IPRO 314
THE FIRST ARTIFICIAL KIDNEY:
BUILDING A WORKING REPLICA OF KOLFF’S ROTATING DRUM
IPRO 314: FACULTY AND STUDENT MEMBERS

Project Advisor:

Paul Fagette, PhD, Department of Biomedical Engineering

Project Sponsor:

Museum of Science and Industry
Patricia Ward, PhD, Dept. of Science and Technology

Student Members:

Niekoo Abbasian, Jennifer Barta, Tim Britt, Abhishek Das, Rebecca Hannah, Mary Hannink, Brendan Inouye, Ryan Jungels, Justin Ram, Shawn Stumph, Joseph Sutalo, Michael Turturro, Sam Vazquez, Aaron Whiting
PROJECT DESCRIPTION:

This IPRO team has the unique opportunity to recreate, from the original plans, a working replica of the first clinically successful artificial kidney. Designed, built, and implemented in 1942, Willem Kolff’s rotating drum was the first successful extra-corporeal medical technological device. It provided a successful technological reference point for subsequent development of dialysis devices. This device literally established the field of artificial organs. There are no working models in the Western Hemisphere. Two exist in Europe both in the Netherlands.
TEAM PURPOSE AND GOALS:

Overall, to build a working model of the rotating drum to present to the Museum of Science and Industry.

To enable students interested in healthcare, BME, MBB, etc., to understand the relationship between basic mechanical forces and device design.

To enable students to work as cross disciplinary team members and contribute to solving design and construction issues for an artificial organ.

To enable students to understand the development of the design of an artificial organ from an historic example.

To understand the interplay of knowledge bases from chemistry, materials, physiology, etc., required to develop an artificial organ.

To understand the relationship between clinical needs and requirements and design of an artificial organ.
MAJOR ACTIVITIES AND TASKS:

Project teams follow the 4 major component parts: hollow axle, wooden drum, blood pump, and stand and basin. The first major effort involved translating 2 dimensional plans into 3-D CAD. The adjustable blood pump is the most challenging and requires the most time. Each team will have to derive a working model from 2-D plans designed in 1947 with very basic materials. Semester goals are to have digital plans for each major component, a stand and basin assembly, a finished wooden drum, and machined preliminary prototypes for the axle and blood pump components.
Four rotating drums ready to be sent out to the US, the UK, Canada, and Poland when WW II was over.
The primary example of a rotating drum upon which the current project is based.
A photograph of one of the original Kolff Rotating Drums
Overall schematic of the device from the Kolff 1946 book
Close up photos of the separate components

Fig. 16.
The angle-iron frame is provided with legs, and can be lifted with the cylinder from the frame.

Fig. 17.
The frame with the enamelled bath and the outlet. The heating-element has been brought in; the switch has been put on the bath at the back.

Fig. 25.
The supply-end of the dialyser, half-lateral.
The blood, coming on through the rubber tube to the left, flows into the rotation coupling, mounted in the hollow axle and from there into a second rubber tube which passes into the cellophanetube on the outside of the drum. (This is not a photo of the latest type of kidney, but of the second kidney which was constructed.)

Fig. 26.
A rotation coupling, half drawn out of the hollow axle. The winged nut is seen with which the coupling is fixed in the axle. A counternut has been screwed against the screwcap.
Close up photo of the mechanical blood pump which takes the blood from the drum and continues the flow up to a device which separates clots and bubbles from blood and returns it to patient.
Blood pump schematic
Further schematics of axle and blood pump
Stand (with casters) and drum support frame developed this semester
First iteration of hollow axle from this semester
SPRING SEMESTER 2006 OBJECTIVES:

Stand: Fill, sand, prime, and paint, drill and tap in eye bolts, drill holes for pump and pinch block, wood supports.
Basin: Fill, sand, prime and send out for enamel coating.
Drum: Finish assembly, sand, and varnish.
Blood Pump: Continue machining, fitting, and testing to finished product, base plate, and chain.
Axles and Couplings: Continue machining, fitting, and testing to finished product.

New Items:
- Design and fabricate drum drive gear and pulley, and fit.
- Acquire electric motor and control, construct wooden base, with belt.
- Clot and bubble catcher: fabricate components including glass chamber.
- Splash shield: design and fabricate.
- Wooden reel for cellophane: design, construct, and varnish.
- Heparin glass burette: design and fabricate.
- Glass canulae.
- Heater assembly and regulator: design and fabricate.

Additional Museum Objectives:
- Print out 2D schematics on 36" poster paper.
- Develop animation for each component and total package.