHNICIAN DEGREE PROGRAM

CALHOUN COMMUNITY COLLEGE

256-306-2676
calhoun.edu/SET

YOU can be in the first wave of a new class of professionals— Systems Engineering Technicians!

Systems Engineering Technicians (SET) will be the anchor of the growing field of Model Based Systems Engineering (MBSE). MBSE uses computer models to coordinate large-scale, complex engineering projects like NASA's Mars Exploration Program. Your SET degree will give you the computer programming and database skills needed to build and maintain those models. Your role in maintaining the "single source of truth" will be pivotal in keeping the engineering teams on track and making progress.

Calhoun Community College is developing the nation's first-ever SET program in a joint effort with Auburn University, Victory Solutions, Inc., and Institute for Digital Enterprise Advancement (IDEA), under agreement with the Department of Defense. This program will be the pattern for future SET programs around the country. Start with us this Fall and you can be a member of the first-ever SET graduating class.

Your SET coursework will prepare you for these industry-recognized certifications: **CompTIA® Network+ and Security+, OCSMP Model User, Model Builder – Fundamental, and Model Builder – Intermediate**. These certifications will give you a solid foundation for your career.

Calhoun's competitive tuition costs can be reduced further by financial aid. See calhoun.edu/financialaid for more information.

Calhoun Community College is accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC) to award associate degrees. Questions about the accreditation of Calhoun Community College may be directed in writing to the Southern Association of Colleges and Schools Commission on Colleges at 1866 Southern Lane, Decatur, GA 30033-4097, by calling (404) 679-4500, or by using information available on SACSCOC's website (www.sacscoc.org).

Calhoun is a member of the Alabama Community College System.

Apply today!
calhoun.edu

Figure 2. SET Rack Card

- April 12 through April 16: Meet with internal Calhoun staff to promote SET. Calhoun SET personnel met with members of the college's advising, recruiting, and financial aid teams to educate them about the SET program and encourage them to assist our recruitment efforts. Emphasis was on identifying potential students and guiding them toward the program. This activity took place the week prior to Fall semester registration.

- April 19 through August 20: Enrollment monitoring
Throughout the entire Fall semester registration period, the college collected data from its Advising, Recruiting, and Admissions and Records offices to track interest and progress via enrollment reporting, admissions, advising, and registration, and used that information to refine and redirect the marketing campaign as appropriate.
- April 26 through May 7: Personal contacts with veterans' groups and other interested organizations
Calhoun and IDEA personnel discussed the program with influential contacts within the local veteran community to inform them about the program and the potential opportunities for veterans. We encouraged them to publicize the program with their members/contacts and guide potential students to the Calhoun SET program contacts. This engagement could be improved for the next cohort.
- May 3 through August 17: External marketing through local broadcast, print, billboard, and social media
The college's primary external marketing efforts were conducted during this time, concluding the day before Fall classes begin. Activities included:
 - Billboard ads along high-traffic routes in Huntsville and Decatur. The college purchases billboard space on an ongoing basis and allocated some of this space to SET.
 - Television spots. The college purchased 30-second TV spots from Huntsville stations. The initial TV spots generated a great deal of interest.
 - Television and radio interviews. IDEA and Calhoun personnel released press notices which were picked up by some local media. Limited interviews did occur and some news was reported by local television and radio.
 - Social Media. Calhoun PR publicized the program through the full array of social media platforms used to promote the college's regular offerings. Social media activity was monitored to generate data to fine-tune the marketing program and reach our target audiences more effectively.
 - Newspaper articles. Calhoun and IDEA personnel released press notices for the local newspapers.

The marketing and recruiting efforts were successful as shown by the number of students enrolled and the number of inquiries from industry requesting student interns. The television spots can be viewed at the following urls:

Television Commercial 1: <https://youtu.be/QKv0kTOoHow>
Education Minute: <https://youtu.be/1NugO7yvlQc>

5 SET Sustainability

Metrics A.iii (1-2) as stated in section 2 above have been successfully met during SET Phase 1. The SET planned activities are broken into three distinct time periods. Period one, which encompasses Phases 1-2, is referred to as the **SET Project**. The SET Project includes the bulk of establishing the SET framework and establishing a local pilot activity during Phases 1-2. Period two encompasses Phases 3-5 and is referred to as the **SET Initiative**. During this time the initial project is expanded into multiple geographical areas. The time beyond Phase five is referred to as the **SET Program** and consists of the expansion and sustainment beyond the currently scheduled horizon.

The maturity of the planning does not yet select a specific path for SET Initiative sustainment but included in this document are key thoughts, issues, and options that may be taken. Additional work is required to research the viability of these and perhaps other options and to select the path or paths to be taken. We believe a successful pilot program can be expanded geographically and across multiple industrial sectors to comprehensively cover the entire nation. Further, we envision a SET Initiative that will become wholly self-sustaining and become completely integrated into the engineering community.

SET sustainment will include the continuation of ongoing activities, expansion into additional geographic and industrial markets, and integration into related educational activities. Initial continuation of activities will be anchored by local Northern Alabama community support and local financial arrangements. However, expansion of the SET Initiative into other geographic areas and industrial sectors will also be a contributing factor to the sustainment of the SET Program core functions. These contributions will assist in providing the capability to perform local sustainment as well as the additional goals of expansion of the SET Program.

1. Continue and expand current local activities and infrastructure
 - a. Identify and encourage demand for SET skills
 - b. Support an academic pipeline into the SET curriculum
 - c. Enable professional internships and apprenticeships to aid student/industry integration
 - d. Ensure potential employers can best incorporate technicians into their overall system engineering organizations

2. Enlarge the target academic, student, and employer population regionally and beyond
 - a. Identify and engage potential employers beyond the initial internship partners
 - b. Determine and support industry in incorporation of MBSE elements
 - c. Expand the academic program to additional 2-year degree institutions
 - d. Encourage student participation
3. Build new relationships with other partners to develop funding sources and opportunities
 - a. Engage regional development organizations which may aid the SET Program
 - b. Engage state and local governments in the target areas
 - c. Engage a wide variety of industry starting with large organizations known to be implementing MBSE
 - d. Identify key champions both locally, regionally, and beyond (e.g., consortia, professional organizations)
4. Promote broader policy initiatives related to deployment of SET into related educational levels
 - a. Promote development of an upward educational path from SET to a 4-year degree
 - b. Include SET elements into existing 4-year degrees for traditional engineering students
 - c. Identify and incorporate preparatory work and pipeline development into secondary schools

In Phases 3-5 of the SET Initiative, each of these objectives will be addressed and work started.

The concept for expansion consists of creating a geographic or industrial segment network of clusters of instructional nodes through which the SET curriculum can be offered. An ideal cluster is centered around a 4-year institution with an ongoing Systems Engineering curriculum surrounded by community college nodes supporting local Design, Development, Test and Evaluation (DDTE) and manufacturing communities. Node clusters may be initiated and anchored by IDEA until sufficient local support allows IDEA to transition to a local center. Local support of any given clusters may then be anchored by regional or local development groups or industrial/academic partnerships. At that point, IDEA will become a consulting service, assisting partner, or sustainment

provider. The intent during node cluster establishment is to leverage resources in the expansion area to minimize direct IDEA labor and infrastructure expenses. The intent during sustainment of a given node is to position IDEA as only a sustaining vendor and network communications hub.

The IDEA SET activities, as they mature, will financially sustain core functions by three primary elements.

1. SET Academy

At the conclusion of the pilot program, IDEA will have developed a valuable cache of relevant, consistent, and desirable products that should have value for potential adoptees of the SET curriculum. The concept will be distributed via licensing through enrollment into the SET Academy. Licensing, of course, refers to a relationship whereby the licensee acquires the right to use the products but the ownership remains with the licensor. Examples include curriculum and course materials, internship agreements, job classifications, job announcements, apprenticeship procedures, marketing material, and other administrative materials. Initial licensing will, of course, be a source of revenue. In addition, however, essential updates to the products may be purchased as individual add-ons or as part of a subscription service. These updates will likely be essential and perhaps frequent as the MBSE field is rapidly evolving.

2. IDEA Partnership services

In the process of presenting the SET concept to industrial and government entities, the experience and expertise of the IDEA personnel will be invaluable to the local partners. These services can be offered by IDEA within consulting contracts. Additionally, as the SET initiative is established in a community, the IDEA expertise in MBSE and direct access to the SET node clusters represents considerable value in networking. As local nodes become self-sufficient, they will likely see some of the services provided by the IDEA SET partnership as valuable commodities and continue to avail themselves of those services. Examples include the managed intern program, the SET node communication network, employer/job seeker bridge, MBSE expertise, distance-teaching and subject matter expert lecturers. These services may be offered individually or as part of a service contract. Some of these services may be provided by IDEA personnel or by IDEA subcontracts or partners.

3. Donations and Grants

The SET Program may be of fiscal interest to regional or industrial developmental groups, industrial partners, government labs or other stakeholders. These groups may be able to provide funding through donations, grants, startup packages, or expense-offsetting, in-kind contributions to initiate expansion into their region or industry. IDEA requires a stable revenue stream in order to deploy the SET Initiative and ensure instruction keeps pace with both the industry and the advancements in digital engineering. We believe donations will constitute a large portion of sustaining funds.

6 Regional Node Deployment

To demonstrate the feasibility of SET, we need to extend our pathfinder approach within the region and test it in a traditionally rural area with several partner schools. Digital engineering makes it possible for distance learning as well as telework from anywhere. Expansion of SET in the nearby region is ideal with a number of community colleges in neighboring counties within Alabama including these candidates:

- Wallace State Community College
- Snead State Community College
- Bevill State Community College
- Northeast Alabama Community College
- Northwest Shoals Community College
- Gadsden State Community College
- Central Alabama Community College

Wallace State has tentatively agreed to begin SET instruction Fall 2022. The Calhoun Community College President has offered to assist Wallace in SET startup with instruction, marketing, and IT support.

Secondary Node Deployment

The regional expansion is not limited to Alabama. Figure 3 depicts our plans for Initial and Secondary expansion. Our initial research has identified some schools in Mississippi with complementary curricula

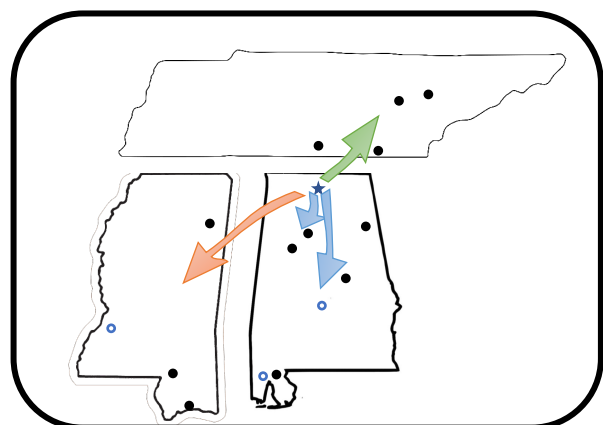


Figure 3. SET Regional Node Expansion

that could adopt the SET concept including:

- Itawamba Community College
- Mississippi Gulf Coast Community College
- Pearl River Community College

With our early involvement in the Tennessee Valley Corridor advocacy group, many Tennessee schools have also expressed interest in the SET concept. Some early targets include:

- Roane State Community College
- Pellissippi State Community College
- Chattanooga State Community College
- Motlow State Community College

Another growth area is within 4-year universities. Auburn University is deriving instructional components from the SET curriculum to populate lab assignments, homework, and eventually electives and certificates. By offering these concepts to other universities the SET Node concept can be extended further by working with a university that features close relationships with community and technical colleges. Some that have already been identified are:

- University of South Alabama—close relationships with Coastal Community College in Alabama and Mississippi Gulf Coast Community College in Mississippi.
- Alcorn State University (HBCU)—with proximity to the Corps of Engineers in Vicksburg
- Tuskegee University (HBCU)

7 IDEA Formation

The Institute for Digital Enterprise Advancement (IDEA) has been formed as a public nonprofit (501(c)3) in the State of Alabama. Registration with the Internal Revenue Service as a public nonprofit was submitted in April 2021, with no response as of yet. Initial steps to operate as a going concern such as a bank account, insurance, office leases, etc. have been taken and our Board of Directors has been selected and have held an inaugural meeting. The directors are:

- David Alan Smith/Victory Solutions, Chairman
- Paulette Risher/Still Serving Veterans, Treasurer
- Dr. Greg Purdy/Auburn University

- Jeff Lynn/President of Central Alabama Community College
- Chris Crumbly/Executive Director and President

The partners have all been operating as defined in the kickoff presentation of September 2020, with Auburn University as Prime, Victory Solutions and Calhoun Community College as subcontractors to Auburn. Phase 2 will add IDEA as a subcontractor to Auburn.

8 Results and Status

Our team has met each milestone and successfully begun instruction of the first cohort of 35 SET students in August 2021. The curriculum has been fully outlined and the first class fully developed. Figure 4 is a photo taken during the very first SET class.



Figure 4. SYS 101 Class August 19, 2021

The SET Exit Criteria for Phase 1 was stated in the Kickoff presentation charts in September 2020. They are presented in Figure 5 below:

1. A pathfinder 2-year SET curriculum attractive to students and employers
<i>RESULT: Complete. A successful curriculum has been developed and approved by the Alabama Community College System (ACCS)</i>
2. Attract at least five students interested in the first cohort
<i>RESULT: Successful. 35 students enrolled in the first class, SYS 101</i>
3. A plan for SET Expansion that provides nodes within the North Alabama region <u>as members of the IDEA Academy</u>
<i>RESULT: Complete. A multifaceted plan for deploying the SET concept to schools in the region and beyond has been developed.</i>
4. A plan for revenue generation that provides a path for self sustainment
<i>RESULT: Complete. A plan that provides a path for self-sustainment following the Cornerstone investment has been developed. Alternative sources of funding have already been applied for with proposals pending.</i>

Figure 5. SET Exit Criteria and Results

Milestone deliveries are shown by Figure 6. All milestones were met with submittal of products as shown.

#	SOW	Description	Type	Due Date	
1	P.1	Kickoff Presentation	CHART DECK	SEP 2020	✓
2	P.2	Monthly Status Report	CHART DECK /DOCUMENT	OCT 2020 THEN MONTHLY	✓
3	1.1.3	SET Curriculum—DRAFT	DOCUMENT	NOV 2020	✓
4	1.2.2a	Marketing/Recruiting Plan—DRAFT	DOCUMENT	DEC 2020	✓
5	1.3.1a	Local Sustainability Strategy—DRAFT	DOCUMENT	JAN 2021	✓
6	P.3	Semi-Annual Program Review	CHART DECK	FEB 2021	✓
--	1.2	Marketing/Recruiting Plan	--	--	
7	1.2.2b	Marketing/Recruiting Plan—FINAL	DOCUMENT	MAR 2021	✓
8	P.2	Monthly Status Report	DOCUMENT	APR 2021	✓
--	1.1	SET Curriculum Plan	--	--	
9	1.1.5	SET Curriculum—FINAL	DOCUMENT	MAY 2021	✓
--	1.3	Sustainability Plan	--	--	
10	1.3.1b	Local Sustainability Strategy—FINAL	DOCUMENT	JUN 2021	✓
--	1.4	Regional Node Deployment Plan	--	--	
11	1.4.1	Regional Node Identification--DRAFT	DOCUMENT	JUL 2021	✓
12	P.3	Base Year Program Review	CHART DECK	AUG 2021	✓

Figure 6. Milestone Deliverables

9 Next Steps

Phase 2 of the SET initiative will be focused on three major tasks:

1. Complete the development of all SET courses (during the two-year Phase 2 plan)
2. Place interns with area industry and government organizations
3. Deploy the SET concept within the region

Phases 2 and 3 are highly integrated in the deployment of SET in other schools. Outreach during Phase 1 has identified strong interest in south Alabama, Fort Worth, Texas and El Paso, Texas. Outreach will continue across the region within Alabama, Mississippi and Tennessee. Industry partners Lockheed Martin and L3Harris have emerged as early adopters of the SET concept in regards to interns, apprentices, and graduates. The SET team will concentrate on developing these relationships further in geographic areas of interest to these companies.

The next campus to bring SET instruction online will be Wallace State Community College in Hanceville, Alabama. This residential campus is approximately 50 miles from Huntsville, Alabama and will help demonstrate that a rural campus can produce the needed skillset for a DoD design, development, test and evaluation (DDT&E) community.

The SET Project Team is excited to bring this unique instructional concept and new skillset to maturity. Phase 1 has exceeded our expectations and the momentum gained will carry this project further towards the goal of nationwide adoption. Thanks to the support from the Cornerstone OTA initiative, another leap forward has been taken in the pursuit of maintaining and advancing our Nation's DDT&E competitive edge.