# ROBOTCOWBOY: ONWARD TO MARS
# A ONE ASTRONAUT SPACE ROCK OPERA

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## ABSTRACT

This paper discusses the development of *robotcowboy: Onward to Mars*, a one astronaut space rock opera and Master of Fine Arts thesis influenced by the author's time at the Mars Desert Research Station. Begun in 2006, *robotcowboy* is an audio/visual performance platform using wearable computing with an emphasis on embodiment and action. *Onward to Mars* represents a new robotcowboy chapter with the focus shifted towards space and humanities future on the Red Planet.

How do you talk about going to Mars to a general audience on stage? Wear a spacesuit.

## KEYWORDS

Education and Public Outreach

## INTRODUCTION

I am an an artist, engineer, musician, and performer who combines live musical performance techniques with experimental electronics and software for exploration into themes of science fiction, space travel, cyborgification, and far futurism. My father was an aerospace engineer, I grew up in the Rocket City (Huntsville AL), and have performed in Europe and around the US with my one man band cyborg performance project, *robotcowboy*.

As an artist with a background in computer engineering, I feel that my role is to perform "Research & Development for humanity." For me, art is like philosophy - you play with ideas and pose questions through visual work or performative action. My tools are not paint brush and canvas, but hardware and software: the medium of our current age. Due to my background, my work is a constant tug of war between utopian engineering perfection and the wants/needs of our literally squishy existence. I enjoy creating performative systems which both project a complete ideal yet contain an integral aspect of chaos, from the computer vision translation of my slippery mouth to performing in a cyborg system that can crash at any moment: *robotcowboy*.

### robotcowboy: Cabled Madness

*robotcowboy* is a wearable computing platform to explore new types of man-machine music & artistic performance. Embedded computing, custom software, and audio electronics are utilized to build

portable, self contained systems which both embed and embody the computation on the performer. This cyborg approach is both empowering and compromising as new sonic capability & movement are offset by the need for electrical energy: elements of tension between human and system. *robotcowboy* shows are always live and contain aspects of improvisation, feedback with the audience, and an inherent capability of failure, i.e. the "live" in live performance. [1]

The first incarnation of the project, now called *robotcowboy: Cabled Madness*, is a cyborg suit consisting of the wearable computing & audio hardware mounted on a "Batman utility belt" and a working computer monitor helmet complete with built in camera and video goggles (Figure 1). Songs using this system are generally performed using USB HID (Human Interface Device) gamepads or digital guitar and are reliant on improvisational input & control. It could be said that these songs are "danced" as much as they are played. Control movements are visualized on the face of the monitor helmet, partially to emphasize the live nature of the performance as opposed to prerecorded playback. The fourth wall is always broken when audience members are required to help replace unplugged or missing connections in the "cabled madness".

The result of my 2007 Master of Science thesis [2], *robotcowboy: Cabled Madness* performed at various music and art festivals in Europe and the US from 2006 to 2011, including a 2 month tour in 2008. The system and its design ideals of portability, ruggedness, and plug & play were tested in the field and survived numerous shows in front of disparate audiences, from house parties to bars to art galleries to electronic music festivals.

*robotcowboy* was always meant to be a platform to explore different ideas, but by 2009 it had solidified into a single act without a driving concept beyond the conceptual requirements of the system. It was time to look in a new direction.

**ROBOTCOWBOY: ONWARD TO MARS**

It's been 45 years since the last Apollo astronauts left the moon and Buzz Aldrin laments on the cover of the MIT Technology Review: "You promised me Mars Colonies. Instead, I got Facebook." [3]

If we didn't go then, why don't we go now?

For the next *robotcowboy*, I returned to my childhood interest in spaceflight and researched contemporary space programs and near future plans for planetary exploration which mostly lead to Mars. The Moon is closer but less interesting for colonization since it doesn't have an atmosphere to hold in heat and useful gases. Venus has the opposite problem with the densest atmosphere and highest temperature of the interior planets, not to mention its sulfuric acid clouds [4]. Next up is Mars.

Of the planets in the Solar System, Mars is an ideal candidate for long term human habitation. It's smaller than the Earth with a surface area roughly the size of all of Earth's continents combined and 1/3rd the gravity. It has a lighter atmosphere consisting mostly of carbon dioxide which keeps it warmer than the airless vacuum that is the surface of the Moon. Water exists at its north pole in the form of ice and evidence exists for water trapped in permafrost [5]. You couldn't go chipping ice blocks in your T-shirt, but you could wear a lighter weight atmospheric suit instead of a full space suit.

Mars is relatively close and we've gotten pretty good at landing things on it. Its only some 35 million

miles away at its closest and manned missions would take roughly 6 months to reach it, which is the next block over in astronomical terms and doable with current technology. Heavy lift rockets such as the upcoming NASA Space Launch System (SLS) or the SpaceX Falcon Heavy could send a small crewed vehicle to Mars in one launch. [6]

It's possible, we're just missing the will. For many people, a mission to Mars is only within the realm of science fiction, even though it could have been a reality decades ago. At the same time, NASA has plans for Mars in the 2030s [7] and private organizations such as Mars One want to start colonization in the 2020s [8], so this could be something we'll all be watching live on TV in the near future.

With this in mind, I decided the new *robotcowboy* would head to Mars. The cyborg suit becomes a space suit and the wearable computer is now built into the life support system backpack: the cyborg is now an astronaut. This new show is designed to convey the realities of a contemporary Mars mission through performance and music in order to bring this discussion to new audiences. The basic pitch is: "new wave rock band DEVO and performance artist Laurie Anderson meet astronomer Carl Sagan on the Red Planet." The show's name, *robotcowboy: Onward to Mars*, is adapted from the "To Mars! To Mars! Onward to Mars!" greeting of engineers in the 1930's era Soviet Group for the Investigation of Reactive Engines (GIRD) [9] and used by members of the Mars Society.

Conceptually, this new show is designed to contrast the expectation of space flight and its utopian ideals with the day to day reality of such a mission to the Red Planet. As postmodernist theorist Jean Baudrillard says of the space race [10], the interest for most people in landing a man on the Moon was not in the event itself or the fulfillment of some dream, but with the "perfection of the programming and the technical manipulation, by the immanent wonder of the programmed unfolding of events." I feel that the sheer routine of sending people into space since Apollo 11 has both lessened interest into the mundane aspects of space and increased our desire for another utopian mission, except now this utopia feels unattainable. I hope to show to a general audience that such a mission is not only possible but that the day to day work involved is both exciting and worth backing.

*robotcowboy: Onward to Mars* is about crossing lines. In leaving this planet as a species, we'll be crossing a line for the first time since we started walking erect, using tools, and created civilization thousands of years ago. Similarly, with this show I hope to encourage my audience to cross a line in their view toward a contemporary mission to Mars: that it would not have to remain in the world of science fiction, but could cross over into reality if we have the will to do, as Kennedy said, "something hard".

**FIRST HAND RESEARCH AT THE MDRS**

As an artist with an engineering background, I started this "R&D for humanity" project by getting a "feet on the ground" perspective. The Mars Society, a nonprofit space advocacy group promoting human exploration of Mars, initiated the Mars Analog Research Station (MARS) program in the early 2000s to build a series of Mars-like centers for experiential research [11]. The Mars Desert Research Station (MDRS) in eastern Utah (Figure 2) is the second deployed station where, in this Martian analog on Earth, crews spend 2 week rotations living and working in a remote, simulated habitat: planning Extra Vehicular Activities, wearing space suits (Figure 3), exploring the terrain on foot or via rovers, maintain/upgrading systems, and experiencing a tin-can existence. Through this research, they are able

to better understand how people will live and work effectively on the Red Planet.

**Crew 119**

In the fall of 2012, I applied and was accepted to be the Journalist for Crew 119, the first crew rotation in season 12 at the Mars Desert Research Station. In my official capacity, I took notes and photos, wrote daily public affairs reports, and tweeted our progress on Mars. In addition, I planned EVAs, wrote mission reports, and compiled maps and points of interest. Since we were the first crew in the season, there were no footprints or tracks left over from the last crew, so our rotation was a "first landing" simulation. We approached our 2 weeks as the first crew on Mars and began with a blank slate as pioneers, exploring and mapping the area.

**Heading to Mars Book and Exhibition**

After returning to Earth, I compiled these journalist reports, tweets, photos, & personal notes into a book (Figure 4), *Heading to Mars: MDRS Field Journal, Crew 119*. Both PDF and EPUB versions can be downloaded from my website: danomatika.com/projects/heading-to-mars.

The book, photos, video, & pigment samples were also part of the 2013 Master of Fine Arts graduate group exhibition titled "Basement Miracle" at the Carnegie Mellon University Miller Gallery [12]. My presentation, *Onward to Mars*, was both documentation of my research experience as part of the MDRS Crew 119 and a lead in for the upcoming *robotcowboy: Onward to Mars* show.

(For detailed information on Heading to Mars see the accompanying paper *Heading to Mars: MDRS Field Journal, Crew 119* in the 17th Annual Mars Society Convention proceedings.)

**The Experience of Standing on Another Planet**

From this experience, I gathered insight and material for *robotcowboy: Onward to Mars* I would never have come up from second-hand research alone. I learned that being an astronaut involves lots of paper work, that dehydrated vegetables taste best for cooking if you've soaked them in hot water for at least 15 minutes, and that a space suit feels normal after only a few days. I learned to love the white noise of my oxygen supply, taking minimal showers, and sharing a purpose with strangers who became crew mates. I became acutely aware that the world outside our tin can wants to kill us, that resources are limited, and that a cold night is not when the generator should fail. I learned that fear will always be present for life in space, but that we have the training and the technology to be prepared for it. I know the pioneer spirit and the quest for knowledge will push humanity beyond its current limitations.

**INFLUENCES**

> *If we are going to move human beings into outer space, you are going to have to move their culture with them. - Lowry Burgess [13]*

In addition to research spent at the MDRS, *robotcowboy: Onward to Mars* is influenced by space art, contemporary artists working with space themes, the space operas of classical composers, and the musical vibrations of Sun Ra.

Roger Malina, astrophysicist and editor of *Leonardo: Journal of the International Society for the Arts, Sciences and Technology*, defines Space Art as "contemporary art which relies on space activity for its implementation" and further states that the "creation of contemporary art is inextricably tied to the process of creating human civilization." In this light, he feels that art making in space should not only be encouraged but that human culture in space would be incomplete without it. [14]

The origins of Space Art coincide with that of the Space Age of the 1960's when the predictions of science fiction became reconciled with that of science fact, where art in space moved from imaginary to contemporary. The 1962 inception of the NASA Art Program brought artists such as Norman Rockwell, Nam June Paik and Robert Rauschenberg into the agency to explore the cultural impact of space exploration [14]. Artists unofficially hitchhiked to the Moon with the *Moon Museum* etching (Figure 5) allegedly hidden in the Apollo 12 Lunar Excursion Module [15] and *The Fallen Astronaut* sculpture brought as part of Commander Dave Scott's personal effects on Apollo 15. [16]

With the development of the Space Shuttle program in the late 1970's and 1980's, artist Lowry Burgess worked with NASA to develop rules allowing for non-scientific payloads and personnel policies, resulting in the 1989 launch of Burgess's *Boundless Cubic Lunar Aperture* onboard Space Shuttle Discovery during STS-29 [17]. After the end of the Cold War, access to space began to open up with works such as Arthur Woods' *Cosmic Dancer* sculpture being carried to the Mir space station [18]. Similarly, artists began to engage with zero gravity including Frank Pietronigro's "drift paintings" [19] and choreographer Kitsou Dubois's dance experiments onboard parabolic jet flights. [20]

On the ground, contemporary artists, as with popular culture, have been utilizing space themes, imagery, and data. More recently, self-described "bricolage artist" Tom Sachs' 2007 *SPACE PROGRAM* recreates the Apollo 11 landing in the art gallery and the subsequent *SPACE PROGRAM: MARS* in 2012 portrays a fictional Apollo Mars landing (Figure 6) through meticulously crafted space suits, vehicles, and tools using common, everyday materials [21]. Similarly, Peter Hennessey's life-sized replicas of the Apollo Lunar Rover, the Hubble Space Telescope, and the Voyager spacecraft are "an investigation into a class of objects that we can see but cannot touch" but ironically, have a "large presence in the world". [22]

In the realm of music, artists have long explored space themes from Mozart's Magic Flute and Joseph Hayden's *The World in the Moon* to Gustav Holst's *The Planets*.

> *I'm looking for answers in the entire universe because I want to know the real potential of man. - Sun Ra [23]*

Experimental jazz composer, band leader, and performer Sun Ra's work routinely called to space travel and astral projection through sound, dissonance, and harmony. Open to investigation into new modes of expression, he was one of the first musicians to experiment with synthesizers in jazz. He created his own afro-future mythos based on ancient Egypt and space travel with his band, the Sun Ra Arkestra (and its many variations), spreading his message through their sonic vibrations.

**STORY**

> *It was 2030 when we discovered the fundamental frequency of the universe.*

**tuning fork rings**

*From this tone can be constructed the harmonics of life, death, and movement in the cosmos. Although, we can so far only comprehend one billion billionth of the available data, we do know that each celestial body sings its own song and those who wish to live upon a new planet's surface, must know its melody by heart.*

The story for *robotcowboy: Onward to Mars* follows a single astronaut on a one way trip to the Red Planet. In the near future, it is discovered each celestial body emanates harmonics on the newly found fundamental frequency of the universe related to their electron cyclotron resonances. Particles rotating within magnetic and gravitational fields generate unique frequency patterns related to both this fundamental and that of the body itself, forming a fingerprint or "song". Life on each planet evolves to the frequencies of its home and must adapt if it is to live on a new world or perish. Specially trained, the Astronaut is sent ahead of an existing crew with "scientific (musical) instruments" in order to discover the "song of Mars" and ensure the success of the following landing and colonization efforts.

Although the show is a contemporary hard science fiction mission to the Red Planet, one conceit of fantasy was chosen to explain the nature of the "solo one way trip": the Astronaut is the pathfinder to discover the "song of Mars". Providing the basis for the narrative action but not directly referenced within the show, the concept of "planetary frequencies" is influenced by the Age of Enlightenment *musica universalis* ("universal music") theory that postulates each planetary body in the solar system moves in a perfect harmony related to intervals within the Pythagorean musical scale (Figure 7). Backing this up is a small amount of scientific fact in the Jupiter electron cyclotron emissions detected by the Voyager 2 plasma wave instrument in 1979:

*Jovian electron cyclotron emissions are intense narrow-banded emissions, generated by energetic electrons spiraling along the magnetic field lines of Jupiter and its magnetized moons. The frequency bands of the electron cyclotron emissions occur at harmonics or very precise multiples of the electron cyclotron frequency, a characteristic frequency of the plasma surrounding the planet. - University of Iowa Radio and Plasma Wave Group [24]*

**SYNOPSIS**

The show itself is a concept album with each song being a thematic part of the narrative. Song titles appear in *italics*.

**Pre-Act: Press Conference**

Press conference on the mission in the theater lobby with small stage, table, curtain, and projection. One interviewer, a camera or two, and the Astronaut. End with open audience question and answer session.

**Act 1: The Trip**

3 month trip to Mars with backstory only explained through preceding press conference and context within the show. First 1/3 of the stage acts as the interior of the Habitat (Hab) which spins via pendulum action from the weight of the stage 3 rocket booster on the end of a tether. Discussion and songs of the excitement & isolation of the journey. (Figure 8)

Song 1, *Instrument Calibration*: noisy introduction played with gamepad, simulates show instrument calibration in a manner similar to a pre-flight checklist

Song 2, *Wanting the Universe*: opening rock theme played on guitar, establishes overall premise of heading to Mars

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put me on a rocket
out into space
give me a chance
to move the human race
out to the stars
we'll start on Mars
and go from there
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Song 3, *Traveling*: voyage to Mars improvised on gamepad, accompanies spoken word sections on distance, isolation, and expectation

Song 4, *MartianPlain*: rock landing sequence played on guitar, acts as climax of Act I

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I've traveled 40 million miles
will I make it?
braking burn completed
orbital insertion begun
aerobrake deployed
we've got to try
all I can do is try
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**Act 2: Exploration & Discovery**

Transformation from traveler to explorer within inflatable space ship, stage right. Don space suit (as second skin) stage center and embark on first EVA. Feelings of excitement and discovery: walking on Mars! Move to scientific investigation and preparation where high technology sends a human to Mars in order to dig in the dirt: “Spaceman Caveman”. (Figure 9)

Song 5, *Suit Donning*: a set of generative sequences that provide atmosphere for the donning of the space suit, controlled by gamepad (Figure 14)

Song 6, *Spaceman Caveman*: rock song noting the simultaneous triumph and irony of the first steps on the Red Planet, the highest technology on Earth allows the Astronaut to dig in the soil of Mars like a caveman

```
I'm a spaceman caveman
all the way from earth
I'm a spaceman caveman
now I'm digging in the dirt
I'm a spaceman caveman
can life be found?
I'm a spaceman caveman
evolution's come to town
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**Act 3: The Song of Mars**

The frequencies begin to manifest themselves as the Astronaut moves farther from the Hab. They then appear as 3 challenges: radiation, a 30 mile high dust "devil", and the cold night (Figure 10). Overcoming these challenges yields the Song of Mars.

Song 7, *EVA*: a set of sequences which explore and confront the dangers of the Red Planet in order to find the "song of Mars", performed on Theremin & integrated penetrometer gamepad

Song 8, *Night*: loss, isolation, and doubt in the cold Martian night, suit life support shutting down, recognition of the missing piece of the "song of Mars", reflection of audience members as stars in the universe through a suit mounted camera (Figure 11)

Song 9, *Ball of Love*: celebration and finale performed on guitar, life support kicks in and the completion of the mission

**SPOKEN WORD**

The story and thematic content of *robotcowboy: Onward to Mars* are conveyed through spoken word segments by the Astronaut, an archetypal "everyman" character. Inspired by the work of performance artist Laurie Anderson, the Astronaut delivers his point of view as the narrative progresses, noting both positive and negative aspects of the experience. Although presented in an ostensibly theatrical setting, the spoken word in *robotcowboy: Onward to Mars* is delivered directly to the audience in an improvised manner without following a strict script in order for the performer to better play off of timing and audience feedback. This approach also helps to "keep things live" in the *robotcowboy* conceptual tradition.

This content of the show is gathered from research and my own aforementioned personal experience at the Mars Desert Research Station (MDRS). Sources include Dr. Robert Zubrin's *The Case for Mars* [6], the history of Soviet and NASA missions to the Red Planet, Mars in popular culture and science fiction, Martian planetary exploration data (size, gravity, weather, etc), long term space strategy via the Rockwell Integrated Space Plan [25], the Mars One project [8], NASA's Apollo project, various space

travel and human physiology studies, popular views of contemporary space exploration via media and online commentary, and first woman in space Valentina Tereshkova's affirmation that she would go to Mars "without coming back." [26]

**MUSIC**

The music of *robotcowboy: Onward to Mars* is a combination of computer music and rock & roll which has been described as "experimental pop". As with the previous *robotcowboy* incarnation, composition is focused on live performance and experimental in nature. Some songs are performed much like "digital jazz" through free improvisation with custom controllers and digital instruments while the rock songs are played using voice and guitar along with pre-sequenced bass and percussion voices.

Musical development of the show is inspired by a number of composers and musicians. The space-themed operas of Haydn & Mozart lend to the overall thematic arc of the show. The conceptual and experimental sound of 50's and 60's electronic composers Delia Derbyshire, Pauline Oliveros, and Louis and Bebe Barron showed how simple instrumentation approached with experimentation and a conceptual backing can lead to new and interesting soundscapes. Sun Ra's afrofuture space jazz and performance aesthetic opened new doors: "We've tried the possible, its now time to try the impossible" [27]. Finally, the pop/rock stylings of DEVO, the Talking Heads, the B-52's, the Cramps, and the surf rock band Man or Astro-man? (sic) directly inform the musical and performance aesthetic for the rock songs within the show.

**VISUAL DESIGN**

An important aspect of this new project over the previous *robotcowboy: Cabled Madness* is the development of a coordinated design based on a conceptual backing. Like NASA's Apollo project and contemporary space programs, the visual design for *robotcowboy: Onward to Mars* was approached with the ideal of practical, functional, detail-oriented engineering.

**Stage, Lighting, & Projection**

As with the previous incarnation of *robotcowboy*, the *robotcowboy: Onward to Mars* show is designed to be performed in a variety of venues, with our without lighting and/or projection. For the initial show at the New Hazlett Theater in Pittsburgh, however, we had access to a large, open, and reconfigurable "black box" space with stadium seating and decided on a "minimal-maximal approach": minimal stage & lighting elements combined with the large area, scenery, and projection. The 30x30 foot floor space is divided from front to back with the first third being the interior of the Habitat and the back two thirds being the Martian surface. The Astronaut is thus closer and confined while on the journey to Mars and then farther & free once on the planet's surface. The back wall is a 30x30 foot projection surface lowered flush to the floor to create a seamless horizon. Inflatable sculptures made of silver and gold mylar serve as scene elements, with a 16 foot tall & 8 foot in diameter silver rocket nose cone / space ship stage right and a set of smaller golden "blobs" to depict Martian topography stage left. (Figure 12)

Lighting is kept minimal (Figure 13). The font third of the stage signifying the Hab literally boxes in

the Astronaut by masked, rectangular light. During the first act, the back two thirds of the stage are kept black aside from the projection, further isolating the Astronaut within the Hab. The transition to the second act moves from the front Hab space, through the silver inflatable space ship on stage right, to the Martian surface on the back two thirds of the stage. This action is facilitated by the donning of the space suit. As the journey to Mars unfolds in Act 1, a remotely-controlled fan slowly inflates the spaceship and a small lamp lights it from within during the transition from Act 1 to 2 (Figure 14). During Acts 2 and 3, the back two thirds of the stage are flood lit with textured, red light to create the Martian surface (Figure 9). A single center stage spot light is used for the final scene where the Astronaut confronts the cold Martian night. (Figure 10)

Small white LED lights are distributed to audience members at the entrance to the theater and a set of TV's on stage show the live feed from a wireless camera backstage facing forward. After the suit donning procedure, the camera is attached to the suit to provide a first person perspective of the Martian EVA during Acts 2 & 3. As the stage lights dim into a single spot during the cold night section of Act 3, the Astronauts asks to see the rising of the stars provided by the lights of the audience which is shown through the video feed from his viewpoint. The audience then becomes the universe as the Astronaut returns from the cold. (Figure 11)

The show's systems design continues my approach from *robotcowboy: Cabled Madness* where a wearable, embedded computer system provides the audio and control for a separate laptop running projected background and visuals. This digital projection is generated by custom software on the large 30x30 foot back wall screen and acts as a virtual backdrop, providing both context and scenery. (Figure 15)

The show is established with a large star field from the Hubble Space Telescope, "diagnostic text" for checking show audio systems, and the mission patch for the intro song. Act 1 provides imagery for the journey to Mars including multiple looping video clips of the HAB rotating on its tether as it travels, HAB interior views, the approach to the Martian landing site, and overflight landscape views from orbital data. Acts 2 and 3 share large scale landscape views, many of which originate from the NASA Mars Pathfinder and Curiosity rover missions. An animated evolution scene in Act 2 backdrops the song "Spaceman Caveman" and Act 3 features backdrops for the 3 enemies of life on the surface: cosmic radiation, dust storms, and the cold of night. The show ends with a rotating animation of the Red Planet taken from space by one of the Viking orbiters for the song "Ball of Love".

This scene imagery is generated by "Visual", a custom software application written for the show in C++ using the OpenFrameworks arts-engineering toolkit. "Visual" is the next generation of the "rc-visual" application used in *robotcowboy: Cabled Madness* and can show images, movies, and dynamic programs written in the Lua scripting language within separate scenes. Transitions and scene element properties can be controlled dynamically over a wireless network connection for distributed control from the PASS backpack.

**Color & Typography**

Lines are clean and the color palette consists primarily of white, gray and black with bright orange functioning as a highlight (Figure 16). The reason space craft are mostly white and black is simple: white reflects energy while black absorbs it. Reflecting the sun's radiation in zero gravity helps your

spacesuit passively regulate heat while a black heat shield helps concentrate energy on the bottom surface during reentry. Also, high contrast color choices are important in extreme lighting swings where a white object reflecting sunlight stands out against the blackness of space.

Similarly, typography for the show follows clean contrasting lines with round bold headings, modern thin weight body text, and an angular vector font for "robotcowboy" to imply the technical nature of the platform (Figure 17). A typographical logo was also made using these fonts with contrasting grey and orange, where the orange highlights "On Mars" within the show title "Onward to Mars". (Figure 18)

**Mission Patch**

Every great mission needs a patch. Influenced by Apollo, Soyuz, Space Shuttle, and International Space Station patch designs, the *robotcowboy: Onward to Mars* mission patch consists of only a few main elements: the Earth, the Moon, Mars, and the outline of a guitar on a sparsely starred black background (Figure 19). The Earth & Moon are within the guitar outline on the left which represents both the spacecraft and "scientific (musical) instruments" used in the show. A yellow line signifying the journey connects the Earth to Mars on the right. A series of cosmic vibrations emanating from the guitar outline on the left also connect with the Red Planet and represent the goal of discovering the "song of Mars". The text "robotcowboy" is centered along the top and "Onward to Mars" is along the bottom with both following the curve near their respective edges.

**SUITS**

> *I have a symbiotic relationship with my spacesuit. I take care of it, and it takes care of me in return. - Astronaut Don Pettis [28]*

The space suit is an icon in a show about space travel and exploration. As such, work on the *robotcowboy: Onward to Mars* suit began before the show had a story or a name. A prototype initially explored a "new space" compression suit design and the second, final suit design combines an MDRS sim suit approach with the Apollo moon suit. A blue NASA flight suit is worn during the press conference and Act 1 while the space suit is worn during Acts 2 & 3. A headset microphone is used with both suits throughout the show. The transformation and suit donning sequence are an important aspect of the show as living and working in space revolves around this ever-important "miniature habitat".

**Flight Suit**

Accompanying the space suit for the press conference and HAB interior scenes in Act 1, the Astronaut wears a blue NASA flight suit complete with astronaut wings name tag and *robotcowboy: Onward to Mars* mission patch. (Figure 8)

**Suit 1: Bio-Suit**

The first prototype was modeled after the futuristic Bio-Suit from Professor Dava Newman's group at the MIT Man-Vehicle Laboratory [29]. Grandchild of NASA's Space Activity Suit research [30],

the Bio-Suit is a compression-based suit designed for a partial-pressure atmosphere like that of Mars. Unlike traditional suits, it is not a full pressure "balloon" but an elastic compression garment with stitching in all the right places to "keep you from exploding" (this is the author's colloquial explanation). The wearer would be able to have much greater fields of motion at much less expenditure of energy as compared to pressure suits and less oxygen would be needed since only the helmet would need to be pressurized. (Figure 20)

In modeling the Bio-Suit, a suitable looking helmet with an open face profile was obtained and and a test sleeve was made which replicated the stitching patterns and padding as shown in the prototype Bio-Suits. Further, other off the shelf accessories were assembled along with color palette tests: a gray stitching on white background design with an orange highlight. (Figure 21)

Appearance-wise, this suit design is more streamlined and form-fitting than NASA's Apollo A7L moon suit or the Space Shuttle EMU suit. Unfortunately, the desire for a "new space" suit design for the show ran against the expectation of the audience. When tested at the *Heading to Mars* exhibition, the feedback on the first *robotcowboy: Onward to Mars* prototype suit was that it "doesn't look like a space suit" and instead reminded people of either pajamas at worst or a motorcycle suit at best (Figure 22). Obviously, neither of these fit the very iconic role of "space suit" within the show and, although some elements could have been refined further, it was decided a different approach was required.

**Suit 2: MDRS Suit meets Apollo**

For the next suit, we decided to go for a more "traditional" design by adapting the MDRS (Mars Desert Research Station) sim suit and its recognizable "bubble helmet" (Figure 3) with the large backpack and color scheme of the Apollo A7L moon suit. By going more bulky, this new suit reflects the expectation of the viewer ("that's a space suit") while providing an emphasis on itself as the Astronaut's second skin. As with the MDRS sim suit, the donning & doffing procedures are simple yet still require a certain number of steps which I feel are important to demonstrate in order to convey the transformation required for an EVA with current technology.

With information from the Mar Society [31] and my own firsthand notes while wearing an MDRS sim suit, this new suit was designed in a similar fashion: bubble helmet with locking collar strapped to a backpack worn over a jumpsuit with gloves and boots. The helmet is fabricated from two nested 14" clear acrylic spheres with the outside covered with fabric to approximate the A7L's visor assembly cover (Figure 23). The jumpsuit is white and patterned after the A7L Integrated Thermal Micrometeoroid Garment with extra layers and pockets added to provide a simulation of requisite bulkiness. As an amalgam of past & current NASA suit designs, it has red "Commander Stripes" similar to those on the later Apollo lunar missions (13-17) [32] and both the EVA and American flag shoulder patches found on the Shuttle EMU. The NASA "meatball" logo and *robotcowboy: Onward to Mars* mission patch flank the crewman name tag sewn to the chest flap. The gray and white Bio-suit inspired prototype is reused as the Liquid Cooling Garment worn under both the A7L and EMU suits. (Figure 24)

**PASS Backpack**

Complementing the *robotcowboy: Onward to Mars* suit itself is the MDRS sim suit and Apollo inspired PASS (Personal Audio Support System) backpack. More than a physical stand-in, the backpack

is the heart of the live performance and contains an embedded computer and audio interface. Like the suit, its size and appearance are modeled on both the MDRS sim suits and the Apollo PLSS (Personal Life Support System). (Figure 25)

Airflow

The MDRS sim suit backpack is covered in a thick quilted material and contains fans and a battery to provide airflow into the suit helmet through 2 flexible PVC tubes. This is important for 2 reasons: 1. to immerse the wearer within the sound of their air supply; 2. to keep the helmet from overheating and fogging up. The onboard battery also stands in as a consumable resource to represent the life-support system in a real suit. When your fans stop, you're out of oxygen. Similarly, the *robotcowboy: Onward to Mars* backpack contains a battery, fan, and tubing to provide much needed airflow to keep the helmet clear during the performance.

Embedded Computer System

The embedded computer system runs GNU/Linux, the open source Pure Data audio DSP environment, and custom software for handling USB gamepad & MIDI interfaces. Control data is routed bother internally and with the external laptop using the OSC (Open Sound Control) networking protocol. For *robotcowboy: Onward to Mars*, the utility belt of the previous *robotcowboy* incarnation has become the space suit backpack: the Apollo PLSS (Portable Life Support System) is now the PASS (Portable Audio Support System). In fact, the functional requirements of both systems are similar: self-containment, portability, and ease of use. This approach continues the fundamental *robotcowboy* project requirement for wearable, embedded computing for performance while matching the thematic elements of the show's concept.

The old wearable computer from *robotcowboy: Cabled Madness* has been replaced with a 4 core 1GHz ARM UDOO embedded computer. A lead acid battery, charging system, and the aforementioned helmet airflow fan have been added ala the MDRS sim suit backpacks. The battery allows the system to run for up to 4 hours, enabling a more realistic, cable free performance. (Figure 26)

Software-wise, the system is nearly identical to the *robotcowboy: Cabled Madness* setup: Debian GNU/Linux, Pure Data & custom software daemons to handle control device hot plugging. All audio DSP takes place in Pure Data, an open source object oriented graphical patching environment developed by Prof. Miller Puckette at UCSD and international community contributors. The main Unit-Control Pure Data "patch" handles networking, playlist control, and audio output. Songs are written as separate patches which are loaded through the playlist and started and stopped during the performance by a physical control box on the front of the suit. All mixing is done in software and down mixed into a stereo signal for both the performance PA and live WAV file recording.

**SCIENTIFIC (MUSICAL) INSTRUMENTS**

In *robotcowboy: Onward to Mars* the Astronaut utilizes a set of "scientific instruments" to detect the song of Mars and explore its landscape. Some stand in for existing devices while others are repurposed musical instruments, the main goals being to include both varied control for the solo show as well as

directly reflect both physical tools and the essence of the data they are to measure or control.

**Gamepads**

Gamepads have been a natural interface for *robotcowboy* since the beginning of the project. They are ubiquitous, cheap, and provide a large number of digital and analog IO in a small package while using the standard driverless USB HID (Human Interface Device) protocol. They can be easily hacked and embedded within other devices and/or connected to new switches or sensors to create entirely different physical interfaces. For instance, the "button box" playlist and song transport control interface used in *robotcowboy* and mounted on the PASS backpack shoulder strap in *Onward to Mars* is a plastic case with buttons connected to the logic board of a gamepad housed within, its original purpose redefined by a different single purpose interface design. (Figure 24)

One major addition to *robotcowboy* in *Onward to Mars* are wireless Playstation 3 controllers using the Bluetooth radio protocol. Many *robotcowboy* songs use a digital instrument written in software mapped to the physical interface of a dual analog thumbstick gamepad which provides natural 10 finger control over 4 voices (thumbstick x & y), percussion (up to 4 parts), and tracking control (voices or percussion) [2]. Previously, these songs required physically hot plugging the gamepad during the show which can break up the action, especially when trying to insert the USB plug backwards! In *robotcowboy: Onward to Mars*, the use of wireless controllers now makes this transition seamless.

A white PS3 controller acts as the main instrumental interface for Act 1 and the transition scene to Act 2. This color was chosen to match the color palette of the space suit and other equipment.

**Cosmic Ray Detector**

The "Cosmic Ray Detector" in *robotcowboy: Onward to Mars* is an electronic musical instrument called a Theremin which uses the body's capacitance to ground to sense the movements of the player's body in space. Named after its inventor Leon Theremin, the instrument is literally "played on the ether" using the proximity of the hands to two antennas which control the pitch and volume of two heterodyning oscillators. Its sine wave-like tone and glissandi became a staple of 1950s science fiction movies

What better instrument to detect invisible radiation than one that is played via unseen control? The Theremin in the show is painted white and features a blue NASA "meatball" logo to give it an official look. It is used in an exploratory sequence that detects and measures cosmic radiation on the Martian surface. The Theremin audio output is mixed into this song and drives other digital software instruments, signifying the hidden effects of radiation. (Figure 27)

**Penetrometer**

A soil penetrometer is a simple geological instrument that measures soil compactness. We used one at the MDRS and I later recognized the same instrument in photos of the Apollo program on the Moon. Nominally consisting of a shaft that is driven into the ground and a dial indicator with two handles on the end, this tool would be one in a standard set used by extra-planetary geologists on the Red Planet.

For *robotcowboy: Onward to Mars*, the penetrometer symbolizes a human connection to the "mars" (what would a Martian word for "earth" be?) and is used to probe the Martian regolith and sense wind frequency during the dust storm sequence. A replica constructed out of wood with an integrated wireless Playstation 3 controller between the handles, it streams its accelerometer position and orientation to control several digital instrument voices that reflect the motion of stabbing and sensing the soil. These motions and voices are then used to harmonize with the dust storm as it approaches. (Figure 10)

**Guitar**

I have been playing the 6 stringed electric guitar for a number of years. A natural interface within *robotcowboy*, it provides a more one-to-one audiovisual performance feedback with the audience as compared to digital instruments. For me, it is important that the project has a "slippery element" to the instrumentation as opposed to complete sequencing of sound. A clean ideal meets the loud messiness of the electric guitar in order to both provide a needed edge and human element.

In *robotcowboy: Onward to Mars*, the guitar plays a central role. Combined with the space suit, it is a symbol of the musical style and performance aesthetic of the show and its outline is featured on the mission patch. A headless guitar with a simple, straight design was chosen in order to remove the symbolism already associated with popular guitar styles and imply a more generic, futuristic, and non musical instrument (Figure 24). The guitar is used to perform roughly half of the songs and is played through a single analog distortion circuit which is plugged into the PASS backpack's USB audio interface. Digital software effect processing is then added on a per song basis and includes delay, reverb, and/or chorus. At the end of Act 3, the guitar brings the Astronaut back from thermal shutdown during the cold Martian night and is used to play the "song of Mars" in the finale: *Ball of Love*.

**FIRST SHOW**

The show was selected for the first annual Community Supported Art (CSA) series at the New Hazlett Theater in Pittsburgh, PA with the show date of February 8th, 2014. Work began in the fall of 2013, although preliminary design and research had taken place on and off since the Summer of 2012. Access to the performance space opened in January 2014 and main rehearsals took place the week before the show.

My wife, artist Anika Hirt, provided assistance for the costuming, scenery, and graphic design and the show was facilitated by the gracious staff of the New Hazlett theater who handled promotion, lighting, and sound. It received online and print promotion with posters put up across Pittsburgh (Figure 28) and played to an audience of about 100 people.

**Reception**

Overall, the show went well despite some last minute hiccups including a coffee spill on the laptop providing the visuals. The script was simplified from the original scope of the background research into a more focused presentation. The costuming and scenery were more highly developed while the music and visuals were not taken as far as originally planned. Simply put, the project was perhaps too much to "chew" at once, especially by a single artist used to working alone. In this respect, the first

*robotcowboy: Onward to Mars* is more of a draft show rather than a completely finished piece, the first iteration in an ongoing process.

The immersion of the Astronaut into the space suit worked well and really brought the audience into the idea of the "second skin". Due to the difficulty of donning the suit, a helper assisted the Astronaut as it was deemed more important to maintain the flow of the show than to break the illusion of a "solo journey". The wireless audio system and suit battery allowed for complete autonomy for the audio system allowing effective use of the entire stage. One minor problem that occurred during the performance (and not during the rehearsals!) was that the cooling airflow tube from the PASS backpack was pinched during the suit donning, so the helmet fogged up during the singing portions of Acts 2 & 3. It literally became a one astronaut terrarium (Figure 24). Like any R & D project, future work will involve making sure problems that arise during testing will be corrected for repeated iterations.

The main goal of *robotcowboy: Onward to Mars* is to get people thinking about contemporary space exploration and a mission to Mars, not as science fiction but as a reality. It is intended to present a fictional story but with a real world perspective from the Astronaut who asks questions into both the profound and absurd nature of a future in space. I knew this goal was reached when the audience left the theater talking amongst themselves, debating whether or not they would personally go to Mars, and discussing points and asides made by the Astronaut. I received messages for days afterward from people who said they were still thinking and talking about aspects of the show. Despite the incomplete nature of this first performance, it was a complete success.

**Future**

In the future, I plan to take *robotcowboy: Onward to Mars* on tour. It is designed as a modular performance that can take place on and off a theatrical stage and most of the physical gear and software system are currently in place. Thanks to the support of the New Hazlett, I have photos and live video in a professional setting in order to market the show.

In the meantime, I plan to revisit the music and visuals in order to make a greater connection between the two and the thematic and atmospheric elements of the show. Much of the music was not developed as far as I feel it needs to go, so that will be a main focus. I might also look into adding one or two more exploration tools / musical controllers in order to expand the initial landing portion of Act 2.

For me, the show itself is not the extent of the entire project, but one branch from my research and time at the Mars Desert Research Station (MDRS). This theme of contemporary space and exploration will lead to new songs, shows, and performances. I may not be an Astronaut, but I can play one on TV and continue new iterations of creative inquiry.

**CONCLUSIONS**

Whether humanity heads to Mars in 2023 or in the 2030s or 40s, this is something that should and will happen. It is important for those outside of the space, engineering, and scientific communities to think about what this means to them and society in general as a landing on the Red Planet will impact culture as much if not more than Apollo 11's *Eagle* touching down on the Moon. Created through research, the artist's MDRS experience, and experimentation, *robotcowboy: Onward to Mars* hopes to open up

these questions to a new audience. An evolution in the *robotcowboy* project, the first show achieved this goal through a conceptual basis and synchronized music, spoken word, and design which will be further refined and developed into the future.

How do you talk about going to Mars to a general audience on stage? Wear a spacesuit.

**ACKNOWLEDGMENTS**

My wife Anika for creating the costume and scenery, last minute stage hand help, and constant encouragement as I embarked upon this journey to Mars.

Artist Carl Bajandas for prop fabrication

My advisors at Carnegie Mellon: Golan Levin, Bob Bingham, and Diane Turnshek

Rene Conrad, Alex Bard, Dave Bjornson, and the crew at the New Hazlett Theater

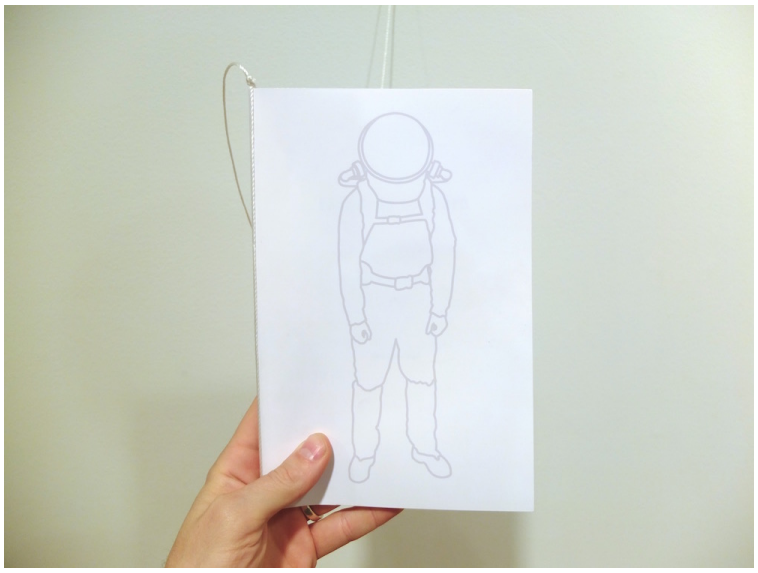
The CMU College of Fine Arts, School of Art, & the Frank-Ratchye Studio for Creative Inquiry

**FIGURES**

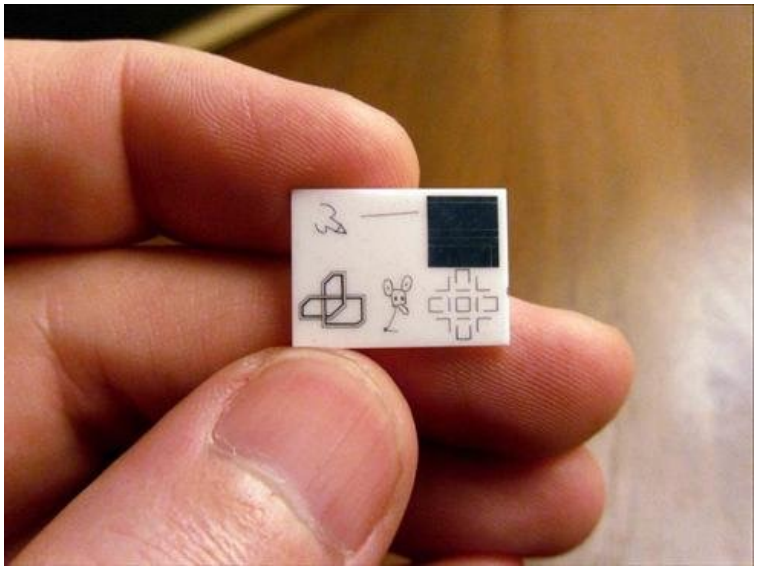
*robotcowboy: Cabled Madness* performing at New Media Meeting 2009, Norrköping Sweden


The Mars Desert Research Station HAB (Habitat), Greenhouse, and ATVs


A Mars Desert Research Station sim suit

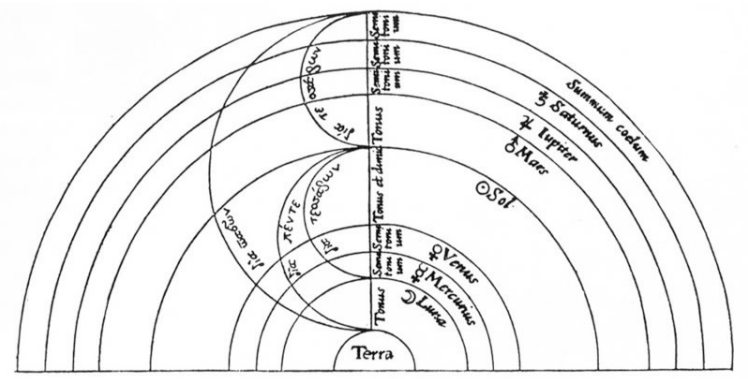


*Heading to Mars* 6x9 inch book



A *Moon Museum* ceramic wafer, one of which was allegedly concealed in the Apollo 12 Lunar Lander *Intrepid* and left on the Moon

"Astronaut Eannarino and the Handtool Palette Carrier (HTC)" from Tom Sachs' 2012 *SPACE PROGRAM: MARS* live exhibition and performance




From Stanley's *The History of Philosophy.*

THE INTERVALS AND HARMONIES OF THE SPHERES.

*In the Pythagorean concept of the* music of the spheres, *the interval between the earth and the sphere of the fixed stars was considered to be a diapason—the most perfect harmonic interval. The following arrangement is most generally accepted for the musical intervals of the planets between the earth and the sphere of the fixed stars: From the sphere of the earth to the sphere of the moon, one tone; from the sphere of the moon to that of Mercury, one-half tone; from Mercury to Venus, one-half tone; from Venus to the sun, one and one-half tones; from the sun to Mars, one tone; from Mars to Jupiter, one-half tone; from Jupiter to Saturn, one-half tone; from Saturn to the fixed stars, one-half tone. The sum of these intervals equals the six whole tones of the octave.*

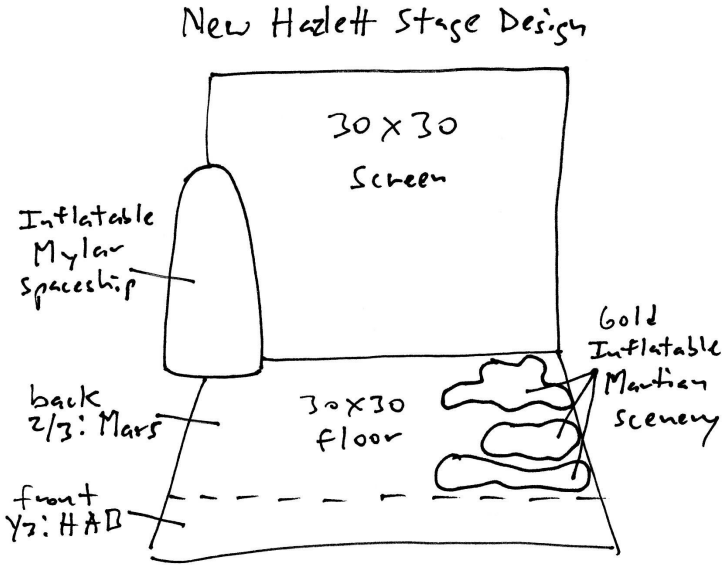
*musica universalis* or "Music of the Spheres"

Act 1: Landing sequence. The author is wearing a blue NASA flight suit with custom astronaut wings and mission patch.

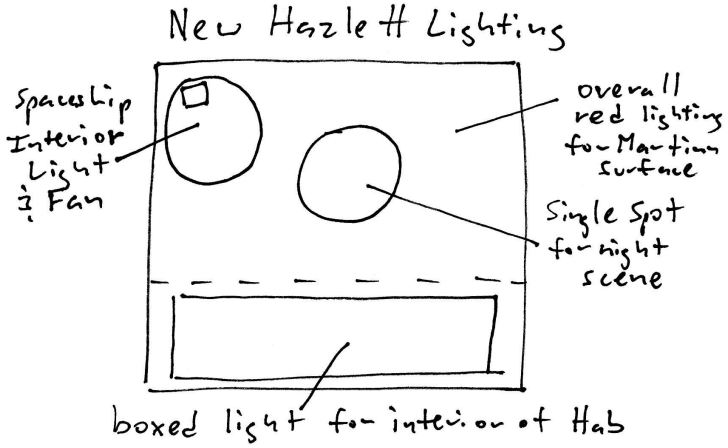
Act 2: Spaceman Caveman, a song of evolution.

Act 3: Cold Martian night. The Astronaut is using a replica penetrometer musical controller.

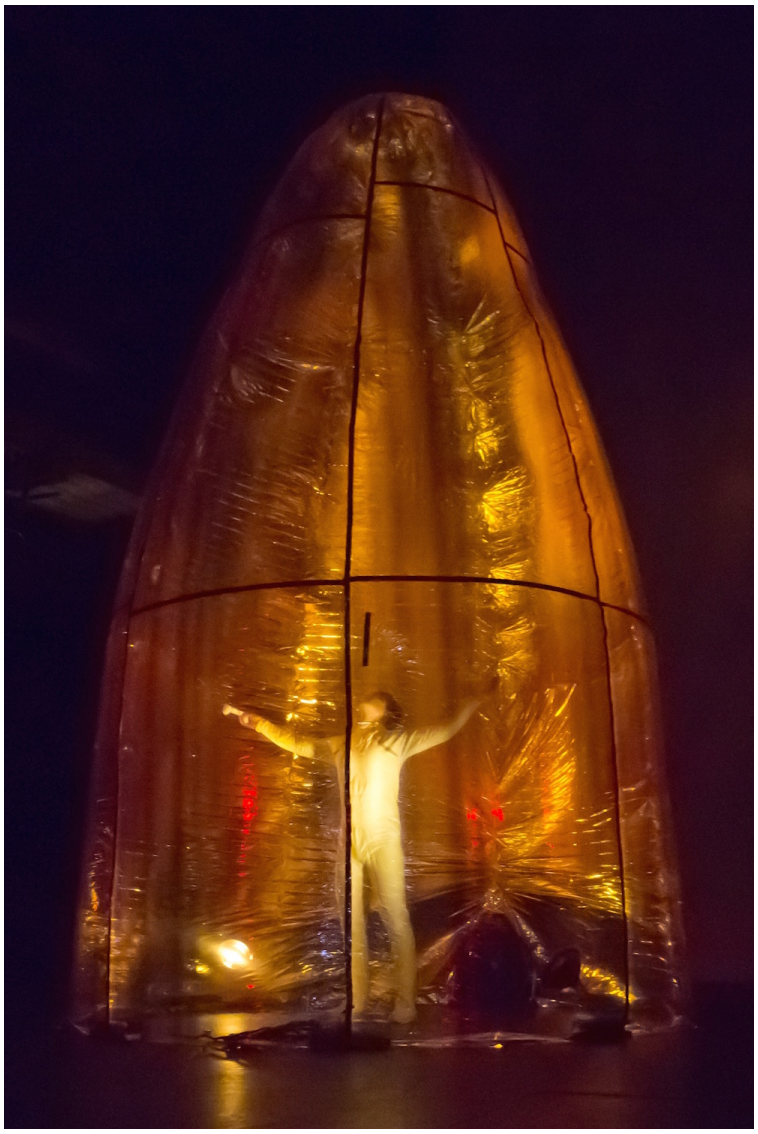
Video stream snapshot of the audience members using white LED lights as stars seen by the Astronaut on stage during Act 3.



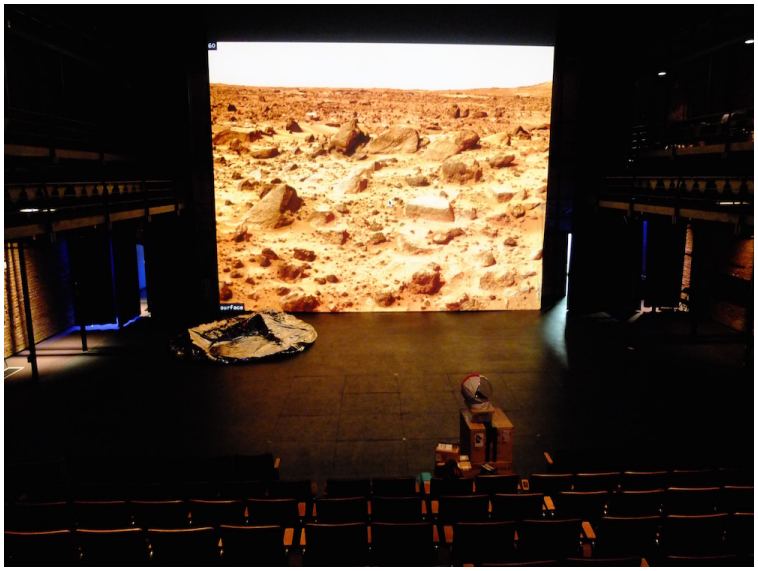

*robotcowboy: Onward to Mars* stage design (from audience) at the New Hazlett Theater, Pittsburgh, PA



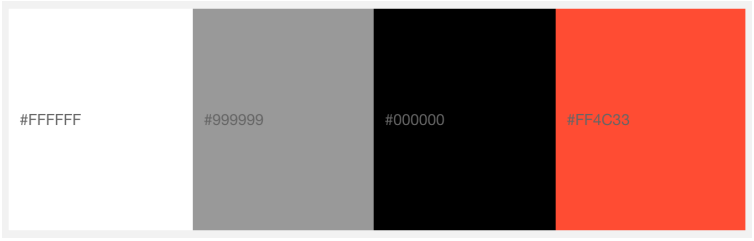

*robotcowboy: Onward to Mars* lighting design (from above) at the New Hazlett Theater, Pittsburgh, PA



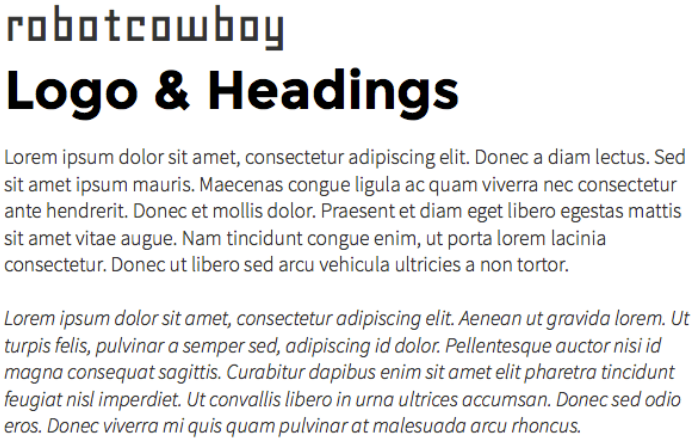
The Astronaut within the silver mylar inflatable spaceship on stage right during the transition from Acts 1 to 2. With the stage lights off, the mylar is translucent when lit from within.



*robotcowboy: Onward to Mars* projection test (from audience) at the New Hazlett Theater, Pittsburgh, PA. Note deflated silver mylar space ship on left.




*robotcowboy: Onward to Mars* color palette, inspired by NASA and contemporary space programs

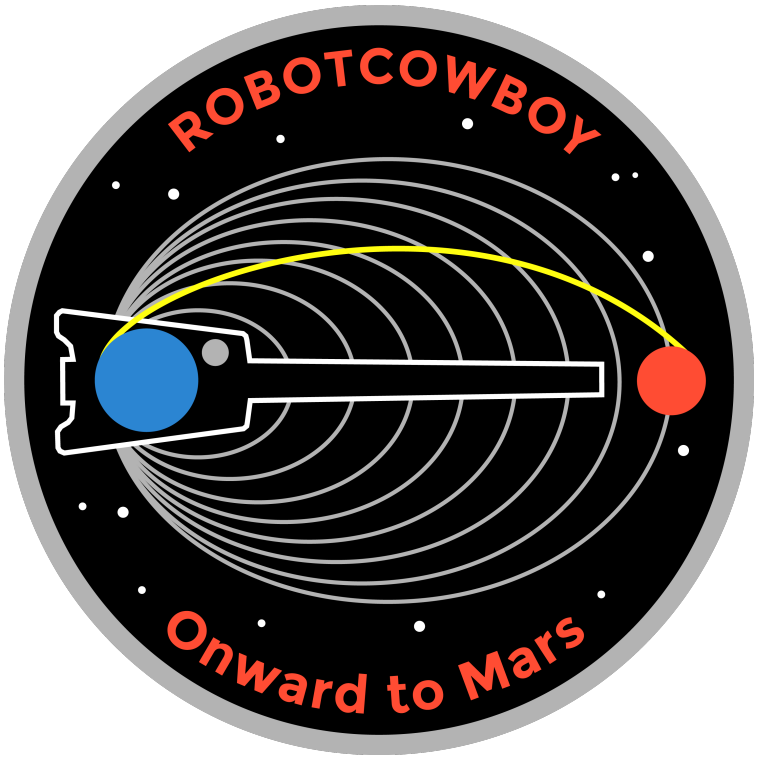



*robotcowboy: Onward to Mars* sample typography

r o b o t c o w b o y

# Onward to Mars

*robotcowboy: Onward to Mars* typographical logo




*robotcowboy: Onward to Mars* mission patch

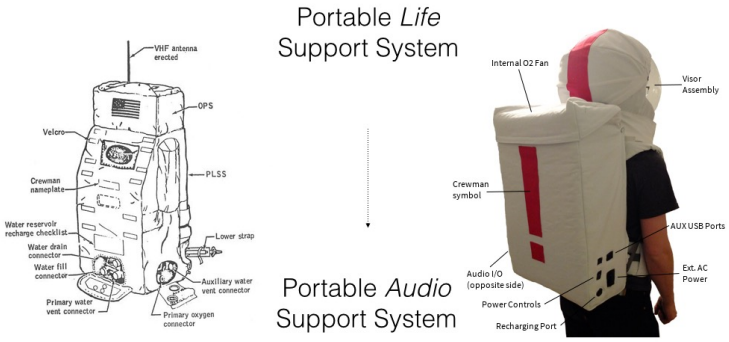
MIT Professor Dava Newman modeling the Bio-Suit compression atmosphere suit

Preliminary *robotcowboy: Onward to Mars* Bio-Suit replica test sleeve with grey stitching and accessories.

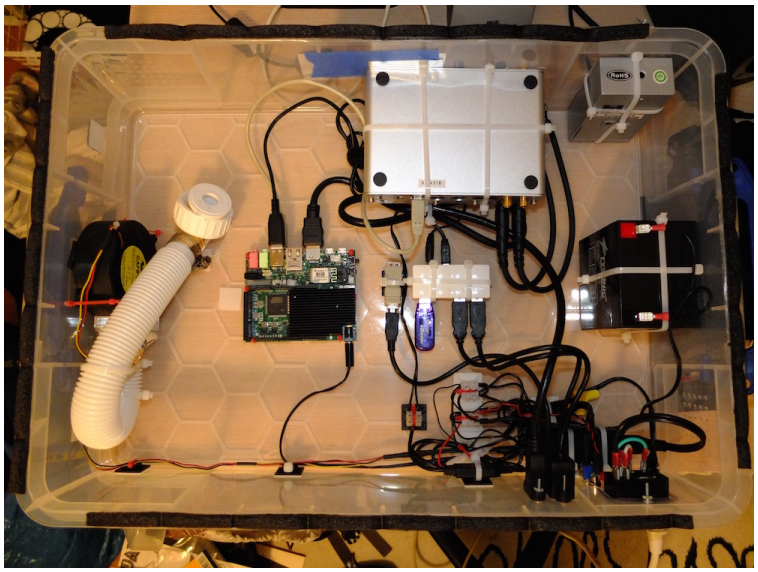
Preliminary white Bio-suit replica with grey stitching and zippers

The author during a helmet and backpack fitment test for the second suit inspired by the MDRS and Apollo

The *robotcowboy: Onward to Mars* space suit in action. The song transport control box is mounted on the left backpack shoulder.

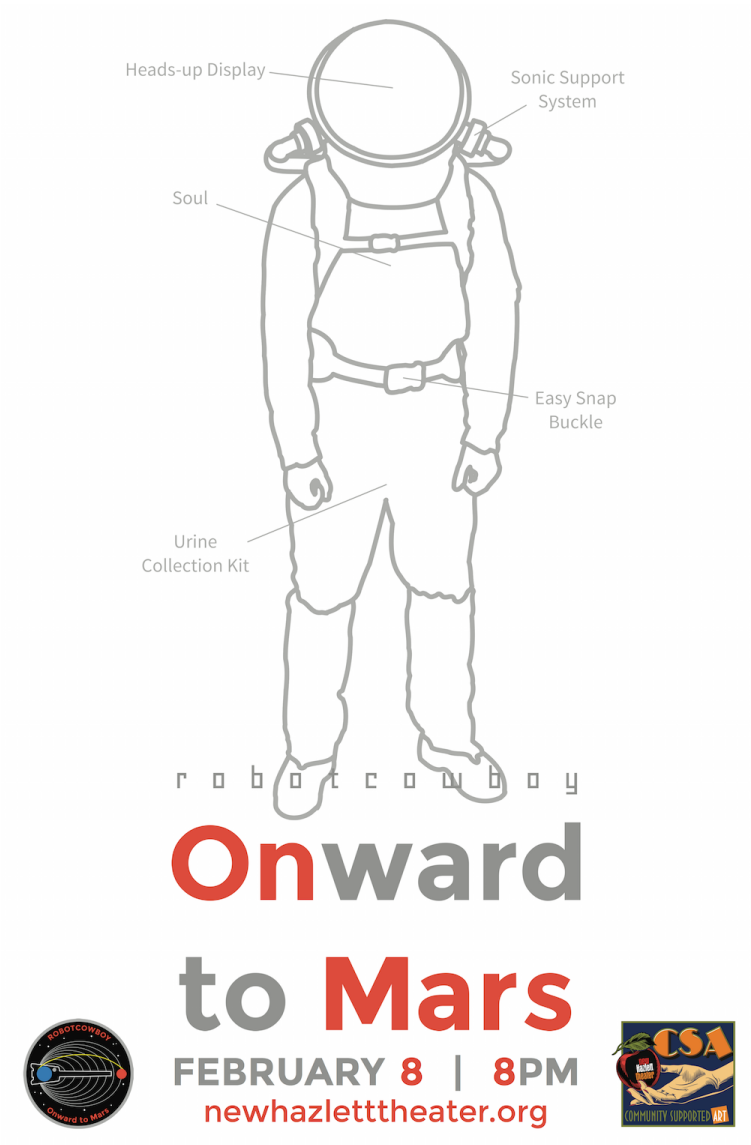



Apollo PLSS influence on the robotcowboy PASS Backpack



*robotcowboy: Onward to Mars* PASS backpack internals: airflow fan (far left), UDOO embedded computer (center left), white USB hub (center right), silver Roland Edirol UA-25EX USB soundcard (center top), silver Behringer DI Box (top right), 4 Ah lead acid battery (right), and the power/charging system & controls (bottom right).

Theremin in use as the “Cosmic Ray Detector” during Act 3




*robotcowboy: Onward to Mars* first show promotional poster

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