DIGITAL MANUFACTURING for ONE HEALTH

A healthcare revolution capitalizing on digital manufacturing is underway, establishing the capability to create personalized 3D printed medical devices, perform patient-specific surgical planning, customize surgical implants, and develop optimized prosthetics. An increase in the aging population, rising incidence of osteoporosis, growing number of amputees and a spiraling number of patients with dental problems have driven the market. 3D printing in healthcare is expected to grow to a $2.3 billion industry by 2020. Through a dedicated focus on healthcare, Digital Manufacturing for One Health will position our state to play a critical role in the digital manufacturing in healthcare revolution, bringing the opportunity for substantial economic impact in the region.

The primary goal of the Digital Manufacturing for One Health (DMOH) focus is to develop an infrastructure that will advance materials, design and modeling processes, and fabrication technologies used in the digital manufacturing of surgical implants, pre-surgical and intra-surgical planning guides, surgical instrumentation and prosthetics. Technologies used in the fields of orthopedics, reconstructive surgery, oral and maxillofacial surgery, trauma surgery, and rehabilitation will benefit from these advancements. Our DMOH team will develop a streamlined medical image-to-surgical implementation pipeline to accelerate surgical planning, synergistically combine new hybrid biocompatible materials, design, and fabrication processes to improve implants and exoprosthetic components, and integrate dynamic biomechanical functional analysis into the surgical implant and exoprosthetic component design processes.

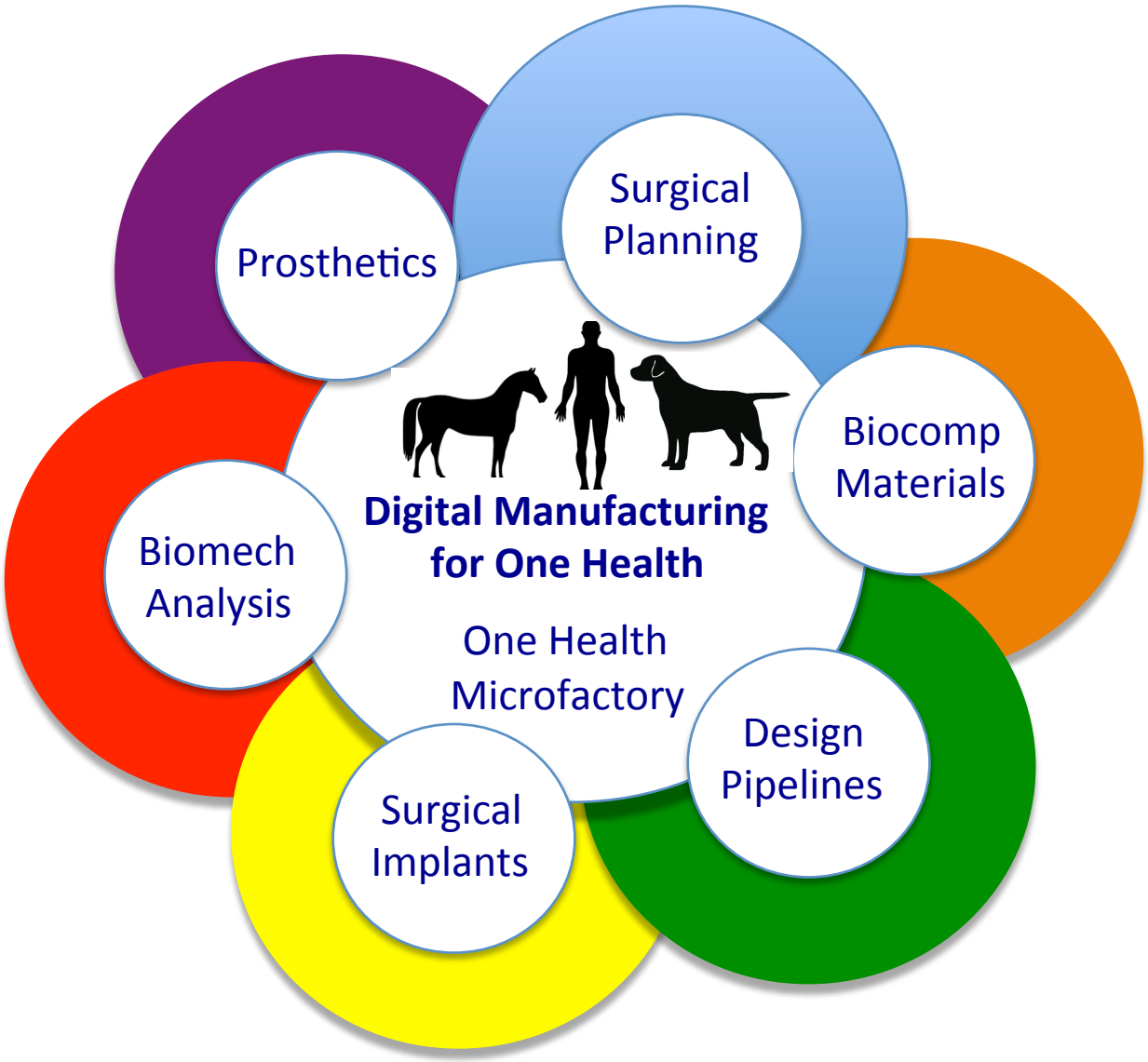
Our Digital Manufacturing for One Health team brings together scientists with complementary expertise with the capacity to address fundamental science challenges needed to promote digital manufacturing in key areas of healthcare in Kentucky. Children and adults in Kentucky who are challenged by congenital deformities, cancer, disabilities, traumatic injuries, dental disease and even aging will realize improved quality of life through implementation of this research. We will take a bold One Health approach to jointly advance equine and companion animal health alongside human health by tackling digital manufacturing challenges that present barriers to both. Through a One Health Microfactory we will promote innovative solutions to meet human and animal healthcare needs by harnessing our Kentucky's Advanced Manufacturing Ecosystem expertise using an industry-academic co-creation model that will deliver microfactory-to-operating suite and microfactory-to-clinic products. We will achieve our DMOH goal through the following specific aims:

Aim 1: Integrating knowledge gained from our materials, design and process cores, develop turnkey technologies that enable accelerated and validated *patient-specific medical image-to-surgical reconstruction pipelines* that accelerate the process.

Aim 2: Using a systems approach, describe combinations of new hybrid materials, implant designs, and additive manufacturing processes that *optimize an implant's mechanical and microstructure properties to improve biomechanical compatibility and biological integration*. Such advancements are critical in the management of end-stage joint disease and in cases of poor bone health.

Aim 3: Using a system-based approach, identify combinations of new hybrid materials, prosthetic component designs, and additive manufacturing processes that *decrease cost and streamline the fabrication process*, while maintaining or improving lower extremity prosthetic biomechanical function. By decreasing cost and simplifying the fabrication process, lower extremity prosthetics will be more widely available to the amputee population.

Aim 4: Develop a turnkey system to enable *integration of dynamic 3D biomechanical modeling and functional analysis* to optimize customized surgical implants and prosthetic components *in silico*. Current techniques employ static evaluation of surgical implants and prostheses based on morphology alone; this technology will enable simulation of functional performance.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Surgical Planning
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Surgical Implants