

“Fight to the Finish” - How Autodesk Inventor Gave Satan’s Mutt the Edge in Battle of the Robots

Robo Challenge, one of leading organisers of robot combat events in Europe, knew it would be a daunting task when it was asked to develop a technically advanced new robot to take on the current RobotWars European champion, Beauty 2, in an upcoming episode of Channel 5's The Gadget Show. Fortunately, for the company's dedicated designer, John Reid, the solution was clear. He chose Autodesk Inventor, the foundation of the Autodesk solution for Digital Prototyping, to handle all elements of the robot's design.

Working to the tightest of deadlines, Reid used Autodesk Inventor for everything from creating models for all the main components to evaluating the layouts and checking the weight of the design as the project progressed.

Once the simulation and physical testing process was complete, the final version of the robot, known as Satan's Mutt, was ready for combat. The success of the design process was reflected in the robot's fortunes in battle, as Satan's Mutt won out against two of its three opponents including Beauty 2. It's achievement was a fitting testament to the power of high-quality digital design solutions like Autodesk Inventor in successfully facilitating the development of complex products to demanding technical specifications and to the tightest of final deadlines.

Autodesk Messages

- Autodesk provides interoperable tools that enable manufacturers to connect their entire product development process - from conceptual design to engineering, manufacturing, and the end customer - through a single digital model, enabling them to compete and win.
- By putting powerful Digital Prototyping technology within the reach of mainstream manufacturers, Autodesk is changing the way manufacturers think about their design processes and is helping them to create more productive workflows.
- Digital Prototyping gives conceptual design, engineering, and manufacturing departments the tools to virtually explore a complete product before it is built.
- With Digital Prototyping, manufacturers can design, visualise, and simulate products from the conceptual design phase through the manufacturing process, boosting communication with stakeholders while getting more innovative products to market faster.

- By using a digital prototype created in Autodesk® Inventor® software, manufacturers can visualise and simulate the real-world performance of the design digitally, reducing their reliance on costly physical prototypes.

“Fight to the Finish” - How Autodesk Inventor Gave Satan’s Mutt the Edge in Battle of the Robots

Robo Challenge, a leading organiser of robot combat events, and North One TV, producers of television’s *The Gadget Show*, are in regular contact. Robo Challenge has worked with the Birmingham-based production company on several previous episodes of the long-running Channel 5 series. But when North One TV called recently, it was to present Robo Challenge with one of its hardest ever assignments.

The Gadget Show had asked two of its presenters, Jason Bradbury and Ortis Deeley, to create a robot to battle against Beauty 2, the RobotWars’ European champion, and two other impressive fighting machines. Now North One TV wanted Robo Challenge to organise the whole event. The brief involved building the arena and designing and developing the robot to the highest possible standards - all in just over one week.

To make the task even more difficult, Robo Challenge would need to work to strict specifications in designing the technically advanced robot, later known as Satan’s Mutt. First, the show’s producers insisted that the challenger be equipped with multiple weapons rather than the one typical with most robots. Second, these weapons were to be controlled by a ‘Wii-Mote’ from the Nintendo Wii rather than traditional remote control technology. Third, the robot had to feature high quality armour. And fourth, it needed to have a highly distinct visual appearance.

Robo Challenge’s dedicated designer John Reid knew it was a daunting task but his first decision - choosing the best design software package to carry out the work - was straightforward. In Reid’s view, Autodesk Inventor was the one design tool capable of handling the complexity of the design and helping to deliver a high-quality final product to the tight deadline required.

As Reid states, “I was immediately impressed with Inventor. It is easy to use and it makes adding dimensions and modifying parts intuitive. Being able to integrate the design data into a single digital model enables you to streamline the entire workflow without compromising on quality.”

Inventor supports [Digital Prototyping](#) which helps designers to visualise a product before its real, allowing senior decision-makers to make well-informed choices quickly. This was particularly critical on this project where time was tight and building by trial and error simply not an option.

Delivering the Design

Inventor played a key role at the beginning of the design process in helping Reid to rapidly create models of all the main components, including a pneumatic ram for the flipper, a gas bottle and regulator, a drive for the motors, an electronic speed controller, battery, motors for the spinner and, of course, the wheels themselves.

It was agreed that the robot's chassis and armour should be built around the components to ensure the entire package was as small and lightweight as possible. Reid used Autodesk Inventor to evaluate all the relevant layouts – allowing for the fact that the gas bottle would need to be removed periodically for refilling. He used Inventor's Synchronous Belts Component Generator to design belts for the drive wheels and for driving the spinner. This enabled him to quickly locate the required mounting holes in the chassis for the wheels, taking into account available belt lengths.

Managing Complexity

Autodesk Inventor demonstrated its flexibility and rich functionality particularly strongly in the way it handled the more complicated elements of the design. Reid needed to remake the piston for the pneumatic ram that drives the flipper arm in order to lose some weight from the overall design. He used Inventor's built-in stress analysis to determine an appropriate thickness for the piston and to establish what weight could be 'saved'.

As he explains, "we needed to achieve a 'lift-ratio' on the flipper of around 3 to 1 – in other words, the tip of the flipper moves three times the distance of the ram rod. Inventor allowed us to make changes quickly to try out various ways of achieving this goal."

Reid also used Inventor to check the total weight of the design as the project proceeded – the competition rules specified a maximum weight of 13.6 kg – and also to check the centre of gravity to ensure that the robot would handle well.

Bringing Satan's Mutt to Life

Once the design was completed, Reid was able to produce the files from which the physical parts of the robot could be developed. Specifically, he created drawings of all the chassis and flipper parts, exported these from Inventor as DXF files, which were then emailed to the watercutters, enabling the relevant designs to be cut from 4mm titanium.

In addition, he exported models of the spinner mount and ram base to IGES files and emailed them to a team at Warwick University to be 'machined' on their CNC mills. He also created drawings of other parts of the design that were to be made manually.

Once the machining process was finished, the design was nearly complete. The final stage, in which the flexibility of Inventor was again key, was simulation. The concept was to run calculations within the design software that computed what the real-life reaction of the design would be to certain engineering situations. In one case, Reid and his team worked out what would happen when pressure was applied to the robot's pneumatic cylinder at the same time as the device was trying to flip over a 13.6kg block of steel.

With this simulation process over, the final build of the robot was completed. Less than a week had elapsed between Reid receiving the brief and the raw materials and his team completing production of the robot itself. Without the use of a high-quality design software solution like Autodesk Inventor, the rapid and efficient development of Satan's Mutt would have been impossible.

A physical testing process now took place. With time short before the Gadget Show episode needed to be recorded, presenters Ortis and Jason got involved. Satan's Mutt immediately performed well with very few problems or issues recorded. Reid confidently predicted that this success would be replicated on the actual show where the fights would take place in a RoboChallenge designed 2.5 tonne battle arena made from bulletproof polycarbonates and steel in front of a specially invited audience of robot enthusiasts. Reid put much of the credit down to Autodesk Inventor.

"I see it as the industry standard software for this kind of design," he said. "I knew that using it for Satan's Mutt would give the Gadget Show team the best possible chance of success." And he was right. Satan's Mutt put in a starring performance on the show and ended up beating two of the three robots it was pitted against – including European champion Beauty 2 - to win the challenge.

Satan's Mutt's achievement is a fitting testament to the power of high-quality digital design solutions like Autodesk Inventor in successfully facilitating the development of complex products to demanding technical specifications and to the tightest of final deadlines.