Space Operas, Art Exhibits, and Performances:
Transforming the Dome into an interactive performance space

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Abstract: Why not try to open up the planetaria around the world for this sort of shows that are on the edge of science, education, entertainment, wonder and amusement. We see it as a new challenge for the planetarium world, the planetarium dome becomes an ‘arena’ where art, science, education and wonder meet and compete. Bringing back the wonder and amazement in our domes, sometimes we focus too much on the education, on the ‘knowing’ = we always want to show what we know about the Universe. But why not focus on the beauty, on the vision of non-scientists on our dome and how to use it. The panel will discuss ways in which the dome can and has been used as an interactive art piece and lessons learned.

Artists and Planetarians
We propose a regular gathering of artists and planetarians to foster collaborations and new productions. The first meeting will happen Tuesday, August 18 at 10:00 am EDT, 2:00 pm UT via zoom. Register in advance for this meeting:
https://colgate.zoom.us/meeting/register/tJMtf-yqpz0tE9G3s8InZFoiXdyq8eXi3Sxn

Art in the Dome, Anne-Lize Kochuyt, Planetarium of the Royal Observatory of Belgium in Brussels

- Presentation of Planetarium Brussels
  - Open since 1976: Zeiss Mark II planetarium model UPP 23/5 (first used for the World Fair Exhibition Brussels in 1935). As far as we know it’s the oldest Zeiss projector still operative.
- In 2009 fulldome system: RSA Cosmos and 8 Barco SIM 7 projectors
- Dome 23 m diameter, 340 seats concentric seating, Zeiss in the middle, still operational
- 47,000 visitors/year: mix of school public, families and tourists
- School: lessons and workshops on astronomy and meteo (for 3 till 18 years students) given ‘live’ by our animators in two languages: Dutch and French
- Public: fulldome films presented in three languages (Dutch, French and English) with headphones and an audio system.

www.planetarium.be

- Planetarium Brussels as a unique venue for artists, background
  The Planetarium Brussels has a long tradition of working with artists, our first concert was an evening with electronic music groups in the eighties.
  For several years we had a partnership with a concert organisator “De Vaartkapoen” who presented concerts of young musicians from the alternative underground music scene.
  Now we have approximately 2 concerts a year (mix of classical, pop, folk and electronic music).
  Already 4 years we organize BPPF = the Brussels Planetarium Poetry Fest, where we collaborate with PoetryFest on the theme of performance and slam poetry (with international artists).
Three examples of artistic collaborations

“Macrocosmos” - Brussels Philharmonic (march 2017)
Concert of a philharmonic orchestra (28 musicians) and a choir (24 singers) who brought a program with music from Bach, Strauss, Mozart, Pärt. Music of unearthly beauty at a surprising location, accompanied by video’s made by the artists Pim Heerkens & Jochem Van Laarhoven. And also by our Zeiss planetarium.

Music: Brussels Philharmonic and Vlaams Radio Koor.
Video artists: Pim Heerkens & Jochem Van Laarhoven.

Video impression: 
https://www.facebook.com/BrusselsPhilharmonic/videos/10156702164079569
“Tip of the Tongue” : theatre written and performed by Pieter de Buysser, a writer-philosopher (may 2017) accompanied by a fulldome video.

A philanthropist endowed with immense faith in progress and a speech defect undertakes to build a spacecraft. The story traverses a pronounced curve in space-time, a little girl tired of the Messiah and a lost detective who no one is looking for anymore. A portable particle accelerator, whirlpools in the China Sea, a dozen nebulous spirals and a majestic black hole gradually increase the tension… Because, fabulous as they might be, all the elements in this planetary show are inspired by today’s political and scientific reality. The Tip of the Tongue is an exploration of borders for nationalists, a local geography lesson for cosmopolitans and a cosmology lecture for pioneers of a new image of the world.

Text, direction & play: Pieter de Buysser
Scenography: Herman Sorgeloos
Full dome video: Elias Heuninck
Scientific advice: Kurt Vanhoutte (Universiteit Antwerpen)
Dramaturgy: Esther Severi

More information:
“EON” by Meteor Musik (may 2019)
A fulldome movie and live concert by the Belgian electronic music group Meteor Musik. EON tells the solitary story of a stranded cosmonaut facing his imminent death. EON explores the worlds that reach beyond.
In search of new material Meteor Musik worked around the sonic narrative of solitude and claustrophobia that deep space evokes, creating vast and intricate sound worlds. Combined with the visual storytelling of Jaak De Digitale this resulted in an ambitious feature length film. EON unites exploration, imagination and emotion into an experience that challenges you to ask questions while tingling your senses with live music and immersive 360° visuals perfectly tailored to the fulldome film projection of a planetarium.

Music : Meteor Musik
**Video:** Jaak De Digitale  
**Actor:** Dirk Hendrikx

**More information and video impression:** [https://www.meteormusik.com/eon](https://www.meteormusik.com/eon)

**Lessons learned**
- Collaboration with artists gives us (planetarians) another view on the dome, we always see it as the heaven-dome (realistic point of view) and artists more see it as a ‘canvas’ where they can visualize their arts.
- Inviting a new public (more cultural / arts orientated) into the dome.
- Bringing back the wonder and amazement in our domes. Sometimes we focus too much/only on education, on ‘knowing’, why also not focus on beauty?
- Planetarium becomes a ‘place to be’ in the society and not only a scientific/educational place.

**Difficulties**
- Time-consuming: to create an artistic full dome movie, you need a lot of time
- Degree of difficulty: creating visuals for full dome is not easy, since our minds are stuck to a square screen vision. You have to let go of the idea of ‘up-down-left-right’ and that’s not easy and you have to learn to work with different software.
- Reward for the artists: the production of an artistic creation takes time and effort of the artists and the problem is that this creation cannot tour and be presented a lot of times. So the return for the artist is minimal (both financially and in terms of reputation)

**Hopes for the future**
- Transforming the Dome into a theater: this is an important evolution for planetaria, for artists and for society and I hope we can continue and even elaborate this further on.
- Creating a world wide network of ‘arts loving’ planetaria who are willing to cooperate and present these artistic performances and exhibits, across national borders and even across continents.
Lessons Learned from a Demon Haunted Opera

Paul Catanese, Columbia College
Joe Eakin, Colgate University

● **Background**
  ○ Century of Progress / Sleep is an experimental opera that I have been developing since 2016. Originally conceived as a solo-performance with live visuals, this work was expanded in 2018/19 into an ensemble work for five musicians, staged within the planetarium dome at Colgate University.

  ○ This experimental opera reflects on the intellectual, environmental, spiritual, and cultural consequences of mischaracterizations of science, lawless theories of knowledge, and epistemological chaos.

● **Prerequisites for Conceiving and Producing**
  ○ For several years, I had been working to orient myself to what would be involved in creating an artwork within the context of a planetarium dome. This involved visiting planetaria, reviewing literature in the field, conversations with artists and visualization experts working in planetaria, as well as a visit to the IMERSA conference in Denver in 2017. This preparation, at best, convinced me that I wanted to create an artwork in a dome environment, but it wasn’t until an opportunity for a year-long artist residency at Colgate University in 2018-19 sponsored by the Art Department and Visualization laboratory that I was able to make the leap into developing a working knowledge.

  ○ The development of Century of Progress / Sleep was supported by a year-long artist residency at Colgate University, which facilitated multiple trips to campus spread out over a year that allowed intense periods of learning and testing. This iterative process was critical for building my understanding of the environment of the dome, while providing ample time for reflection and response. Four early visits ranged from one to three days, the middle of the engagement was a 2-week visit, and the culmination of the engagement was another 2-week visit. I am grateful to have been provided with such depth of support and development time. Emerging from this experience, I recognize that re-staging this project in other domes would not require the same time investment – and I am hopeful to be able to present this project again in the future at other domes.

  ○ My orientation included familiarization with industry conventions, terminology, technical capabilities and limitations, and gaining experience understanding the
role of turnkey solutions in the dome environment. Building a working understanding of the visual space of the dome was a key goal during this time. For example, how to focus the eye, drawing the vision to a specific place in the dome, and/or how to use areas in the peripheral vision, or areas beyond the shoulder of the viewer to imply an expansive space, claustrophobic space, etc. was particularly important. It was also important to familiarize myself with what at times felt like innumerable approaches for incorporating video footage within a dome show. I could not have done this on my own; I am extremely grateful to have had Joe Eakin’s tremendous generosity, expertise, and partnership throughout the process to help guide, clarify, and encourage my learning.

○ It is the mission of the Tech Director of the Vis Lab, Joe Eakin, to partner with faculty across the campus. Opened in 2008, the Ho Tung Visualization Lab & Planetarium has become a beacon of multidisciplinary projects for Colgate University including Art & Art History, Geography, Geology, Biology, Physics and Astronomy just to name a few. Being set in a liberal arts environment, this cross discipline approach is the foundation for productions in the planetarium. This collaboration with the Art department is key to bringing in creative art pieces into the dome but partnerships can take some time to build. Examples of Art productions include:
  ■ Theory of Flight Opera
  ■ RPM: Sound Art China
  ■ Constellations Play
  ■ Shakespeare’s Caesar
  ■ Many video art projects

• **Black Box Thinking**
  ○ In my creative practice, I strive for ideas to be malleable enough to adapt to a wide spectrum of spaces and venues (e.g. art galleries, theaters, industrial spaces, public spaces, wilderness, etc.) My starting point for this project was to meet the space on its own terms; to consider the venue not just as a visually encompassing screen, but as a theater for crafting an experience. To consider this space, with its explicit and implicit capabilities, for realizing something “one of a kind” where every aspect of the space is potentially expressive. My shorthand for describing this type of approach is ‘black box thinking’ - taking cues from the flexibility, immediacy, and improvisational strengths of experimental performance.

  ○ The central focus of this project is a live performance featuring five musicians on stage at the front of the dome. We used theatrical lighting throughout the show to create silhouetted textures (gobos) as well as focused pools of illumination on the performers. In
In some scenes, theater lighting without accompanying digital projection on the dome was to shift or destabilize audience focus. The planetarium was not setup for theater lighting – though advances in LED-based theater lighting instruments meant that we could make use of normal outlet voltages for powering our lighting. We also installed four temporary boom pipes on cast iron bases to create positions for hanging our lighting. This involved compromising on some of the equipment extending above the horizon line of the dome, as well as taking over one of the walkways. The show control system for the planetarium was already setup to transmit DMX signals to the cove lighting, and it was fairly straightforward to include commands for the theatrical lighting into this same network - so that theater lights, cove lights, and house lights could be controlled from a centralized system.

- Several fog machines were used to create atmospheric cloud effects and ground fog effects that at times obscured, revealed, or blended with the visuals on the dome. Many of the projected visuals included video-recordings of theatrical fog as well as simulations of cloud and fog. Two fog machines were located on stage with the performers at ground level, and two were behind the audience, hung from the same lighting booms in order to burst clouds of fog just above the heads of the audience.

- Metalized mylar was hung on the walls surrounding viewers, creating a mirror-like wall in all directions below the horizon line of the dome, making the space more visually complex through inter- and imperfect reflection. In some scenes, stage lighting was pointed at the mylar on purpose to increase these effects, to perceptually blur the boundary between audience and environment.

- The musical composition was performed live by five performers (lap steel guitar and vocals, double bass, two main vocalists, and a percussionist playing vibraphone, timpani, crotales, orchestral chimes, and hand percussion). In addition, Ableton and custom Max for Live instruments were used for sound processing on the vocals, generative environmental sounds such as winds and waves, and the playback of field recordings – all of which made extensive use of the 7:1 sound system in the dome to locate sounds around the audience – in some cases making them swirl about, recede into the distance, emerge from below or behind, etc. The ambisonic encoding/decoding capabilities of Ableton and Max for Live were particularly of critical utility in this regard.
Even though we already had a fairly small number of seats (60), we additionally removed the first row of seating (12) so that we would have enough room for the musical instruments and performers at the front of house. The show benefitted from the intimate scale of the space. Audience and performers were in close proximity which served to heighten the tension in the work.

These elements of the environment: dome, mirror, fog, and cloud projections worked in concert to create a composite experience intended to make it more difficult to locate one's own body in relationship to images and sounds. The combined effect was meant to challenge certainty – to invite the audience into the activity of questioning what we think we know and how we think we know, thus reinforcing the central concerns of the opera itself.

**Previsualization and Show Control**

One outcome of the residency was the development of a real-time visualization engine created in Touchdesigner software. The engine was configured to stream a real-time equirectangular rendering into the Digistar system. One benefit of generating a 360 degree rendering was that we had more image to work with when designing the final composition for projection onto the dome via Digistar.

At the same time, the Touchdesigner system can be used for pre-visualization - allowing me to work remotely from the dome, as well as allowing me to work improvisationally during technical, musical, and full rehearsals. For this show, the decision was made to use the improvisations to derive cues that could be scripted and recalled via the engine. While not pre-rendered, the scripted cues occupied a middle-ground that paired excellently with the fact that the live-musical performers in the dome would have the freedom to improvise, hold notes, repeat moments, and otherwise “drive” time during the performance. Scenes were devised in such a way that they could continue to generate environments indefinitely.

Control of the cues for projected visuals moved backstage to the dome booth operator - an integrated solution that included control of house and stage lighting. Control of fog and audio levels were kept on-stage.

Show control decisions were influenced by the size of the ensemble (including backstage crew and musicians/performers). Of course, we could have made the decision to add a live-visualist or sound-board operator, but we believed as the ensemble size would increase, our ability to respond nimbly would decrease. A more thorough answer, however, would address the intended hierarchy of elements within the braid of the performance itself. Meaning: though all elements are critical and important, decisions throughout the process were made so that the live music, performed text, and embodied experience of audience members were the central locus around which all other elements were working to support.

Reflecting on the life-cycle of a creative project. The Touchdesigner system is separable from the dome (e.g. system can be used to generate visuals for this
artwork when staged in non-dome environments; when staged as performance, or when re-configured as installation)

- **Reflecting on Documentation**
  - I am thrilled with the still photographs from the event. At times we had up to five photographers on set during dress rehearsals and performances using fish-eye through close-up lenses. This “wide net” approach resulted in a number of iconic images that do a great job of capturing the intensity of the performance.
  - We also put a lot of energy into video documentation: shooting combinations of time-lapse, real-time, tripod-mounted, handheld, 360 video, and rectilinear formats. That said, even though we have a great deal of footage, I find myself concerned with the lack of “magic” that is conveyed through video. Part of this emerges from a personal vision that there was a sense of otherworldliness, awe, and spectacle in the live event that comes across too clinically in video. Another part is due to the inherent challenges of videography of live performance in low-light/mixed light situations, made more challenging by the heavy use of fog and atmospheric effects in the show itself.
  - At this stage, I am working on editing the video footage into an artwork of its own that can convey some of the emotional tension of the experience, as opposed to producing a ‘moment by moment’ document for general release.
  - From the beginning of the residency, there was encouragement to plan for some form of publication for the project. While the video documentation represents one specific set of challenges, I am thrilled that the residency provided resources for the creation of a studio recording of the opera, which was subsequently mastered and produced as a limited edition vinyl LP.

- **Dome as Laboratory**
  - This artist residency additionally functioned in the Colgate community by bringing together arts and science interests to realize a project together. The project recognized and respected that the planetarium is a laboratory, and that the liberal arts campus is a site of interdisciplinarity.
  - The project involved students, class visits, involvement of staff and faculty from across numerous departments.
  - Directly after each performance, the performers would conduct a talkback session with the audience - engaging in a “critical response process” of asking specific prompts to guide the audience into a reflective conversation. The prompts centered on asking audience members “what sensations they recall having in their bodies during the performance” and “where do you imagine your body was residing during the performance” – working to focus the conversation on the experience of embodiment that occurs during a theater performance.
Creative Process in Dome Immersive Environments

...personal reflections as experienced and observed at the Hayden Planetarium.

Carter Emmart  
Director of Astrovisualization  
American Museum of Natural History

There have been just a few examples of creative / artistic events in our case at AMNH:

1. Theremin concert with graphics driven by audio input, led to SonicVision music show.  
2. Gotham Opera staged with visuals selected from space shows.  
3. Cassatt Quartet, twice, both times to interactive visuals from Digital Universe / OpenSpace / Uniview.  
4. Mickey Hart live playing to a mix of space show content with OpenSpace recordings.  
5. Sunday night *unofficial* live music to interactive OpenSpace salons.

The fact we have so few examples speaks to the complexity and expense of staging artistic work in a theater which a large institution banks on working every day for a dozen public shows. The highly technical nature of the Hayden Space Theater has only rarely entertained notions of artistic work being staged there.
Artistic Arc:

1. Anticipating the dome … somehow the dome is “special”.

The dome is simultaneously a facsimile of the night sky, and recreation of our near hemispherical view of the 3D world around us. It was my experience during the construction of the Rose Center that we anticipated what we could do in the dome not purely conceptually, but through analogs available at the time. Full dome video would give us data immersion, and several analogs existed in academia and industry, and one in the planetarium market. Evans and Sutherland, a company founded by legends in the flight simulator innovation, created a spin-off into the planetarium market, called Digistar, a single calligraphic vector based fisheye projection system. Starting in the early 1980’s, Digistar proved the concept of world space full dome scene motion graphics, a field at least tested with fisheye film in certain rare examples such as Reno’s “Atmospherium” in the 1960’s, and GOTO’s multiple synchronized 70mm film projection at the Osaka World’s Fair of 1970 called Astrorama, and later not quite full dome Omnimax fisheye filming. In 1992 From the realm of interactive scientific data visualization, the University of Illinois’s Electronic Visualization Studio developed the Computer Assisted Visualization Environment or CAVE for short. An immersive cubic space with stereo projection on all walls, floor and ceiling aided by a head tracking unit to keep track producing the correct perspective on the world depicted for the single viewer. In the late 1990’s, the company Silicon Graphics or SGI developed a multiple projector immersive projection on a section of a dome, and Teesside University in England developed the world’s first full color, high resolution interactive graphics full dome display called the Hemispherium.
While the planetarium was a discipline about the 2D night sky, these venues emphasized the recreation of our perceptual view of the 3D world around us. Creatively, we learned “the sky is not the limit” and our blue sky thinking of world space emerged by viewing these related immersive theaters. “Celebration of the dome” becomes a rather static notion that emphasizes a locked viewing position as if in a cage. Cathedrals were BIG for a reason - to give a sense of grand immersion with room to roam. It has been our experience with others, that learning to think in world space is a big step.

2. First exposure … rethinking the dome, or rather, thinking in 3D.

Our experience of hiring an outside director of SonicVision echoed early discussions of the discovery phase the Hayden team had to learn. The director wrote a paper with ideas that celebrated the dome surface, which ultimately resulted in scenes far less dynamic than those that addressed the world space. The digital artists working on the shots ultimately learned how to handle world space well, but in my opinion Sonic Vision illustrated the process of learning to think in world space. Part of that is learning to live
with dome distortion awareness which increases the farther away one views from the
dome center. In the creative authoring period, artists learn this quickly. Audience
reactions vary on this point, but we all get asked, “What’s the best seat in the house?”.
Projection systems are also designed with a virtual eye point consideration. To echo the
tradition in Planetariums of seeing a panorama of landscape looking up at the stars, the
Hayden display was designed to be greater than 180 degrees. This produces a forced
perspective that must be considered in content creation, and must ultimately be learned
how to work with.

3. Disappointments…

A number of dome issues are learned the hard way: by doing. Cross reflectivity
especially in captured daylit scenes is a killer. The contrast is reduced because
whatever is bright on the dome lights up the screen and one ends up adjusting gamma
to find best results. This issue varies with projectors. Dim projectors, depending on the
facility can still be a very disappointing issue, however brighter projectors are now
common, but brighter with respect to cross reflectivity is not necessarily better! Contrast
in projector technology is key. (At Hayden we installed the latest Christie Digital High
Dynamic Range system as a collaboration with them on development. I mention this
because as the technology becomes affordable, it is the best solution this author has
ever seen.) Other disappointments can be resolution, and poor projector blending. The
flow of technology is on our side for such things, but in general, artists must be prepared
to work with and around constraints.
4. Motion awareness…

Discovery that one's videogamer skills are not well suited for the dome has been an issue. Depending on the creative direction, the temptation to go fast through a virtual world can cause people to literally get sick in the theater. Different individuals and ages vary on this, but if the content is for mass audience, developing a sense of grace to movement is a skill to be learned in the medium of the dome. Depth perception especially with orbital and spiral motion is very effective to show proportion, distance, scale and context. This was learned in space show production, and its application to the creative process is key.

5. Orientations … worries about getting lost.

The continuous camera path “syndrome” was a big worry in our development of shows, because some felt that the audience would get lost. Our concentric seating at the Hayden, meant that what one side of the audience sees as up, is reversed for the other side. A continuous camera path was adopted to ensure people would stay with the action regardless of up / down. Camera twists and rolling content around the dome, coined the “democratic roll” aided orientation. In our second production we learned how fade transitions to black, and not cross dissolves tended to work in combination of an establishing overview shot, introducing the general layout of a scene, like in the solar system. In more free form artistic work, like SonicVision, scene breaks were in fact the point between fantastical environments. Producing our first show, Passport to the Universe created concern about flying through the stars, and how that would be both boring and disorienting as several likened it to the opening of Star Trek. I trusted it would not, since those who know the constellations would recognize them distort and as we perceive perspective so well of the world around us as a survival mechanism. This delightfully was the case and became a magical element across all space shows.

6. “LIVE, or Memorex?” (Live or recorded?)

Live or movie, basically comes down to theater management and production as in any realm of theater, however in our case at the Hayden, and most planetariums, science is on stage and both movies and live delivery can vary depending on resources and talent. Literally the “sky is not the limit” in production as we can typically produce material far beyond the capabilities available from live, interactive systems, BUT, as in any live theater, there is presence of performance which is fundamental. What is being shown as a movie may be fantastical and ever increasingly so with production techniques. What can be shown live, depending on how it’s presented to an audience can make the audience aware that we are in a true space defined by a world either created or measured as “data”. That level of awareness of being within a virtual space comes from
awareness that the operator is steering us through it, a perception that every 3D gamer understands. A movie can capture a performance, but a world can be interactively explored or toured.

From an academic perspective, it becomes a figure of publication we can walk into, a world space we can come to know. Beginning in academic alliances and later adopted by planetariums the ability to team up and remotely link within the same shared virtual environments is a further enhancement of the notion that while perhaps physically separated we can inhabit that same exploratory space. This theater based version of a shared space while well understood by gamers, is something that creative use of for mass audiences is an exciting arena to consider.

7. Pacing ... show vs. salon.

Attention spans vary, and in space show production, a tension between a sense of exploratory immersion with a need to move between topics certainly exists. The overwhelming “lots to see” is tempered by “I get it, what’s next” and is determined by narrative context. More contemplative, live guided exploratory journeys where time may be open ended allow for the contemplative, meditative appreciation of worlds but not without need of explanation. My own experiments with music, to contemplate by, broken by commentary where it would likely help have generated good feedback. Immersive visuals dominate, so if not guided by explanation, people can get lost or worse, irritated. Presentation of immersive world content is at its core a study in pacing, to lead the audience through material so they can visibly see the connections and the context.

8. Being within data, is an authentic reality.

Care to explain what it is, how it was gathered and how certain it is needs constant reminder. This IS the point in data immersion, taking us inside real information,
explanations of knowns and unknowns, limits to data, which is knowledge. Naming of these virtual immersion facilities is interesting to note. SGI when they developed their version called them “Reality Centers”. Creative content is free to roam but can be no less fantastical, but with data of a places or realms unavailable to us, these explorations are nonetheless “real”

9. Reviews - the “I'm too close to judge” syndrome.

Hitting the mark, creatively is ultimately something the creators can only sense, but not judge. Bad reviews are a good reason to rethink what it is that we’re doing. Reviews and reviewers vary, but good instincts are learned.

But with images showing places far beyond Earth, not much was self-explanatory except for the brief spiraling of planetary orbits and the close encounters on the return trip with the pockmarked surface of Mars and the mountainous regions of the Moon. Without adequate context, the images often devolved into sensory overload: awe-inspiring confusion, but confusion nonetheless. (Context will undoubtedly be provided on Tuesday, in the planetarium’s “Grand Tour of the Universe.”)

All this rendered the music truly incidental, though the Cassatt players performed gamely and artistically, amplified a bit in a room understandably built with little regard for musical acoustics. The pieces that most caught the attention were the three by Mr. Currier — “Quiet Time,” “Time’s Arrow” and “Time Flow” — with rhythmic and textural qualities that sometimes worked against the images in fruitful counterpoint.