2006-2007 National Student Design Competition

Open to programs in biomedical engineering, industrial design, and related fields

Programs receive up to $2000 in reimbursement for design costs;
First prize: $1000, Second prize: $750, Third prize: $500;
Additional $500 award for registration/travel to present a related paper accepted at a major conference

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Design teams are welcome to enter in any of 3 target design areas described below, and designs must satisfy the needs of the hypothetical "clients" on the following page:

Accessible Home Vital Signs Monitoring System

Problem: As healthcare costs escalate, tasks that used to be performed only within medical facilities are increasingly moving into the home. Technological advances have made remote patient monitoring not only possible but also an effective alternative, especially because it minimizes the need for travel by the patient or care provider.

Aim: Design an affordable, easy-to-use, and integrated system that a patient (or his/her personal assistant) can use within the home to collect and transmit vital signs to a remote healthcare provider or facility.

Specs: The system must collect data on at least 4 of the following 6 vital signs: patient's body temperature, weight, blood pressure, heart rate, respiration rate, and blood oxygen (SpO2) level, and store these data in a way easily retrievable. The device should be as easy as possible for a non-professional (whether patient or lay caregiver) to operate, accessible as possible, and appropriate for home use. Teams may use existing devices but must integrate them into a cohesive system, and should simulate an appropriate computer interface. Web-based and multimodal approaches are encouraged.

Accessible Infusion Pump Interface

Problem: Infusion pumps are used to deliver necessary materials (fluids, medications or nutrients) to the body, within its fluids (usually blood). The most crucial concern regarding infusion pumps is accurate delivery of dosing rates and volumes because over- or under-dosing could result in detrimental effects for the patient. Areas of concern in regard to infusion error include: miscalculation of desired dosage levels, data entry error (such as misplacement of a decimal point), and titration error (related to volume or rate of fluid flow).

Aim: Design a portable, reliable, low-cost interface that is easy to use, and that works with or is built on an existing commercially available infusion pump (which may be purchased or otherwise acquired).

Specs: The infusion pump interface must communicate effectively with users (patients or care providers) through both a visual display and audio output, plus tactile cues with any user controls. Consider ease of learning and operation, aesthetics, patient privacy, information and documentation access, and storage/ loading of components. Note that any alarms must be accessible to all users.

Accessible Power-Assist Hospital Bed Back Angle Controller

Problem: Powered hospital beds often use open-loop controls to set the back angle, which typically moves at a constant slow velocity while an operator presses a momentary contact switch. The concept of *extended physiologic proprioception* (EPP) suggests that users might benefit from a more intuitive approach of manually grasping a handle on the side of the upper portion and using force-assist concepts to set the back angle (maybe with the assistance of anti-gravity mechanisms), in which motion speed increases with the amount of force applied to the handle.

Aim: Design a reliable, easy-to-use, EPP-based power-assist back angle controller for a prototype platform (or hospital bed or exam table).

Specs: The operating handle should be mounted on side edge of the bed frame, and easy for a caregiver to reach and grasp. The weight of the back of a patient on the bed will range up to 180 lbs (45% of a 400-lb patient). Operator force will vary normally, in the range from 1 to 20 lbs, but with a caregiver capable of only 5 lbs able to fully operate it (but then at lower speeds). The bed must be stable during and after adjustment, and safe if power is lost.

Client list for design challenges on previous page:

Mat –At 52 years old, Mat is proud of his of 6'-2" height and good physical condition. He is blind and works as a radio commentator. Mat recently experienced a small stroke and his physician wants to monitor his vital signs remotely for the next 90 days. He has been married to Akiko for 16 years, and even though he actively dislikes high technology, he helps her with her infusion therapy.

Akiko – Akiko, 47, has low vision caused by CMV retinitis and receives treatment in the form of foscaret infusions administered at home, generally with the help of her husband, Mat. She works as a medical transcriptionist, loves the Internet and email (especially for staying in touch with her family in Japan), and spends time on the computer most days.

Jorge – Jorge has worked as a home health nurse for the last 30 years, half of his 60-year life. Although he has been careful, he has chronic back pain caused primarily by patient handling over the years and wishes it were easier to help his clients sit up in bed. He has also become somewhat hard of hearing but refuses to wear a hearing aid (yet). In his spare time, Jorge is an avid video game player and partly because of it, he has mild carpal tunnel syndrome that sometimes affects his high scores.

Lakisha – Lakisha is 69 years old and retired. She has Parkinson's disease, which limits her mobility and dexterity and causes her to have tremors. She sleeps in a hospital bed. Lakisha is receiving experimental infusion therapy at home, which is more convenient for her but she still dislikes it. Her home health nurse, Jorge, has helped make the experience much more tolerable, and he is also introducing her to computers.

Sani – Sani is a 31-year-old lawyer who received a head injury in a recent automobile accident. It left her partially paralyzed on her right side, which is especially inconvenient because she is right-handed. She is working limited hours from home, where she has a hospital bed and administers pain medication to herself through an infusion pump. Her HMO monitors her vital signs via a computer system installed in her home. Sani is very concerned about the appearance of all this equipment in her home. She does not want to look "sick" to her friends and family members who come to visit.

Dolores – Dolores just celebrated her 86th birthday with her son, his wife and their son, Tyler, with whom she lives. She is deaf and has severe arthritis, and because of her heart problems Dolores receives infusions at home, which are usually administered by one of her family members.

Tyler –Dolores's grandson Tyler is a bright and busy 11-year-old who has a fascination with electronic gadgets of all kinds. He is small for his age but he loves his grandmother dearly and does everything he can to help her. Because he has hemophelia and receives occasional infusions of a blood clotting agent, Tyler is an experienced infusion pump user and often helps with Dolores's therapy and helps her sit up in bed. He greatly enjoys helping to collect his grandmother's vital signs and transmit them over the computer to her doctors.

For more information about the RERC-AMI National Student Design Competition, go to:
http://www.rerc-ami.org/ami/projects/d/2/