Magnetically-Assisted Artificial Joint

John-William Sidhom, Nicholas Clay, Jerry Zhao
University of Michigan

Overview

Artificial knee and hip replacement surgeries are common today, with the majority of the implants using a plastic-on-metal joint interface. Unfortunately, plastic-on-metal joints are only temporary solutions, as most implants last 10-15 years before needing a second surgery to replace the worn device. This E-Team, incorporated as Magnetic Ventures, is looking to help joint replacements last longer with the Magnetically Assisted Artificial Joint, a patent-pending technology that lowers the contact stress at the joint interface through the use of magnets. The team has written a business plan, won several local business plan competitions, and developed and patented their technology. With NCIIA funding they intend to create computational models of their device, develop a functional prototype, and network with industry and academic experts.

Product

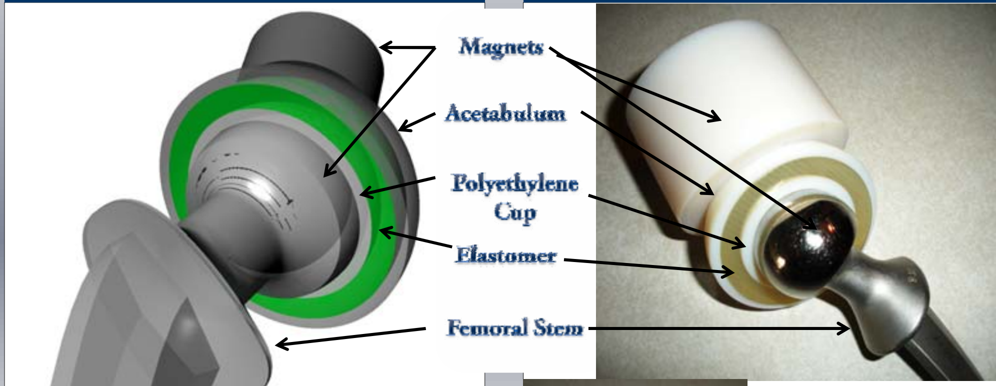
Magnetic Ventures has designed the Magnetically-Assisted Artificial Joint (MAAJ)— a patent-pending improvement on plastic-on-metal knee and hip joints. Our technology lowers the contact stress at the joint interface through the use of rare-earth neodymium magnets. This technology operates on a similar conceptual basis as MagLev, which utilizes electromagnetic forces to lower friction between the train and track, thereby increasing efficiency. A MagLev track experiences a constant load from the train, and the magnetic field needed to lift the train is constant. However, the artificial joint experiences dynamic loading; therefore, we have designed a system comprised of self-regulating magnetic forces. Our technology uses an elastic material as a regulatory material to control the distance between the magnets in the joints and adjust the magnetic force. As the force in the joint increases, the magnets are pushed closer together, lowering the interface force (normal force) and consequently, decreasing friction in the joint. By seamlessly integrating its platform technology within the standard joint interface, Magnetic Ventures will be able to produce a high-performance/lost-cost alternative to current artificial joint replacement.

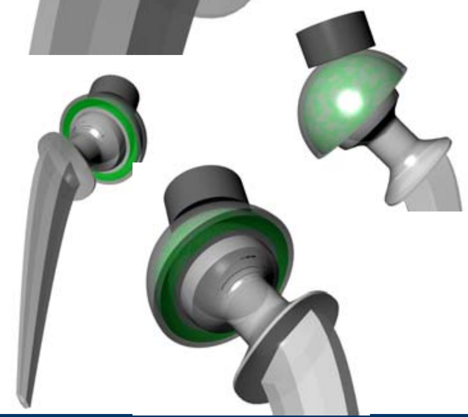
Awards and Honors

2008 Bay Area Innovators Competition, 3rd place
2008 Zell Lurie Dare to Dream Assessment Grant
2008 1000Pitches Competition, Top Health Innovation
2008 Michigan Business Challenge Second Round Qualifier
2009 NCIIA E-Teams Grant
2010 Best Undergraduate Team Award, Michigan Business Challenge

Technology

Prototype





Team

- John-William Sidhom (BSE '11)
  - Premedical/Biomedical Engineering undergraduate at the University of Michigan
  - Receiving Minor in Entrepreneurship and Mathematics
  - Chief Executive Officer, Magnetic Ventures
  - Inventor on MAAJ patent
  - 2 years of experience with CAD
  - Experience with finite element analysis (COMSOL) and numerical methods
  - Research experience in Neural Tissue Engineering (NJIT) & Biomechanics Department (UMICH).
- Nicholas Clay (BSE '11)
  - Engineering undergraduate at the University of Michigan
  - Chief Operating Officer, Magnetic Ventures
  - 1 year of research experience with novel drug delivery
- Jerry Zhao (BBA'11)
  - Developed financial models of Magnetic Ventures' business plan

NCIIA Grant Advisors

- Aileen Huang-Saad, PhD
  - Principal Investigator on NCIIA Grant
  - Biomedical professor at the University of Michigan
- Steve Goldstein, PhD
  - The Henry Ruppenthal Family Professor of Orthopedic Surgery and Bioengineering
  - Associate Chair of Orthopedic Research at the University of Michigan
  - Met with the team over the past 14 months and has served as an invaluable mentor in developing the technology.
- James Ashton-Miller, PhD
  - Director of the Biomechanics Research Lab at the University of Michigan
  - Research professor of Mechanical Engineering.
- David Blaha, MD
  - Professor of Orthopedic Surgery
  - Met with the team several times over the past year and has extended his enthusiasm about the project.

Results from NCIIA Grant

Prototyping

Magnetic Ventures has been working with the Medical Innovation Center at the University of Michigan to develop its preliminary functional prototypes. The results of the prototype have shown that one can indeed generate a significant unloading effect within the spatial constraints of the artificial hip joint. This experience has given the team insights into some novel manufacturing methods for the technology.

Computational Analysis and Optimization

Due to the high cost in testing and building our technology, Magnetic Ventures has relied on computational analysis to develop the technology. In doing a comprehensive scientific literature review, John has began learning the finite element method with programs such as COMSOL and FEMM. He has modeled magnetic interactions in 2D and 3D, and has also modeled the mechanical interactions of the joint.

Networking

Due to their limited experience and knowledge, the team has networked extensively in the scientific areas of their technology.

Magnetics
K&J Magnets
Advanced Magnet Source Co.

Elastomer Mechanics
Dr. Ellen Arruda, PhD

Biomedical Technologies
Accelent

Timeline of Magnetic Ventures' Future

2010-2011
- Complete Computational Optimization of Technology
- Begin working with Accelent to develop biocompatible version of technology

2011-2013
- Apply for STTR Phase I Grant
- Complete Mechanical Testing

2014 - 2017
- Apply for STTR Phase II Grant
- Complete Animal Testing

The work presented has been generously funded by an E-Team Grant from the National Collegiate Inventors and Innovators Alliance.