

# Engineering through Robotics and Automated Patient Care Activity – Engineering Design Project Packet – Answer Key

## Client Statement

Hello fellow engineers, and welcome to the annual DaVinci Engineering team meeting. Due to recent events, the board of directors has decided to change the direction of our company. We are no longer in the business of food processing; instead, we will focus on developing automated medical devices. Together we will create the hospital of the future! The board of directors has identified two medical devices that, if automated, would help increase the quality of treatment for hospital patients. Many patients in today's hospitals are confined to their hospital beds or wheelchairs. When patients spend extended amounts of time in one position, certain health conditions may develop, with deep vein thrombosis and pressure ulcers being the most common. Currently, prevention is the best treatment for these conditions. Unfortunately preventing these health issues from occurring is very time consuming and labor intensive for healthcare workers. If healthcare facilities had robotic wheelchairs and hospital beds that would automatically reposition the patients, healthcare workers would be able to dedicate more of their time to other pressing issues and the quality of healthcare would be improved. As a member of our elite engineering team, you will need to design and build the first generation prototype for either an automated wheelchair or an automated hospital bed.

**Problem Statement** (define the problem in detail):

**Design a wheel chair or hospital bed that will help reduce the occurrence of blood clots or pressure ulcers due to patients spending extended times in one position. The bed or wheelchair should be automated or semi-automated (using a LEGO MINDSTORMS EV3 kit) and require minimal attention of hospital staff. The bed or wheelchair should fit the average adult and take patient safety into concern.**

**Functions** (what the product does):

- 1. The medical device will operate without hospital staff**
- 2. The medical device will reduce the formation of pressure ulcers and blood clots**
- 3. \_\_\_\_\_**

**Objectives** (describe the attributes of the product itself, not what it does):

- 1. The medical device will be automated or semi-automated**
- 2. The medical device will fit the average adult**
- 3. The medical device must not lose the existing functionality of the hospital bed or wheelchair**

**Constraints** (Criteria that must be met to be considered acceptable):

- 1. The medical device must be safe for the patient**
- 2. The medical device must not lose any existing functionality compared to the current counterpart**

**3. The classroom prototype must use the Lego EV3 Mindstorm kits provided**

**Background Research**

Use the internet to research: modern medical devices, pressure ulcers and deep vein thrombosis, as well as other related topics. Make sure to keep a record of relevant material and the website(s) used for research.

**Design Solutions**

In the chart below sketch three design solutions. Discuss each design with your team members. Within the chart, place a check mark or notation for each identified function/objective/constraint that your design solution meets. This analysis should be used to select the best possible design solution.

Design Solutions	Function			Objective			Constraint		
	1	2	3	1	2	3	1	2	3
	X				X		X	X	
		X		X			X		
	X	X		X	X		X	X	X

### Creation of Prototype (Describe selected design and why it was chosen)

We identified three possible design solutions. Each of these design solutions had positive and negative attributes. Our first design solution was to modify the existing hospital bed frame to rock back and forth slowly, similar to an automated rocking chair. We ruled this design out because we felt that the rocking motion may make the patient feel sick. Our second design also modified an existing bed frame, but it was based on a rotisserie design similar to how chickens are cooked. We ruled this design out because we felt that even though the patient would be strapped into the bed, there was major safety issues associated with this design. Our third design, which we have selected as the most promising solution, has a roller that slowly rolls along under the mattress changing the pressure points for the patient. According to the May Clinic “Bedsore are caused by pressure against the skin that limits blood flow to the skin and nearby tissues.” By having this roller change the pressure points throughout the time spent in the bed the occurrence of pressure sores should be reduced.

(Note: The prototypes should include the use of the LEGO MINDSTORMS EV3 kits.)

### Test Design

Develop a three to four question survey to evaluate the effectiveness of your hospital bed or wheelchair design. The survey should evaluate how well your design meets the defined functions and objectives.

Then, have five people evaluate your group’s medical device design.

### Survey and Test Results

Survey Questions (Scale: 1-10, with 1 = “low” and 10 = “high”)	Tester/Evaluator					Average Score
	1	2	3	4	5	
How much effort would be required of the hospital staff to reduce the occurrence of pressure ulcers?	5	6	4	7	6	5.6
How well does the bed fit the average adult?	9	8	10	9	10	9.2
How well does the bed keep the existing functions of the current hospital bed?	4	5	5	3	6	4.6
How well would this bed reduce the occurrence of pressure ulcers?	7	8	9	8	9	8.2

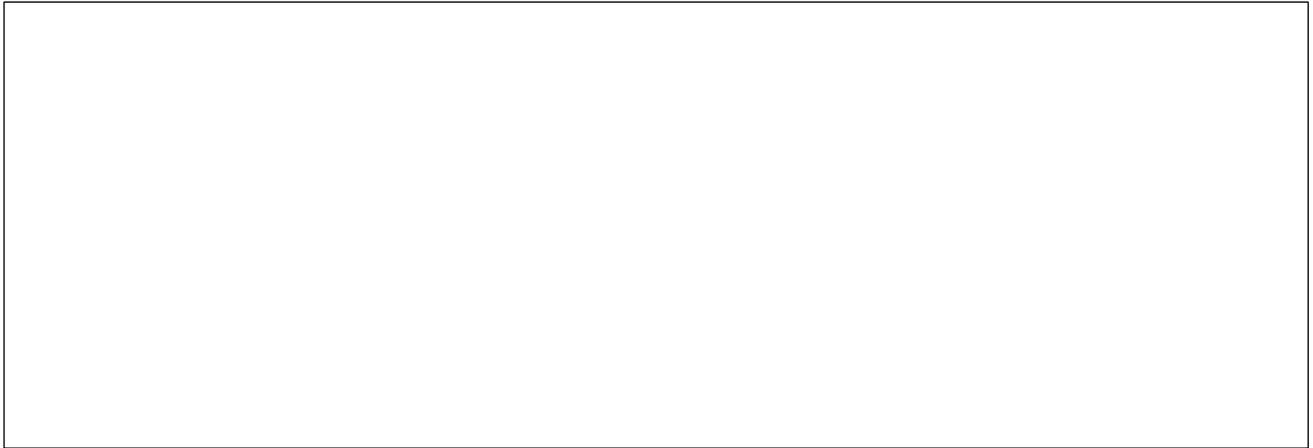
Evaluation of Results (based on test results, was your design effective? How do you know?)

Based on the test results for question 4, I would say that our hospital bed would be successful at reducing pressure ulcer. Unfortunately the rest of our functions and objectives did not receive such high results. We received an average score of 4.6 for keeping the existing functionality of a hospital bed and a 5.2 for its automation. At this point I would suggest that our group completely redesign our hospital bed. Perhaps starting with an existing bed and modifying it to accept the roller we have designed.

**Future Recommendations** (Based on the test results and your evaluation of the results, what you would recommend for improvements to your design, why would you make the selected changes)

**Based on the results of our test we need to completely redesign the frame of our hospital bed. I think that by starting with an existing hospital bed we would increase the score in that category. By adding the pressure roller assembly to the top of the existing frame we would keep our high scores for the functionality of reducing the pressure ulcers. This new combined design shows high promise at meeting our design challenge.**

**Sketch any design changes in the space below.**



**Using a diagram, identify the person or group that filled each role during the design process and their relationship to each other.**

