

# CAPABILITIES STATEMENT

## IN THE AREA OF ADDITIVE MANUFACTURING

**UNIVERSITY:** California State University, Long Beach  
College of Engineering  
Mechanical & Aerospace Engineering  
1250 Bellflower Boulevard  
Long Beach, CA 90840  
[www.csulb.edu](http://www.csulb.edu)

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[www.csulb.edu/colleges/coe/mae/views/personnel/fulltime\\_adj/beyer.shtml](http://www.csulb.edu/colleges/coe/mae/views/personnel/fulltime_adj/beyer.shtml)

**PROFILE:** California State University, Long Beach (CSULB) is the third largest campus of the 23 school California State University system (CSU) and one of the largest universities in the state of California by enrollment. It is a highly diverse, minority-serving and Hispanic-serving institution. CSULB has been recognized repeatedly as one of "America's Best Value Colleges" by the Princeton Review. The College of Engineering is one of the nine colleges at CSULB. Its mission is to develop innovators who design and implement practical solutions to meet the ever-changing societal challenges of today and tomorrow. The MAE Department focuses on providing an education in Mechanical or Aerospace Engineering which integrates engineering practice with theoretical foundations. Our emphasis is to complement engineering education with exciting student projects, internship opportunities and advanced applied research where both undergraduate and graduate students play key roles. The department offers undergraduate and graduate degrees in Aerospace Engineering and Mechanical Engineering, and participates actively in the joint Ph.D. program with Claremont Graduate University (CGU). Advanced applied research areas include launch vehicle and space propulsion technologies, computational mechanics, materials, environmental research, advanced manufacturing and robotics among others. We offer excellent laboratories to enhance the engineering learning experience.

**EXPERTISE:** Dr. Christiane Beyer, Associated Professor in the MAE Department, has 25 years Additive Manufacturing (AM) experience in Germany and the US. She is a recognized expert in the field of Design Optimization for Additive Manufacturing, particularly as it relates to opportunities for strength/weight optimization using sophisticated software, modern materials, and AM fabrication techniques. She teaches undergraduate and graduate courses and conducts research in the fields of Engineering Design, CAD/CAM, and cutting-edge technologies, particularly Additive Manufacturing, 3D scanning, reverse engineering, metrology and nondestructive testing for product development. She supervised projects and coordinated numerous projects for fundamental and applied research sponsored by companies, research communities and public funds in automotive, aerospace, consumer products, bioengineering, and other industries.

**RESOURCES:** Dr. Beyer established the DENSO Computer-Aided Design & Manufacturing Laboratory with cutting-edge tools and technologies for Additive Manufacturing (MarkForged continuous fiber-reinforced 3D printers, Objet Geometrics/ Stratasys 3D printer, diverse FDM printers, etc.), 3D Scanning, CNC machining, etc. The MAE Department also offers an Instron Testing Laboratory with certified test equipment and Composite Laboratories. Collaborators will be able to access information on a wide variety of composite research and services conducted by our laboratory staff.



DENSO Design & Manufacturing Laboratory



Instron Testing Laboratory



Autoclave Laboratory

## RESEARCH AREAS:

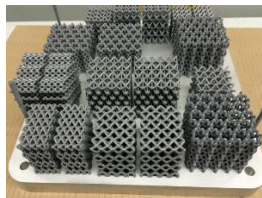
- Incorporation and emphasis of Additive Manufacturing technologies, 3D Scanning, Metrology and Non-Destructive Evaluation (NDE) in a Systematic Engineering Design and Product Development
- Analysis of software tools especially for AM and lightweight structure design (Netfabb, Inspire, etc.) and development of design guidelines
- Determination of material properties and new material combinations for AM (fiber-reinforced parts)
- Design of new equipment for AM (Aluminum alloy AM, bone structure and cartilage 3D printers, fiber-reinforced six axis printer, etc.)
- Analysis of processes, technologies and software tools for Additive Manufacturing Quality control and Inspection (Non-Destructive Examination: 3D Scanning, MRI/CT, etc.)
- Applied design in mechanical engineering, automotive, aerospace, ship design, consumer products, medical engineering, bioengineering, and prosthetics

## PREVIOUS AND CURRENT PROJECTS:

- Theoretical Finite Element Analysis (FEA) and Application of Topology Optimization Algorithm of diverse cell structures under special load conditions – Collaboration with solidThinking Inc.
- Development and experimental testing (compression, bending) of different cell and lattice structures for AM lightweight design and fabrication – Collaboration with Netfabb GmbH and CITIM AM, Inc.
- Potential use of additive manufactured dies and molds with internal cooling channels in optimizing of Injection Molding – Collaboration with Pelican Products, Inc.
- Analysis of lattice structure concepts for heat exchangers – Collaboration with SoCal Gas Company
- AM equipment development: Fusion of aluminum 6061-T6 using induction heating for the purpose of semisolid additive manufacturing – Collaboration with Raytheon Company
- AM equipment development: 3D cartilage printer and 3D Bone Structure printer– Collaboration with LuxNova LLC
- Design and 3D printed custom fit socket for below-knee amputees – Collaboration with VA Hospital
- Design and 3D printed application with embedded electronics in AM parts: 3D printed assistive glove with embedded smart wires for Hemiparesis patients; electronic skin with application to prosthetics



Optimized unit cell result for single plane shear on three consecutive unit cells in Inspire



Additive Manufactured aluminum alloy cubes for compression testing



Optimization analysis of a motorcycle bracket in Inspire and 3D fiber-reinforced printed result



Carbon fiber reinforced tool with embedded hardware

## SERVICES:

### Engineering and Consulting Services

- Design & Optimization for Additive Manufacturing, including CAD modeling, weight/strength optimization and finite element analysis
- Prototyping and benchmarking services in carbon reinforced composites, diverse plastics, and metal

### Training Services

- Additive Manufacturing processes and technologies
- Quality control and inspection processes and technologies
- CAD/CAM software tools (SolidWorks, Siemens NX, Abaqus, Netfabb, Inspire and Evolve from solidThinking, Eiger software, etc.)