Engineering World Health

2005DRAFT

Youth – EWH

Design Projects That Matter

Engineering World Health is an extraordinary fusion of engineers, scientists and physicians who donate their time and talents to positively impact the quality of healthcare in disadvantaged areas around the world. Our vision is embodied in the "Cycle of Caring," which begins with donated medical equipment and parts and relies on professional expertise to recycle and restore the technology for reuse. We then deliver and install the refurbished machinery for a community in need. Our commitment does not end there. Unlike any other organization in the world, volunteer engineers and students return to that same equipment year after year to ensure that it remains in good working order.

Our ultimate goal is to train local engineers and technicians to maintain their own equipment. However, this ultimate goal is constantly frustrated by the lack of adequate testing equipment. Even where the staff are adequately trained, they lack testing equipment which Biomedical Engineers in the developed world take for granted. The objective of these projects is to design testing equipment that can be freely distributed to the developing world.

Individuals, groups of students, senior design teams, BMES or IEEE chapters or just a bunch of friends can submit designs. Designs are generally accepted in December or January, but can be submitted at any time. If your design meets the design criteria, you will receive up to $150 to build a prototype. If your prototype works, it may be selected to be produced. If you wish, in the summer following the production of your design, you, or your team, can travel to the developing world to distribute the product by participating in the EWH summer program.

In order to participate, you must meet several criteria:

A) Your design must be documented, including 1) a description of the theory of the device (approximately two pages) including the specific specifications (accuracy and such) that your device will meet, 2) a detailed parts list, including source, quantity, part number, price (in quantities of 3 and 500) and anything else that would be required for us to order the parts. Your parts list should include the costs of anything needed for production, e.g. printed circuit boards, even if it is not required for the prototype, 3) engineering drawings including construction drawings for the enclosure, if there is one, top and side views of the completed item (multiple if required), 4) a requested amount (up to $150) for the prototype with the detailed budget to support the request, and 5) a cover letter stating your team members (name, address, telephone and e-mail for each) and to whom the prototype check should be made and sent. Additional documentation may be provided, if you deem it necessary.

B) The cashing of the payment you receive constitutes a license to Engineering World Health to freely produce the final design non-exclusively, for donation to hospitals anywhere in the world.

C) All submissions must be made electronically in Word format.

When your design is complete, you will also need the following documentation for the design to enter production:

A) Updated documentation of anything that has changed: 1) a description of the theory of the device (approximately two pages) including the specific specifications (accuracy and such) that your device will meet, 2) a detailed parts list, including source, quantity, part number, price (in quantities of 3 and 500) and anything else that would be required for us to order the parts. Your parts list should include the costs of anything needed for production, e.g. printed circuit boards, even if it is not required for the prototype, 3) engineering drawings including construction drawings for the enclosure, if there is one, top and side views of the completed item (multiple if required),

B) New diagrams which include: 1) detailed construction instructions so that an assembly worker (assume high school student or person in the developing world) could construct your device from labeled parts bins (typically a sequence of photographs is best), 2) testing instructions so that an assembly worker (assume high school student) could test the finished circuit to determine if it works with average classroom tools, 3) operating instructions so that a biomedical engineer could use your device to test the target equipment (must be in pictorial form, not words).

C) Calibration data and testing data to show that your design works.

We prefer that you write us before beginning the design. That way, we can give you any updates or clarifications on the design criteria. If you decide to send a letter ahead of time, please include your projected date for the submission of the design and documentation and your mentors name and title. However, it is not necessary to write ahead of time.

Any design which meets the published specifications and the three criteria set out above receives the $150 to construct the prototype. If the criteria are met on your first submission, you will typically receive the $150 within four weeks. If you have written ahead of time, you may be able to receive the $150 sooner.

If your prototype works, you can submit new design documents (assuming you had to make changes to get the prototype to work) as well as photographs of the prototype and your calibration measurements showing that your design works. At that point, we may select your design for production if 1) it still meets the specifications, and if 2) its performance exceeds (lower cost, more features, higher reliability, etc.) any item which we are currently producing in that category and any other designs submitted that year of the same type. If you write ahead of time, we can inform you of what other teams have selected the same item, and what items we are currently producing in the selected category.

Don't hesitate to write an e-mail to designprojects@ewh.org if you have any questions. Your efforts can have a tremendous impact on the developing world. As they say, "if you give a man a fish he eats for a day. If you teach a man to fish, he eats for life." Your design could enable a clinical engineer in the developing world to fish for life.

This effort is made possible by the generous support of:
MicroNova Education Foundation (www.mnef.org)
914-B Harpeth Valley Place
Nashville, TN 37221

Projects:

These tools have been requested by personnel working with Engineering World Health in developing world hospitals. These project specifications are intended to be used as guidelines. You should design your device to deliver the maximum possible performance while still staying within the cost specification. Some deviation from the cost specification may be tolerable if the benefits in performance warrant. Where superior performance specifications are given, they need not be followed for the design to be acceptable.

We cannot accept designs which are not on this list. However, we can accept suggestions for items to be added to the list. Feel free to suggest a new design project. If the project is accepted, it will be added to the list for everyone to see, and you will be able to submit your design as well. Write an e-mail describing your idea in one paragraph to designprojects@ewh.org to find out if it is a project that we can support.

In the following paragraphs, all costs are for parts only (no labor costs) and include all the costs of production, even costs that you may not encounter in the prototype, like the box or printed circuit boards. You can assume that the parts are purchased in the developing world or the US.

PROJECTS:

<u>Defibrillator Tester</u>

General Performance.
A device which measures the output of a defibrillator. A minimum performing defibrillator tester can indicate that strengths above 300 J are being delivered. A second indication that strengths above 30 J are being delivered is preferred (for internal defibrillation). Please note that EWH is now producing a product which meets minimum design criteria. A superior design would also indicate that the energy had been delivered in less than 20 ms. A bonus feature would test the device timing for synchronized defibrillation. Simple LED indicators for proper operation are acceptable.

Relevant Additional Specifications.
Cost: <$4 in quantities of 500
Size: less than 4” x 4” x 1” when stored (can fold or unroll if desired)

<u>ECG Tester</u>

General Performance.

A device which generates a signal which can be fed into an ECG machine. A minimum performing ECG tester would produce a pulse at a fixed rate when connected to standard test leads from an ECG machine. A device which offers several rates is preferred. A superior design would allow flexibility in the strength of the delivered signal. The ability to switch to sine waves is note required, but would be considered a bonus.

Relevant Additional Specifications.
Cost: <$4 in quantities of 500
Size: less than 4" x 4" x 1" when stored (can fold or unroll if desired)

<u>Flow Meter</u>

General Performance.
A device which can measure the flow rate of a gas (either oxygen, medical air or CO2). It should be able to measure medically useful ranges to within 10% of the measured value. Superior performance would allow for testing at within 1% of certain specific flow rates. A separate tool for each flow rate is an acceptable alternative to continuous readouts.

Relevant Additional specifications
Cost: <$2 in quantities of 500
Size: continuous readout – 4x4x1. Single readout – 1x4x1 (can be in parts)

<u>Volume Meter</u>

General Performance.
A device which can measure the volume of a gas (either oxygen, medical air or CO2). It should be able to measure medically useful ranges, as are used in ventilators, for example, to within 10% of the measured value. Superior performance would allow for testing at within 1% of certain specific volumes. A separate tool for each volume is an acceptable alternative to continuous readouts. The pressure of the gas is that of normal respiration and/or forced exhalation.

Relevant Additional specifications
Cost: <$1 in quantities of 500
Size: continuous readout – 4x4x1. Single readout – 1x4x1 (can be in parts)

<u>Pressure Meter Gas</u>

General Performance.
A device which can measure the pressure of a gas (either oxygen, medical air or CO2). It should be able to measure medically useful ranges (post-regulation,

such as in ventilators, anesthesia machines, etc.) to within 10% of the measured value. Superior performance would allow for testing at within 1% of certain specific pressures. A separate tool for each pressure is an acceptable alternative to continuous readouts. Must be autoclave compatible and reusable. The greatest range of connection flexibility possible is preferred (hose barb, locking ring, quick release, etc.).

Relevant Additional specifications
Cost: <$2 in quantities of 500
Size: continuous readout – 4x4x1. Single readout – 1x4x1 (can be in parts)

<u>Pressure Standard</u>

A device which can be used to test an invasive blood pressure meter, such as a bedside monitor. It should produce a calibrated pressure pulse corresponding to the pressure pulse which would be recorded from a pressure transducer in the pulmonary venous system, aorta, central venous system, or other relevant area. Multiple devices for each placement are acceptable. Must be autoclave compatible and reusable.

Relevant Additional specifications
Cost: <$10 in quantities of 500
Size: 5x5x10

<u>ESU Tester</u>

A device for determining the power output of an electrosurgery device. Simple indications like an LED for the appropriate power level are acceptable.

Relevant Additional specifications
Cost: <$3 in quantities of 500
Size: 1x5x1"

<u>Outlet Release Tension Tester</u>

A device for testing the amount of force necessary to withdraw a plug from an electrical outlet.

Relevant Additional specifications
Cost: <$1 in quantities of 500
Size: 1x5x1"

<u>Power Line Tester</u>

A device which can be plugged into any commonly encountered power outlet (in the developing world) to indicate 1) what voltage is present, 2) if the power is fluctuating, and 3) if the outlet is wired correctly. A separate device for each indication is acceptable. Adapters are preferably to loose leads for making the device compatible with multiple countries.

Relevant Additional specifications
Cost: <$5 in quantities of 500
Size: 3x3x3"

Temperature Tester for Water Bath or Incubators

A device which indicates whether a water bath or incubator is at 37 degrees Celsius. A visual or audible alarm should be made when the temperature deviates by more than 0.5 degrees centigrade. The entire device need not be submersible, but this is desirable. The entire device must tolerate extended exposure to temperatures in excess of 40 degrees centigrade.

Relevant additional specifications
Cost: <$3 in quantities of 500
Size: 1"x4"x1"

Simple Voltmeter

A device which can measure AC and DC in several ranges to one significant digit. Prefer at least two ranges (1-12V and 12-24V). The more ranges the better the device. Prefer to measure AC and DC. LED indicator strip is acceptable as is analog meter. Should have integrated leads.

Relevant additional specifications
Cost: <$3 in quantities of 500 (including leads)
Size: 1"x4"x1" (not including leads)

Phantom for Pulse Oximeter

A device which can be used to test a pulse oximeter. Must have rate and oxygen saturation controllability.

Relevant additional specifications
Cost: <$10 in quantities of 500
Size: 5"x4"x5"

Ionizing Radiation Meter

A device which electronically indicates the production of ionizing radiation from a typical medical X-ray imaging system. Should respond only if intensity peaks above a typical diagnostic minimum. Superior performance could include a connection for an oscilloscope or other mechanism to measure exposure time. Superior performance could also include an integrator to indicate the total radiation exposure. Air chambers, Ge diodes and other similar detectors are acceptable.

Relevant additional specifications
Cost: <$4 in quantities of 500
Size: 5”x4”x5”

<u>Centrifuge Calibrator</u>

Mechanical or electrical device for verifying the RPM of a centrifuge. Must be reusable and applicable to a very wide range of centrifuges. Separate devices for each RPM calibration is acceptable.

Relevant additional specifications
Cost: <$1 in quantities of 500

<u>Autoclave Tester</u>

Mechanical and/or electrical device which verifies the operation of an autoclave. The minimum performance device would measure both temperature and pressure and verify that they exceed at least one combination of minimum values. Additional performance would include an indication that the pressure and temperature exceeded minimums for a set period of time. Additional performance would include multiple indicators for multiple time and pressure combinations. Device must be reusable.

Relevant additional specifications
Cost: <$5 in quantities of 500
Must hold its reading throughout the cool down cycle and for some time after.
Mechanical and/or electrical reset acceptable

<u>Billi-lights Tester</u>

Electrical device which can measure the performance of lights used to treat jaundice in newborns. A minimum performance device would measure the intensity of ultraviolet light. A simple indicator (LED) that the intensity is in the correct range is sufficient. Additional performance would also indicate the performance of any on-board IR (heating lights). Additional performance could indicate that the wavelength of the peak intensity of the radiation is correct and/or indicate the absolute amount of radiation (not just that the intensity is the right range).

Relevant additional specifications
Cost: <$5 in quantities of 500 (not including batteries)

Ambient O2 Monitor

A device which can measure the amount of oxygen in an air sample for testing oxygen concentrators, anesthesia machines and the like. A minimum performance device would have a simple indicator for a few levels, e.g., <22%, >70%, >90%. Measurement time can be very long. Measurement volumes can be very large (up to 5 lpm). More advanced devices would have more levels of distinction and would operate more quickly with less volume. Should be accurate from 20-40 degrees C. More advanced models should operate between 5 and 60 degrees C. Chemical techniques are acceptable (with, for example, color coding that the operator must read), paramagnetic techniques are acceptable.

Relevant additional specifications
If reusable Cost: <$5 in quantities of 500
If disposable cost: <0.10 in quantities of 10,000

Water Purification Check

A minimum performance device would measure the impedance of the water and indicate that it is in the appropriate range for clinical use. Additional performance would add an indication of the presence of excessive amounts of organics. Measurement time can be very long. More advanced devices would have more levels of distinction and would operate more quickly. Chemical techniques are acceptable (with, for example, color coding that the operator must read).

Relevant additional specifications
If reusable Cost: <$3 in quantities of 500
If disposable cost: <0.10 in quantities of 10,000

Frequently Asked Questions

The tester has to be very simple to use, right?

No. Clinical engineers in the developing world are just as capable as you and I to learn how to use a tester. If you can figure it out, they can too.

The tester has to be really quick to use, right?

No. The concept of time is different in the developing world. It is quite an acceptable design to require a significant amount of man-hours (minutes?) to operate your device.

The tester has to be maintenance free, right?

Pretty much. If any maintenance is required, it must be something that itself does not require a specialized tool or part. If your design requires maintenance, you probably should write to us first (designprojects@ewh.org).

What environmental conditions must the tester meet?

It might be built and tested in cities in the far north of the US and then used in countries near the equator. Your design must not be destroyed even with extended exposure to temperatures down to -10 degrees centigrade and temperatures up to 40 degrees centigrade. It should be useable in environmental temperatures ranging from 20 degrees centigrade to 40 degrees centigrade.

My design doesn't meet all the specifications, but it exceeds some. Should I send it in?

If your design doesn't meet all the specifications, you are not guaranteed to receive the $150. However, you may be able to make an argument that the added performance in one area is worth the missed specification in another. Make sure to include a cover letter of one page or less which describes your argument. This most commonly occurs with the production cost target. Try manufacturing runs of 1000 or more and see if that helps.