"SCALE Technical Certification Framework for Heterogeneous Integration and Advanced Packaging"

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Abstract

With the growing demand for a robust microelectronics workforce, the U.S. Defense Industrial Base (DIB) is faced with a current shortage of qualified workers [1-3]. As workforce development programs grow and expand in the engineering education space, there is a need to ensure that students are developing the necessary skills to be career ready [4-6]. The challenge for engineering educators is how to develop students into technicians and engineers with the required technical skills that are highly desired in entry-level microelectronics engineers [4].

To meet the growing need, the Scalable Asymmetric Lifecycle Engagement (SCALE) microelectronics engineering workforce development program created a workforce development model [7]. Through SCALE's ongoing workforce development efforts, a certification framework was created for developing students technical and professional skills in a microelectronics engineering program [4-5]. Specifically, the certification framework identified the technical and professional skills that students must possess to be career-ready and to determine levels of competency related to the necessary skills.

A review of current scholarship, including ABET, NACE, and other widely cited engineering scholarship, and engineering curricula led to the creation of the certification framework. The certification framework provides a universal rubric that is straightforward to use and easily transferable to other domains to ensure that students in microelectronics engineering programs develop both technical and professional skills and that mastery of those skills is measurable. The certification of technical and professional skills was generated based on the knowledge, skills, and abilities (KSAs) that are in demand for students entering the microelectronics workforce. These desired KSAs were defined by project stakeholders through a workforce needs assessment process [5].

Building on the evolution of Bloom's Taxonomy [8-10] and the work of Newton and colleagues [11], this project created a further refined master list of verbs for use in the certification framework. Verbs were paired with a corresponding "Level" to evaluate student mastery of each certification framework "Competency." Levels within the certification framework then serve to provide a mechanism to measure students' mastery of each "Competency." Visually, the hierarchy defined above is translated into a framework rubric. The layout of the rubric is universal so that it serves as a basic framework for the certification all technical verticals. Within the certification framework project, a "Component" is defined as an element of the larger engineering program curriculum. Components are well-defined based on relevant scholarship the high-level KSA is identified for a specific technical area (e.g., Heterogeneous Integration and Advanced Packaging). Where applicable, components may have varying "Themes" to serve as umbrella categories. For example, "Common Package Types" and "Semiconductor Device Fabrication" are Themes within the Heterogeneous Integration and Advanced Packaging component. The Certification Framework also utilizes Competencies, which are defined as

specific skills that students can achieve to have a stronger understanding of the Theme. For example, a Competency within the "Common Package Types" Theme is "ability to identify and describe common package types." Each Competency has a level of progression, Levels 1 through 4, that a student can progress through as their KSAs in that Competency grow.

Focusing on four levels of students' attainment as they progress through their program of study, the certification framework provides engineering educators with clear information that can be used to identify support efforts targeted at developing students' technical and professional skills, including the necessary and relevant academic curriculum, internships, capstone projects, research, and other co-curricular and extra-curricular activities. Additionally, the certification framework can be easily utilized by students to understand the goals they need to set to develop the skills that make them career ready within the microelectronics engineering field. The certification framework may assist students in planning the activities that they must engage in, both inside and outside of the classroom, to become career ready.

This work is an example of the certification framework utilizing the technical skills that Heterogeneous Integration and Advanced Packaging students must develop to be career-ready post-graduation at the Baccalaureate level.

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