How VEX Robotics' Experiences Translate to a Future with Dancing Robots

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1. Introduction

From 2017 to 2029, there is an estimated 8.8% increase in the number of STEM jobs; however, only 1 of 5 high school graduates are prepared for the rigorous course load.

1.1. Boston Dynamics

Figure 1

Boston Dynamics is an engineering and robotics company based in Massachusetts with a focus on innovating robots to further enhance the lives of others. With an aim to develop robots with the same mobility as humans and animals, Boston Dynamics focuses on the dexterity and agility of mechanisms. Having developed some of the world's most dynamic robots, Boston Dynamics sought to program Atlas—5'11, 80kg, bi-pedal humanoid robot—to dance to "Do You Love Me?" by The Contours as well as a human can. Needless to say, Atlas became an overnight social media sensation, a 1.5 year development captured in a mere 3 minute video. Atlas demonstrated human-level agility through an advanced control system, hardware, hydraulic systems, and 3D printed parts. A combination of real-time perception, model-predictive control, and behavior libraries provide the agile locomotion of the parkouring and dancing robot that is Atlas.

2. Engineering Design Process

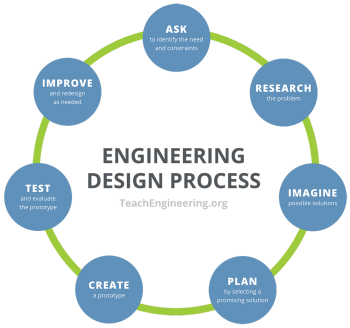

Figure 2

2.1. Identify the Problem

The first step of the engineering design process is to identify the problem and characterize the task at hand. For 507E, it was important for us to read the game manual, and understand the criteria and constraints we had to create our robot under. In addition, in order to effectively design our robot, the problem we identified was developing a multifunctional robot that could manuever the field while manipulating both ring and mobile goal elements. On the other hand, Boston Dynamics identified their task of enabling Atlas to have fluidity of motion similar to that of a human by having it dance to "Do You Love Me?"

2.2. Research

The second step of the engineering design process is to research the problem and begin gathering information. For

507E, much of our research came from watching YouTube videos and reviewing the game manual. It is crucial to completely understand the game in order to generate effective solutions. From the game introduction video to previous designs, everyone on the team spent a week compiling information to manage our time usefully. For Boston Dynamics, Atlas was an already developed humanoid robot that required even further innovation in order to properly dance fluidly. Their research involved aspects such as trials to discover sectors of improvement, an analysis of Atlas' current capabilities, and examining human dancing motions.

2.3. Brainstorm Solutions

The third step of the engineering design process is to brainstorm possible solutions. In order to allow for each unique idea to be heard, we took an additional week to assess the compiled research and imagine possible solutions. With each member's creative thinking process, we were able to generate several possible solutions from previous designs, new ideas, and a combination of both. For Boston Dynamics, the engineers had brainstormed several ideas in order to allow Atlas to dance human-like: develop better motion-programming tools, adjust the weight-strength ratio and expand the energy reserves.

2.4. Decide on a Solution

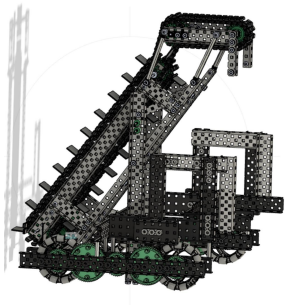

Figure 3

The fourth step to the engineering design process is to decide on a solution. After the development of several ideas, a weighing of pros and cons of each is needed to determine the most appropriate solution to implement. For 507E, we come together after a week of individual brainstorming and spend a few hours sharing our ideas. After a discussion and an overall agreement of our next step, we begin to design the initial prototype through CAD to save time and enhance efficiency. For Boston Dynamics, they decided their solution based on the Atlas' necessity to balance, bounce, and perform simultaneously. Thus, their solution to developing more dynamic motion was to create better motion-programming tools that would allow them to teach the robots to dance.

2.5. Build a Prototype

Figure 4

The fifth step of the engineering design process is to build a prototype or initial design of the decided solution. For 507E, we build our robot based off of the CAD as it allows us to previously ensure correct spacing and create changes as needed. During the building of this initial prototype, we discussed the utilization of sensors and software advancements to increase our robot's functionality. For Boston Dynamics, Atlas relied on a wide array of sensors, including 28 actuators, that served to convert electronic and physical signals into movement which acted like a "muscle." In addition, a gyroscope was implemented in order to aid its balance while the three quad-core onboard computers allowed for the processing of signals and controlling of movement.

2.6. Test the Prototype

Figure 5

The sixth step of the engineering design process is to test the prototype or initial design. For 507E, testing the prototype required usercontrol programming in order to analyze the mechanisms' movement in relation to the motor rotations. Utilizing the field elements, our testing included several trials and hypothetical situations in order to determine what needed to be improved. For Boston Dynamics, much of the testing included the development of rapid-generation tools that allowed for the generation of new dance steps very quickly and integrate them into the performance.

2.7. Redesign as Needed

The seventh step of the engineering design process is redesigning as needed. For both 507E and Boston Dynamics, there are always new ways to push the bounds of robotics and continue innovating. It is a repeated cycle after all!

3. Preparation for Future Careers

VEX Robotics has promoted our experiences with computing and engineering principles that translate directly into future career paths. With the continuous use of the engineering design process in order to effectively tackle problems and continuously improve our solutions, we have come to be more familiar with the very foundation of designing solutions to various challenges. From exposure of real-world applicable engineering and programming to creating long lasting friendships, VEX Robotics has ultimately prepared us for any future career paths—perhaps a robotics experience that will even translate to a future with dancing robots.

Citations

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