Work Completed
During the third week of senior design, our team had its first weekly meeting with Dr. Enderle. While our design was on track, Dr. Enderle suggested that we were not thinking “outside the box” and were too stuck on our original idea of a single bar; he suggested focusing more on a multiple link system. This would not only allow for more adjustment but would solve the fundamental problem that in our previous design, the movement to change the height difference did not take advantage of an anti-gravity system. Following the meeting with Dr. Enderle, the team went right back to the senior design lab and redesigned a multiple link system which addressed issues of the old design. Figure 3.1 shows the new design which was model from T. Rahman’s multilink design from the “A Simple Technique” paper.

Figure 3.1: The new design for the device which includes 4 links.

The design follows the same fundamental concepts developed by T. Rahman that the total potential energy for the system must remained constant throughout the different positions the system may take. This basic concept was then repeated for each of the individual links. As with a single link system, the geometry of the individual links must be altered to accommodate the fact that linear springs will be used instead of the more expensive nonlinear springs. Figure 3.2 shows the partially finished prototype that was based on the new design. The benefit of building another prototype was that we could further understand how the links would interact with each other and the leg and foot supporters which would be added to the final product. Prior to building, there
was uncertainty among the group about being able to meet the needs of the original group of patients, especially those on each end of the height spectrum. By realizing that two center bars’ lengths could be added or subtracted independently to change the length we would still be able to serve the same range of patients.

Additionally on Monday the group visited the Central Warehouse Stores located on campus to select a desk which would serve as our “medical table”. My research over the weekend of the available medical tables on the market determined that buying an actual medical table would be a waste of resources. Since we solely needed the table to act as an attachment point, the table did not need to be a functioning medical table. A metal desk, which is similar to length and size of medical tables available, would be a perfect substitute. I had known that the university sold surplus items at the depot campus once a month at low cost. Researching the surplus sale a little more, I came across the on-campus surplus store which would allow any department to obtain surplus items for free. In addition to the metal desk, we also obtained some scrap metal shelves which can be used to reinforce the metal desk so that it would hold the weight of the patient so that real world testing could be completed on the device. Figure 3.3, shown below, is a picture of the metal desk.
For the rest of the week I worked on contacting the spring supplier of Mansfield supply so that we could purchase the springs without having to then test them to obtain their spring constants. After two calls and an email, I was able to obtain a complete list by product number which should make our spring purchasing easier in the future. I also began to research possibly changing the mechanism that we are currently using to pivot in the x direction. While visualizing this mechanism against our current prototype it became apparent that a fifth link maybe necessary to avoid having to keep the first link level with the table. Our current method of pivoting requires the first link to remain level, adding a fifth link would allow the original first link which holds the leg support to change height. Finally, I received further instruction on how to maintain our website with Dreamweaver, updated our timeline and budget. Finally, our website became password protected per Dr. Enderle’s request.

**Future Work**
In the next week, I will continue to research additional ways to attach the device to the table. The team must create a locking mechanism for the system as an added safety measure. The springs for the final device must be ordered by the required spring constants based on Jennifer’s calculations. Additional metal bars need to be ordered for the lower part of the system which our original orders never accounted for. Gunner will be learning AutoCAD as another way to test our system since it is purely mechanical. Since the changes to our original design, we must also now consider how we will attach the leg and foot supports. Finally, we must research how to install the springs so that changes in weight can be varied without having to change the springs for each patient.

**Project Review**
While our project has undergone significant redesigns over the past two weeks, since these new designs are still based on the same concepts, I feel our project is still progressing smoothly. Overall, due to speed at which we are progressing, I still believe we will be finishing our project on time. After the prototype has been completed, including springs, we are planning to start constructing the finished product. The only differences between the prototype and the final design should be in how the device attaches to the table and how the springs are connected (in series or parallel). It should take roughly two weeks to complete the device since most of it is just increasing the scale of our current prototype. This should allow an additional two weeks for testing and making any necessary changes that may be required in the final device. Figure 3.4 shows an updated timeline for the device based on the new design.
<table>
<thead>
<tr>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>All team members: Build structure for prototype</td>
<td>1 day</td>
<td>Mon 1/2/08</td>
<td>Mon 1/2/08</td>
</tr>
<tr>
<td>Jenny: Meet with Dave to discuss testing on tissue clean</td>
<td>1 day</td>
<td>Wed 1/2/08</td>
<td>Wed 1/2/08</td>
</tr>
<tr>
<td>All team members: Meet with Dr. Enderle to talk about project, 1 day</td>
<td>Wed 1/2/08</td>
<td>Wed 1/2/08</td>
<td></td>
</tr>
<tr>
<td>All team members: Design ways to incorporate self-gravity into AED</td>
<td>5 days</td>
<td>Fri 1/2/08</td>
<td>Wed 1/2/08</td>
</tr>
<tr>
<td>Jenny: Use mechanics calculations to determine best AED design</td>
<td>2 days</td>
<td>Wed 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>All team members: team meeting</td>
<td>1 day</td>
<td>Fri 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>All team members: write weekly reports/Update timeline</td>
<td>2 days</td>
<td>Tue 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>Jenny: Prepare presentation</td>
<td>2 days</td>
<td>Fri 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>All team members: Meeting with Dr. Enderle</td>
<td>1 day</td>
<td>Mon 1/2/08</td>
<td>Mon 1/2/08</td>
</tr>
<tr>
<td>All team members: Build prototype structure (main springs)</td>
<td>1 day</td>
<td>Mon 1/2/08</td>
<td>Mon 1/2/08</td>
</tr>
<tr>
<td>All team members: Go to surplus to find table</td>
<td>1 day</td>
<td>Mon 1/2/08</td>
<td>Mon 1/2/08</td>
</tr>
<tr>
<td>Jenny: Meet with Chris to review initial web page, password protection</td>
<td>1 day</td>
<td>Tue 1/2/08</td>
<td>Tue 1/2/08</td>
</tr>
<tr>
<td>Kade: Begin taking apart table</td>
<td>1 day</td>
<td>Tue 1/2/08</td>
<td>Tue 1/2/08</td>
</tr>
<tr>
<td>Jenny: Calculations for spring constants for prototype</td>
<td>1 day</td>
<td>Wed 1/2/08</td>
<td>Wed 1/2/08</td>
</tr>
<tr>
<td>Kade: Oil spring company for shock spring constants</td>
<td>1 day</td>
<td>Wed 1/2/08</td>
<td>Wed 1/2/08</td>
</tr>
<tr>
<td>Kade: Research pilot points</td>
<td>1 day</td>
<td>Wed 1/2/08</td>
<td>Wed 1/2/08</td>
</tr>
<tr>
<td>Gunner: Research RSFC tables</td>
<td>2 days</td>
<td>Wed 1/2/08</td>
<td>Wed 1/2/08</td>
</tr>
<tr>
<td>Jenny: Research drawings for design</td>
<td>1 day</td>
<td>Fri 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>Jenny: Research weight distribution for obese patients, weight range</td>
<td>1 day</td>
<td>Thu 1/2/08</td>
<td>Thu 1/2/08</td>
</tr>
<tr>
<td>Jenny: Order parts from small parts, 0020</td>
<td>1 day</td>
<td>Fri 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>All team members: Team meeting</td>
<td>1 day</td>
<td>Fri 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>All team members: Weekly report/Update timeline</td>
<td>1 day</td>
<td>Fri 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>Kade: prepare presentation</td>
<td>2 days</td>
<td>Sat 1/2/08</td>
<td>Mon 1/2/08</td>
</tr>
<tr>
<td>All team members: Meeting with Dr. Enderle</td>
<td>1 day</td>
<td>Mon 1/2/08</td>
<td>Mon 1/2/08</td>
</tr>
<tr>
<td>Jenny: develop final self-gravity mechanism for device</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>Gunner: Learn AutoCAD, 3-D picture of device</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>Kade: purchase springs needed to finish prototype</td>
<td>1 day</td>
<td>Mon 1/2/08</td>
<td>Mon 1/2/08</td>
</tr>
<tr>
<td>All team members: test prototype</td>
<td>1 day</td>
<td>Wed 1/2/08</td>
<td>Wed 1/2/08</td>
</tr>
<tr>
<td>Kade: Investigate bolts and bolted locking choices for project</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>All team members: begin to disassemble table to prepare it for mounting</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>All team members: complete up with locking mechanism</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>West 1: begin assembling thin device</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>West 2: drilling, cutting, bolting middle and bottom</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>West 3: attach device to base</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>West 7: attach lines and foot supports to device</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>West 8: install springs and links</td>
<td>5 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
<tr>
<td>West 9-10: assembly</td>
<td>10 days</td>
<td>Mon 1/2/08</td>
<td>Fri 1/2/08</td>
</tr>
</tbody>
</table>

Figure 3.4- Timeline for the device.

Hours Worked
Hours spent on project February 2nd - 8th, Week 3: 17