

Thought ... The Endless Frontier

NASA / HeroX – Played by Captain Nas

Me – Played by Scooty

My Son – Played by Riverlink

January 15, 2017

Captain Nas is very busy planning missions and taking care of the myriad of projects currently in progress. While sitting in the large NASA headquarters Captain Nas was thinking: “There is one nagging design that is long overdue for a solution. The astronauts on space missions perform many amazing things and work with highly complex equipment. They need ... no, not just need, they deserve a modern system of handling one of those most basic biological processes: They need a device that can take care of their space poop ... and related excretions, of course.”

Many smart people have taken a look at this issue within Captain Nas’ crew, but so far nothing new and innovative has passed muster.

Captain Nas thought: “I need to expand my crew by enlisting the talents of my ‘extended crew’ members that can be relied upon to solve any problem that is tossed their way. I will announce this to all the world of bright thoughtful innovators. I will need to announce this challenge using an exciting, yet concise, title: I will call it the NASA SPACE POOP CHALLENGE!”

Here is one of those bright motivated thinkers now: “Scooty, I need to talk with you a moment.”

Scooty was not expecting to have Captain Nas asking him about anything. He usually just reads the news about the wondrous things Captain Nas is doing and never imagined Captain Nas as being this approachable. Somewhat apprehensive, Scooty replied, “Yes Captain Nas, I always look forward to hearing what adventure you are up to.”

Captain Nas said, “Scooty, as you know, the Captain is very busy planning missions, maintaining space stations, launching rockets, and finding answers to deep questions.”

Scooty, still slightly surprised at the conversation taking place said, “Oh yes, I admire the things you do all the time Captain Nas.”

Captain Nas continued, “Well Scooty, I know you are very good at solving technical issues and I have a real life project that needs a solution. Actually, I had announced this project on the HeroX site for solutions back in September, and here it is, late November already: My, how time *goes supersonic*.”

Captain Nas’ attempt at some humor to get me to relax. I thought, “Yes, engineer humor is often very weak: not really all that funny, but I will chuckle a little anyway.”

Scooty replied, “HeroX? What is HeroX?”

A bright smile came across the otherwise stern face of Captain Nas as he beamed: “Well, HeroX is a wonderful organization that helps open the world of thinkers to apply their innovative minds to

solve real world problems. It provides a portal for teams, and individuals, like *you*, to solve real world challenges.”

“Oh, I love to solve challenges,” replied Scooty. “What do you have in mind Captain?”

“Our astronauts have to live in space for days, weeks, months, or longer.”

Scooty enthusiastically replied, “Yes Captain, it must be very exciting for them to see Earth from way up there.”

The Captain went on: “Well, as you may know, we are also looking to the future, with plans for missions to Mars. All these missions require us to consider the best solutions for our astronauts, and in that spirit, I have announced the NASA SPACE POOP CHALLENGE!”

Scooty looked a little perplexed for a moment and then replied, “With all due respect Captain, I think you should rethink that challenge.”

“What do you mean Scooty? I thought it was quite appropriate.”

“Well Captain, I know you must be looking for a faster way to Mars and I am sure a “Pulse Operated Object Propulsion” engine is what you must be looking for, but I would try and find something other than POOP as the acronym.”

“But Scooty, although Captain Nas and his crew dearly love to use a multitude of acronyms, when I said POOP I really meant poop! The challenge really is about pooping in space!”

“Oh come on Captain, your not trying a new spin on that old joke about wiping out the Cling-ons are you?”

“Well, this is no joke at all! Just imagine what it’s like up their floating in space inside a MACES suit and you have to go to the toilet. There are times when you can’t take off your pressurized suit and can’t even scratch your nose, let alone use a toilet.”

“So Captain, tell me more about this poop challenge. Is it really so difficult that the talent on the Captain Nas crew can’t solve it?”

Captain Nas returned to his business face, cleared his throat, and went on to describe the problem: “Here is a little info on what we have to deal with: First, as you may know, the astronauts can’t use gravity to pull waste into a container. They are floating in microgravity and everything floats around them. Secondly, we need to have a design that can be worn with a standard MACES suit and not compromise the air seal. In emergencies the astronaut might be buttoned up in that suit for up to six days. We can’t have the waste sitting on the skin of the astronaut or fouling up the inside of their suit. We have male and female astronauts, so the solution or solutions should keep that fact in mind, and, it should have a comfortable fit. The astronauts already have quite a time donning their MACES suit, so we don’t want to add more than five minutes to put on the waste handling solution. Air is a precious resource so we can’t be opening the suit to let waste out. Power is limited too, so we can’t have a power hogging vacuum cleaner up there. We also can’t wait for some new fangled transporter beam technology: this design requires a Technical Readiness Level (TRL) of level 4, which can be tested within a year.”

Scooty listened very closely to the problems that the Captain listed and made mental notes as each item was described. Instinctively, Scooty was also thinking of solutions while hearing about each presented challenge.

After Captain Nas finished stating the challenges, Scooty had a few questions building up in his

mind and thoughtfully began some probing questions: “So Captain ... you and your crew have been in space for over 50 years. I can’t help but wonder how you have been handling this issue during all that time. With all the technology needed to get space ships launched and to send probes to far off planets, I can just imagine you must already have a better solution than anything I can think up. Please tell me, what do you use now for handling astronaut waste?”

Captain Nas hesitated for a moment and then cleared his throat again before replying, “Yes, we are certainly proud of our technology, and yes, we have been at this for quite some time.”

Scooty was listening with great anticipation that the Captain was going to reveal a technology that would make him sit back in awe and inspiration.

Captain Nas continued on: “Well ... currently ... our solution is to use diapers.”

Scooty sat there for a moment rubbing on his chin. Then Scooty said, “Captain Nas, I think you really should have your crew do a better job of vetting those acronyms. Let me see ... DIAPERS ... *Don Internal Apparatus Personal Excrement Removal System?*”

Captain Nas replied, “No, No, NO! It is not an acronym this time either. The astronauts wear diapers! It is the best we have come up with for the last 50 years.”

Captain Nas was now showing a slight annoyance at the Scooty’s questioning: Captain Nas was starting to think, “Will Scooty skip this challenge?”

Scooty adjusted himself in his chair and then with an inspiring grin exclaimed, “This is great! Certainly I can come up with something better than diapers! I am all in on this challenge!”

Captain Nas smiled and replied, “Welcome to the team Scooty, welcome to the team. Oh, and by the way, did I mention the winner of this challenge will win \$30,000?”

Scooty’s eyes widened and he replied, “Wow, cool challenges and big bucks too. Is this a great country or what! When do you want me to turn in my idea?”

“You must submit your idea by December 20,” replied the Captain.

Scooty’s smile started to fade a little and asked, “You mean December 20, 2017 ... right?”

“Oh, no, I mean next month,” said the Captain.

Scooty started thinking, “Challenge is good, money is real good, time ... not so good. Well, two out of three are good, so I will give it a shot.”

The Captain asked, “Well Scooty, can we count on you to give it your best?”

“Yes Captain, I am on it,” replied Scooty.

Scooty always likes to research some background on a challenge so he started looking for information on the MACES suit and microgravity.

Scooty started searching on the Net: “OK, lets search on space suits. Here is a link: https://www.nasa.gov/audience/foreducators/spacesuits/home/clickable_suit_nf.html that shows lots of space suit info. Oh, this suit is an EMU for space walks, not the MACES suit. I am curious though ...”

Scooty scanned through the list of space suit systems. Finally, he came to the part he was looking for: “There it is, plain as life. They call it the *Maximum Absorption Garment!* So, that’s what it looks like. Well, I am going to have an idea they can use to fix the EMU situation as well as the MACES suit. I’ll be sure to fill my description with plenty of new acronyms to make them feel at home too.”

Scooty continued his research: “Here is another nice summary of the issues at:

<https://herox.com/news/699-how-to-poop-in-outer-space> that can shed some light on this problem. The *Amazing Zero-G John*. OK, this could use some improvement too. I will keep this in mind, but not let the scope of the idea get too far from the MACES focus.”

Scooty kept on doing his research: “So, here they show more info on the MACES: <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20140010572.pdf> and, of course, it has plenty of acronyms. I will be adding to that list some day, just wait.”

Scooty browsed to several more sites looking over space suit designs. He then decided to look at info on microgravity. “Lets see, how about a video on liquids in space at: <https://www.youtube.com/watch?v=o8TssbmY-GM> to help understand the issues?” he thought. “Oh that is so cool! Water sticks to you like syrup. Oh boy, I think the challenge just got a little more challenging.”

The HeroX site also listed some requirements about not violating prior patents, so Scooty decided to look at what other inventions were already out there in patent land. “I suppose I should see what patents are already out there. I sure don’t want to waste my time on reinventing the *wee*’l.”

Scooty searched the net for patents and did not see anything that appeared like the way he would approach the problem. One hit on the net shows a patent on a *Biohazard Suit with Built-In Toilet* that Scooty thought was especially amusing: “Hmm ... this picture shows someone in a biosuit with a built in poop bucket.”

Scooty smiled and thought, “Can you imagine if that idea was being used by the astronauts? I can picture the famous phrase now: *That's one small pot for man, one giant squat for mankind*. No way, not happening on my entry!”

Scooty decided to start working out some ideas. He likes to break down big problems into smaller parts and work through each part he is focused on. He started thinking about the urine collection subsystem: “So, the solution needs to work without gravity. It needs to move urine away from the body and hold it securely. It should be easy to put on, comfortable, and low power.”

Scooty continued thinking through the urine subsystem requirements and at one point sat back in his chair to assemble his thoughts: “Why is it that my ideas lead towards some kind of absorbing material?”

“Some kind of,” Scooty gulped, “diaper!”

“No, no, no, I am not going there!” thought Scooty. “I can just picture Captain Nas saying, *See Scooty, it’s not so slam dunk of a challenge, is it?*”

Scooty then thought, “OK, no cloth, no absorbing materials ... NO diapers of any kind!”

“So, there is no gravity. How about simulating gravity? If the astronaut could stand on a platform, lock down his boots, and then we spin the platform at a controlled speed, it would use centrifugal force to move the waste away from the body.”

Scooty did a quick sketch of the idea and then started to evaluate it: “Now the urine is flung away from the body, which is good. It flings to the inside of the space suit: not so good. The astronaut has air hoses getting all twisted up: also not good.” He sighs, “One idea to flush.”

“It is time for a different approach,” thought Scooty: “I need something that can wick the urine away, but not use diapers. Actually, what I need is some kind of water magnet. Water is not magnetic, but, it is *polar*!”

Scooty continued to recollect: “I recall putting a charge on a piece of acrylic by rubbing it on my sweatshirt and then holding it near a stream of water from the kitchen faucet. The water would always swerve towards the acrylic due to the static charge on the acrylic and the polar nature of H₂O molecules. Now I am gaining some traction on an idea.”

Scooty started to feel the creative energy building up in him. He now has a path to actually start building on: “Let's see, back to the Net. Good: skin is actually listed in the Triboelectric series and it shows a positive charge. I will make sure the urine attractor is negatively charged so that it takes advantage of both the polar molecules of the water and the likely positive charge on the body. This should overcome the surface tension of the fluid's attraction to the skin.”

“Next problem,” thought Scooty: “Now I need something with a negative charge. I think instead of charging a plate with a power source, I will just use a permanently charged electret material. I am sure Captain Nas could find something from his current inventory of technology to use for a good sized, highly charged electret.”

Like an avalanche, starting with a small movement of rocks and transforming into a full blown thunderous crash down the mountain, the ideas for the solution started filling up in Scooty's head.

The inspired Scooty started thinking, “Waste at crotch, attraction to the electret, some kind of pump: just large enough to move the fluid to the back of the body, porous mesh pad to isolate the pump from genitals, Nitrile boxer-like shorts for an inside liner to keep the waste off of the surrounding skin, hoses to rear, larger rear pump for dicing up solid waste and transport, custom molded cushion to mount the rear pump, another electret, outer Nitrile liner to hold all this stuff so it can be easily slipped on, manifold to direct the waste down some hoses, hoses along the legs to the boots, quick connects at the hoses, storage bladders in leg boots, another electret at the bottom of the boots to attract the waste, check valves along the waste path, circulation air inlets, and electronic controls.”

Scooty was sketching out his ideas as quickly as they came pouring in. While looking at his sketches, Scooty's son, Riverlink, happens to walk into the room.

“Hey Dad,” said Riverlink, “what is all that scribbling you have out in front of you?”

Scooty looked down at the sketches of his exhilarating solution and proudly replied, “Riverlink, this is my idea to solve the NASA Space Poop Challenge.”

Riverlink took another look at the sketches and said, “Dad, you need some help with your drawing, here, let me show you.”

Riverlink grabbed a fresh sheet of paper and began to quickly draw a picture of a cartoon character he had made up and then said, “See this is what you need.”

Riverlink had drawn a character with arms and legs waving, big eyes, grinning teeth, and tall pointed ears. We both had a nice laugh.

I started to think though, “Riverlink does have a point: my art is awful. If I draw fast, or slow and careful, it would still be awful. Captain Nas is not expecting perfection on the ideas, but he is expecting it to be presented first rate, not first grade!”

Riverlink asked, “Dad, did you say you are working on a poop idea for the astronauts?”

I replied, “Yes, Riverlink. I know it seems like a funny topic, but Captain Nas presented me with this challenge to solve.”

Riverlink smiled and said, “Oh yes, I can imagine the astronauts up there doing their duty.”

I immediately knew what Riverlink meant, since we had both seen the *Wreck-It Ralph* movie and the little girl in the movie made quite a direct link between the word duty and poop. Well, I tend to use good ideas wherever the inspiration comes from, so in that moment it came to me:

“Thanks for the idea Riverlink, I now have a name for my idea.”

Smiling, Riverlink said, “What is it Dad?”

Scooty replied, “I will call them *Duty Boots*.”

Riverlink chuckled while leaving the room and said, “Have fun with your *dooo teee* boots Dad. Oh, I forgot to mention, mom wants some time on the computer today, so take a break sometime.”

Scooty thought, “I do tend to hog the computer all day and night on the weekends, but time is short: this project is due in less than three weeks.”

The reality of Scooty’s poor art skills started to settle in and Scooty needed to solve that problem quickly if he is going to have a chance at submitting even a minimal Captain Nas’ worthy idea. Scooty thought, “Captain Nas has a place at the top of the challenge entry to put a picture of the idea. I’ll bet, with the thousands of entries in this challenge, if the picture sucks, they won’t even look at the idea. No doubt, if I submit a sketch, my idea is a gonner.”

Scooty started working on a solution to documenting his challenge idea.

Scooty recalled trying out a free 3D art program last year while kicking around ideas for creating a video game with Riverlink: “It has been a while, but let’s check out Blender.org and see if I can use it to save my challenge,” thought Scooty.

Scooty went to the web site and downloaded the latest version of Blender. “Wow”, thought Scooty, “the art that people can do with this free program is amazing. If I can just get a good, free, open, humanoid 3D model to start with, I can figure out the rest.”

“Bingo! I’m saved!”

Scooty found exactly what he had hoped for on the web site: <http://www.manuelbastioni.com> (1).

“Now that is an artist! How generous of him to make his creations available for everyone to use.”

The 3D model fit perfectly with what Scooty needed. He began adding each of his ideas to the model. It was a somewhat slow and tedious process at first: Scooty had not used Blender for almost a year and, even at that time, did not learn enough about using it.

“Learning to use Blender is a slow process, but at least I like what I see. Now I can organize my ideas,” thought Scooty: “I can also see some areas that need improvement. Waste might stick to the inside of the manifold or on the hoses to the boots. I will make everything with, or coated with, non-stick surfaces: possibly Teflon. The inside of the manifold and boot hoses will have collapsible Teflon liners to squeeze out any accumulated waste residue. The rear waste impeller will have a common shaft to a pneumatic pump to control the expansion and contraction of the liners.”

As Scooty imagined the waste system in operation he went through the checklist of requirements: “OK, it removes waste, it is comfortable, the boots can hold the required amount of waste, plus some spare capacity. It is easy to put on: you just pull up the Waste Boxer Shorts, put on the boots, attach the hose quick connects, and connect the power cable.”

Scooty continued reviewing the rest of the requirements and then came back to one specification that he needed to go back and check with Captain Nas about.

“Hello Captain Nas,” said Scooty in a confident manner.

Captain Nas replied, “How is it going Scooty? Only a few days left to get that challenge done.”
“Will you be ready?”

“Yes Captain, I think my idea will be ready for launch! I did have one question though.”

The Captain said, “Sure Scooty, how can I help you?”

Scooty presented his question: “Captain, you mentioned that electrical power is limited on the requirements. What exactly is the available power?”

The Captain replied, “It is up to 28 volts and under 100 milliamps.”

Scooty hesitated and then said, “That seems kind of stingy on the power doesn’t it?”

Captain Nas replied, “Scooty, remember, our existing design does not use any power. I think we are being quite generous with the specification.”

In a slight panic, Scooty replied, “But, Captain Nas, my design has a motorized impeller that dices up the solid waste and throws it down tubes to the storage area.”

Captain Nas, looking a little annoyed, said, “So why is that a problem?”

Scooty, becoming more animated at this point replied: “Captain, obviously, when the defecation hits the rotary impeller, it could seize up! I need more power or this project is going to die!”

Captain Nas replied calmly, “Why does this remind me of a movie plot? Anyway, I trust you will figure something out, so stop wasting time and get on with it.”

Scooty went back to his computer chair and started trying to solve the power issue. Pressing his hands together and interlocking his fingers, he tapped his thumbs together and set his chin on top of them. Staring at his design document, he began figuring out a solution: “OK, just relax, think, focus: this is a solvable problem. Its late. Maybe I should sleep on it and take a fresh look in the morning. No, I won’t sleep, there is no time for that.”

Scooty continued to try and break down the issue into solvable parts, which is a method that has served him well: “State the problem,” thought Scooty: “When solid waste enters the rear impeller, the limited power available may cause the impeller to stop spinning.”

Scooty then thought, “Sometimes the best approach to solving a problem is to invert it. After all, a solution is just the inverse of a problem, so I will invert this problem: When solid waste is not entering the rear impeller, I have all the power I need and ... MORE!”

Once again Scooty knew he hit on the solution and the adrenaline picked up in his body: “The astronaut is not pooping 24/7: in fact, their ‘Duty’ cycle is just a few minutes a day! Captain Nas said I have 28V and 99.9 milliamps to work with. I will just include a super capacitor or small rechargeable battery with a trickle charge of power while solid waste is not entering the impeller. When the solid waste is present, there will be plenty of stored power from the super cap to keep the impeller spinning.”

“Yes ... bring on that big bad log; when your number comes up, you are going down!” thought Scooty, basking in the glory of his latest solution.

“Now, I can sleep. Five hours and I have to get up for work.”

When Scooty was home from work the next day, he started looking at his latest solution to the power problem: “Wow, just look at that solution to the power. Last night it seemed so difficult, such a brain bender, yet now it seems, so, so obvious. What was I thinking? I should have slept on it after all.”

Scooty went on reviewing his design idea to check for other issues. Once he felt comfortable

that the specs on the challenge were met, he decided to go one step more.

Scooty started thinking, “This solution does not require any air outside the MACES suit: it merely moves air within the suit wherever it is strategically needed. It does not matter if you are in the pressure suit, or not. You just need 28V/99.9mA with you. The impeller provides kinetic energy to move the waste to the boots and the collapsible liners in the manifold and boot hoses help clear those lines of any stuck waste. Why not add a couple more pneumatic hoses to collapse the storage bladders in the boots and add a coupling at the soles of the boots to purge the bladders?”

Scooty updated his 3D model with the added pneumatic hoses, boot couplings, and boot hold down latches: “Yes, that should do it. When the astronaut wants to purge the waste from the boots, she (or he) just steps on to the waste receiving platform, locks the boots in place, waits for the platform waste tank to equalize pressure with the MACES suit, and opens up the boot valves. The electronic controls would sequence: purging the manifold, then the hoses, and finally the boots. It could all be coordinated with a simple wireless interface to the waste receiving platform. After the waste dump is completed, the boot valves are closed and the boot latches disengage. It only took a minute and the astronaut walks away, back to business. Nice!”

Scooty, feeling real good at the extra effort, thought, “Captain Nas should really like this design. It not only took care of the MACES challenge, it could easily be used as normal astronaut attire in the pressurized cabin. If Captain Nas put some waste receiving platforms on the outside of the space craft, the same system could also be used for the EMU suit while on a space walk.”

Scooty, finally relaxing thought, “Well, I finished the challenge, and with a couple of hours to spare. Upload to HeroX: complete. Upload of 3D model to Dropbox: complete. Satisfaction: Complete!”

The Nasa Space Poop Challenge turned out to be a big hit at HeroX with thousands of entries by the world of thinkers. Now HeroX has the challenge of going through all those entries and deciding which will be chosen as the winner. Maybe, they might even choose mine.

What might come next?

Captain Nas said, “Scooty, now that you have solved the Space Poop Challenge, I would be very interested in hearing more about this *Pulse Operated Object Propulsion* engine that you mentioned earlier. My crew is always looking for a better way to travel in space.”

Scooty happily replied, “Why certainly Captain, I have given it some thought and have already solved the first critical problem on this design.”

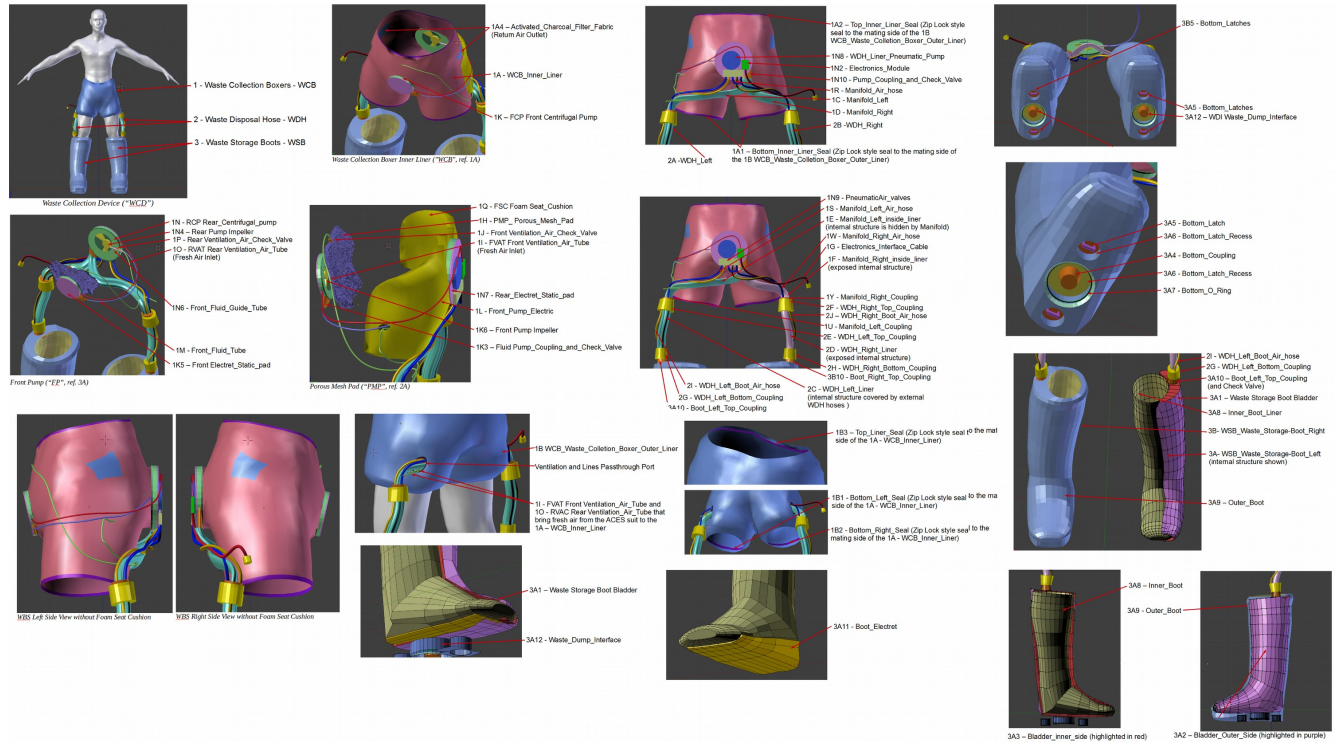
A surprised Captain Nas replied, “Scooty, you sure do work fast. Please tell me, how did you solve the first issue?”

Scooty smiled and said, “It was simple Captain. I just dropped *Operated* from the name!”

Captain Nas, with a smirk said, “Yes, I can sense the improvement already. So, Scooty, how about the next step in a solution?”

Scooty slowly nodded, “OK Captain Nas, I will give it some thought.”

Scooty – A picture is worth 4,677 words?



(1) The 3D model was generated using the open source tool “ManuelbastioniLAB” so this model is a derivative of the character created by Manuel Bastioni (www.manuelbastioni.com) and is licensed under CC-BY 4.0. The adapted humanoid and attached mechanical devices were created by BIG IDEA on HeroX.