Pictures Worth a Thousand Words

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In microscopy and astronomy items that are either too small or distant are visualized through optics and captured as images, but not everyone is capable of seeing the world through pictures. For those who are blind, images have no meaning. The vision impaired must rely on written text to describe anything that they perceive beyond their remaining four senses. Students who are blind, or who do not have sufficient vision to read print, are consistently restricted to second-rate access to STEM (science, technology, engineering, mathematics) content, and are expected to learn the material and be proficient enough to pass the course. There is no evidence that people who are blind lack the necessary analytical abilities to pursue a range of careers in STEM. On the other hand, the lack of opportunities to develop and use those abilities impedes both their educational and employment advancement in STEM disciplines.

In the United States there are approximately 21.5 million people that are either totally blind or vision impaired [1]. Studies have shown that by the age of 16 years old, the average vision impaired student is 3 years behind in subjects such as mathematics in comparison to their peers [2]. From the population of individuals who have STEM careers, less than 5% will be held by those who have some form of vision disability [3]. Almost all aspects of normal life are vision based which means that items we use every day to function require the ability to see. This circumstance causes an unintentional bias because the mechanisms for doing most anything rely on sight. Since courses involving microscopy and astronomy, as well as the majority of all STEM disciplines, are image based, this image rich content must be converted into a tactile format to enable the visually impaired student to have the same access to the course materials as their peers (Fig. 1, 2).

Within the 3D IMAGINE project, we are addressing the issue of low participation in STEM courses by creating 3D tactile prints and models that will help the blind "visualize" images that are critical in understanding key concepts. These tactile displays are incorporated into entry level STEM science classes to assist blind students with learning image rich material. Current technologies used to create projected tactile surfaces include raised ink printing or changing 2D images into a height field 3D surface geometry that is then converted into a CAD format and used to create MDF (medium density fiberboard) boards or rapid 3D prototype models [4, 5]. Through the development of pilot courses which are enriched with tactile image displays, we are exploring the limitations encountered by those who are visually impaired and are working to develop new technologies that will make it possible for these students to learn and find their place in the STEM community [6].

References:

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Fig.1. Anaphase spindle from an aortic smooth muscle cell shown as confocal microscope (A), texturize painted (B) and 3D height field (C) images. Bar = 10 um.

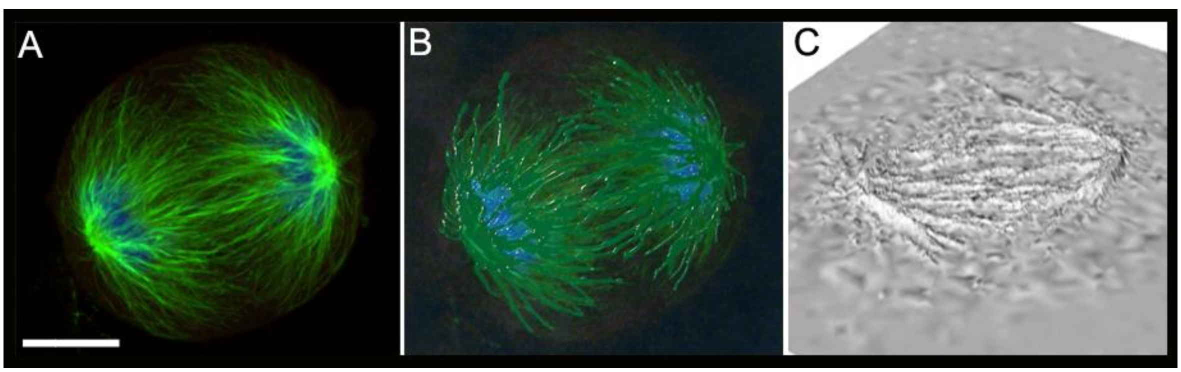

Fig.2. Airy disk diffraction pattern (A) transformed into a 3D height field geometric image (B) that will be converted into a CAD file which will be used to create a 3D model through CNC machining.