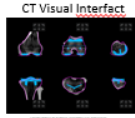


**Team Members:** Brent Keller, Drew Howat, John Humphrey, Samuel Wan, Spencer Johnson

**Mentors:** Dr. Milton Aguirre Chris Jones, Robert E. Dodde Ph.D.

## Customer Background

The MAKO Robot by Stryker Corporation is an advanced medical device enhancing joint replacement surgeries with precision. It utilizes a patient's CT scan to create a 3D joint model, guiding surgeons in real-time with visual, tactile, and auditory feedback. This technology ensures accurate implant positioning, resembling a natural joint post-surgery, and promotes faster recovery. It also aims to preserve healthy bone and tissue, contributing to better patient outcomes and longer-term joint health.



## Problem Definition

### Problem Definition

The Sterile Interface Plate (SIP) is a plate with a fully sterilizable, floating, bi-stability-mating connector designed to pass electrical signals from a surgical robot machine to a robotic tool-arm. The robot is isolated from the sterilized operating room via the use of plastic sheathing to apply to minimize the amount of time, resources, and effort required to sterilize all tools and equipment that will be present in the operating room. Since the robot is not sterilized, a connector is required to pass commands from the robot to the tool-arm which is itself sterilized. This connector is installed on the SIP. Stryker needs a way to measure SIP functionality before it ships a surgical robot to customers as part of its quality control program.

The team is tasked with developing an "inspection fixture" that will be operated by a human user. The fixture must confirm that all electrical components are functioning properly via a continuity test and relay the results of the test back to the human operator. The device should conform to the working requirements set forth by Stryker's technical assembly team.

## Requirements

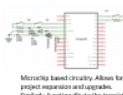
Req. ID	Requirement	Priority	Category
R1	The fixture must confirm that all electrical components are functioning properly via a continuity test and relay the results of the test back to the human operator.	High	Functional
R2	The device should conform to the working requirements set forth by Stryker's technical assembly team.	High	Compliance
R3	The fixture must be easy to use and operate.	Medium	Usability
R4	The fixture must be able to handle the weight and dimensions of the SIP.	Medium	Mechanical
R5	The fixture must be able to handle the electrical signals from the SIP.	Medium	Electrical
R6	The fixture must be able to handle the sterilization process of the SIP.	Medium	Material
R7	The fixture must be able to handle the cost of the SIP.	Medium	Cost
R8	The fixture must be able to handle the time of the SIP.	Medium	Time
R9	The fixture must be able to handle the space of the SIP.	Medium	Space
R10	The fixture must be able to handle the weight of the SIP.	Medium	Weight
R11	The fixture must be able to handle the dimensions of the SIP.	Medium	Dimensions
R12	The fixture must be able to handle the electrical signals from the SIP.	Medium	Electrical
R13	The fixture must be able to handle the sterilization process of the SIP.	Medium	Material
R14	The fixture must be able to handle the cost of the SIP.	Medium	Cost
R15	The fixture must be able to handle the time of the SIP.	Medium	Time
R16	The fixture must be able to handle the space of the SIP.	Medium	Space
R17	The fixture must be able to handle the weight of the SIP.	Medium	Weight
R18	The fixture must be able to handle the dimensions of the SIP.	Medium	Dimensions
R19	The fixture must be able to handle the electrical signals from the SIP.	Medium	Electrical
R20	The fixture must be able to handle the sterilization process of the SIP.	Medium	Material

## Experimentation and Concepts

### Electrical Design Iterations

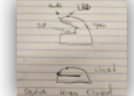


Transistor based design. Simple circuitry provides a reliable test consists of a power LED and a FET and full notification.



Microchip based circuitry. Allows for project expansion and upgrade. Similarly, functionality to the transistor-based circuit.

### Mechanical Design Iterations

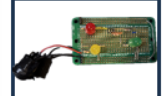


Initial "sketch" or "throw" design. Inspired by Nature, and household items.



CAD design of test fixture. Simulating functionality and visibility.

### Conceptual Testing and Prototyping



First iteration of the Transistor circuit test. Proves functionality and provides the foundation to build on.



Initial mechanical prototype for functionality test and proof of concept. "Work and Fail Test"

## FMEA

### Sip Test Interface

**Effect:** Improper PCB Connections  
**Mode:** Circuit not completed when energized  
**Cause:** False negative reading  
**Prevention:** Proper insulation and insulation of pins

### Digital Processor

**Effect:** Circuit over current  
**Mode:** Faulty I/O ports  
**Cause:** Improper data transmission  
**Prevention:** Utilize high quality components

### Power Supply

**Effect:** Wired Improperly  
**Mode:** Under or Over the set voltage (5V)  
**Cause:** Circuit Malfunction  
**Prevention:** Proper connection of power supply to circuit

### LED's

**Effect:** Incorrect or no input  
**Mode:** LED doesn't notify operator  
**Cause:** LED malfunction  
**Prevention:** Component verification of schematic and PCB creation

## Testing

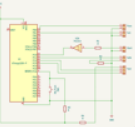
Description	Test Verdicts
Device setup/press	True or not if power switch
Initial verify setup	Amount of light visible depending on initial control switch
Test setup developed when device is plugged	Check for cables and test continuity of wiring
Continuity test requirements	Perform test 10 times in 10-30 seconds
Initial LED's operational when system is completed and in use	System will be opened during operation to ensure safety, verify system continuity
Final LED's test on either continuity test or ground	Three times inspection during system test with 480 properly handling wiring connections
Final LED's test on either continuity test or test	Three times inspection during system test with 480 when both components
LED's display projects results for each when continuity test power is lost	LED's display the correct output of the test and a 7
Initial test between open and closed position	Test safety leads when system closed to ensure light
Device operation in place able to be used	After being subjected to the sterilization process the device should be being removed work operation
Device test open and closed continuity	Operation of device when test LED test open

## Final Design

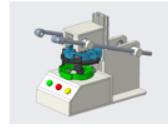
### Program and Testing Flowchart



### Test Device Circuitry

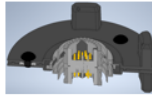


### Mechanical Design and Test Fixture



### Final Design and Operational Test Fixture

#### SIP Connection Cross Section



Final Test Fixture allowing for the testing of the SIP. Easy operation for the fixture with recognizable pins/led indicators.