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Beneath the Dome: GoodWork in Planetariums

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Introduction

The dark dome of the Planetarium has been illuminated by numerous research studies across the decades, many of which follow similar questions in different settings. The question 'Where does the planetarium optimally lie on the spectrum between education and entertainment?' is frequently posed by researchers in the field, but seems rarely to be the central focus of the investigation. In order to approach an answer this question, I contacted a number of 'Planetarium Professionals' who perform diverse roles in diverse institutions. I conducted in-depth interviews exploring how they themselves conceived of their work and the implicit tensions it includes. From their insights I have developed a model showing some of the ways in which Planetarium Professionals think about their work in order to be successful.

To frame my study, I interrogated the major research documents on Planetariums since their inception. Smith, in his (then) comprehensive review of the literature (1974), organized the existing research at the time into three central categories: descriptive studies, comparative studies, and curriculum studies (with 'Other' a catchall for research not fitting these broad areas). Descriptive studies "have attempted to describe the status of planetarium operations at various stages in the development of the planetarium" (p14), while comparative studies are

"those studies which compare in some manner the planetarium experience to the traditional classroom situation." (p24) Finally, curriculum studies deal with the effectiveness of planetarium curricula as modes of instruction in astronomy in and of themselves, or in contrast to other planetarium curricula. This tripartite classification neatly captures the majority of planetarium research, but points to a problem implicit in all of the research I have uncovered: there is significant disagreement over the proper place of the planetarium in educational and other settings. While a small section on the 'Philosophy of Planetarium Usage' highlights specifically this issue, and Alter (1941) (which discusses some philosophical issues as relates to planetarium usage) is cited, it is striking that none of the work he cites explores the research question as the main focus.

Downing (1971) highlights some of these potential disagreements over the most effective usage of a planetarium. He recorded the responses of 145 planetarium directors in the USA and Canada to a questionnaire about the adult education activities their institution provided. The questionnaire elicited data referring to the "types of programs offered, [the] evaluation techniques used to assess the programs and the progress of the adult learners" (abstract)**.** The participants were also asked to rank in order of their perceived importance eight principles of learning applicable to adult learners. The result is a snapshot of adult-education practices and the educational views of planetarium directors at the time; the responses revealed disagreement and divergent practice, as well as widely differing levels of success, among different institutions. For example, while

many planetarium directors felt problem-centered learning was desirable, much disagreement emerged over how important it was to involve learners in the development of instructional goals. Furthermore, even in institutions where both these principles were ranked highly, success was far from guaranteed: "problem-centered learning and participation in planning were rarely successfully utilized" (abstract).

A number of studies track the changing state of the planetarium across time, as priorities and practices change. Petersen (1989) investigated how planetariums across the world were affected by new technology, profiling some which had successfully adapted to keep pace with advances in computerization and the competing temptation offered by the cinema and interactive multimedia experiences. Likewise, Sunal and Sunal (1977) tracked the evolution of the planetarium in education in order to come to a historically informed picture of the state of the field across three decades. They found that the stated goals of the planetarium had remained constant across the time periods they investigated, while the concerns and priorities of wider society molded and reinterpreted those goals to fit the pressures of the time. As this trend occurred, the means by which planetariums sought to achieve their goals morphed to fit the changing institutions in which they were housed. In other words, while the values expressed by the planetarium domain remained relatively constant, the interpretation of those values affected what planetariums needed to do to be successful at different time

periods – and the balance found between education and entertainment fluctuated.

Similar historical perspectives offered by Norton (1985) and Brill (1982) refer to the research question elliptically without bringing it into clear focus. Norton (1985) surveyed the history of planetariums when asking "Will Planetariums Become Extinct?" He explored the effect of major historical events such as the launching of Sputnik on the state of planetarium usage, and tracked the development of laser rock shows and other high-tech entertainments offered under the dome. He concluded that the most successful planetariums do not stay the same: they change over time to embrace the new desires of the public and compete with wider entertainment offerings while maintaining their core educational mission.

Similarly, Brill (1982) reviewed the state of planetariums against the backdrop of then-contemporary technological and theatrical innovations such as the Digistar (a computerized projector) and theatre and dance performances within the planetarium. The rise of a new concept of the planetarium is tracked: the 'space theatre'. Brill saw planetariums of the future offering an expanded range of "artistic visions of the universe around us" (p33). This intriguing notion, of planetarium as performance-venue as well as educational space, may offer a unique perspective on the education-entertainment question. It is important to note that, while Norton was somewhat skeptical of recent trends in planetarium usage, Brill was clearly enthusiastic: another example of the lack of a single reigning philosophy of planetarium usage.

More typically ‘experimental’ studies tend to deal with the education-entertainment question only in passing, if at all. Ortell (1977) provided a typical comparative study, comparing the performance of students taught astronomy in regular classrooms with those taught in a planetarium. Using official data provided by two community colleges, he found that planetarium instruction was beneficial to all groups of students, and demonstrated how the benefit derived from planetarium instruction was more pronounced in relation to the comprehension of certain astronomical concepts. While assumptions were made regarding the validity of test-scores and grade-point averages to determine student success, the wide range of tests applied and the comprehensive analysis of the data over numerous subgroups suggest that planetariums can be valuable in educational settings. What it does not elucidate are gains in the affective domain, which have frequently been cited among the primary benefits of the planetarium experience (evidence to back up this supposition is scant, however).

Similarly, Sunal (1973) compared the performance of second-grade children in a wide range of educational goal areas related to astronomy. He studied three groups: one experienced a classroom astronomy unit; the second experienced a combined astronomy-planetarium unit; and the third had no instruction of astronomy or planetarium visit. The use of the third group, a point of comparison with Ortell (1977), strikes me as valuable. It allows consideration of young children who may have already acquired a basic level of astronomical understanding

similar to the level of concepts being taught in the astronomy and planetarium units. Providing further support for the benefits of planetarium usage, Sunal found that students who experienced the astronomy-planetarium unit made gains in *all of* the ten educational goal areas above those made by the other students. In addition, Sunal notes that those who attended a planetarium unit showed "increased perception and understanding of science principles and processes" (abstract) some six weeks after the event, suggesting that educational experiences within planetariums may assist students in tackling scientific material in areas other than astronomy. It would have been interesting to investigate, in addition, if students' *interest* in science was affected by the planetarium experience but this variable was not considered.

Pertinent to the topic of this paper, Reed and Campbell (1972) provide a contrasting view. They directly compared the effectiveness of classroom teaching with a chalkboard and astronomical-globe to teaching in a planetarium. Contrary to the findings previously cited, they found, that the classroom teaching situation (with astronomical-globe and chalkboard) was significantly superior to the planetarium teaching situation. They concluded that planetariums should be most effective when used in conjunction with traditional classroom instruction, and should not be used as a stand-alone 'demonstration chamber' for astronomical concepts. Reed confirmed and extended these findings in a follow-up study (1973). These results are consistent with those of Smith (1966); this investigation compared

planetarium lecture-demonstrations with classroom lecture-demonstrations with sixth-grade students and also found the classroom setting to be superior.

The contradiction between the results of this research and the previous papers cited is striking. This puzzle is particularly apposite to the question of how planetarium professionals should deal with the education-entertainment question: perhaps the differences in effectiveness of planetarium experiences noted here were due to sub-optimal positioning on this scale? Fisher's (1997) research (which compared retention rates of astronomical concepts between a 'standard' planetarium show and the same show with 'humorous' lines inserted) implied precisely that, suggesting that humour in planetarium shows actually negatively affects retention of astronomical concepts. While significant questions can be raised about the research methodology used by Fisher (lines introduced to make the standard planetarium show 'humorous' were not necessarily very humorous), the results of his investigation raise important problems seemingly unsolved by current literature.

By analyzing the effectiveness of planetarium curricula themselves (rather than their differences and relative effectiveness as regards classroom programs), the research goes some way towards alleviating the contradictions that have been observed. By performing a meta-analysis of prior research, Sunal (1976) derived a number of implications for effective planetarium usage. He made the suggestion that the traditional single-visit model is not effective. Instead planetarium educators

should look to provide combined classroom-planetarium instruction, pre-visit orientation programs, and a focus on use of the planetarium late in the astronomy unit, rather than at the beginning.

One further significant finding of Sunal's research: for a planetarium to be effective, as much consideration of educational techniques must occur in the planetarium as in the classroom: the planetarium cannot be considered a stand-alone device that will provide educational outcomes 'for free'. Research by Reed (1971, 1972), Thompson (1968) and Tuttle (1966) provides such consideration of the educational techniques most valuable in planetariums, proposing an inquiry-based model in which dialogue between the students and the instructor is essential. Clearly this finding has significant implications for pre-recorded planetarium shows in which no such interaction is possible: how illuminating can we expect a single-visit, humorous, pre-recorded planetarium show to be when these elements may be educationally invalid?

The 'education-entertainment' question has been raised more explicitly in other domains, however. Weinstein (1998) focuses squarely on this tension in his study of 'Robot World', an interactive science museum / theme park. Hendershot (2004) presents a compelling series of studies investigating how the Nickelodeon T.V. Network became a seminal part of American and world culture. Particularly relevant to the question at hand are discussions of how the network shifted its emphasis from more overtly educational programs to those with a clearer

entertainment focus in order to catch a broader market. Likewise, the research of Singhal and Rogers (2002) seems apposite. They provided a theoretical model with which to investigate "Entertainment-Education", a concept that was born in the media domain but is beginning to spread into Science Museums. Finally, Fisch and Truglio (2000) and Morrow (2005) investigate how Sesame Street, possibly the world's most famous educational TV show, came to be so successful. Included are discussions of the entertainment-education tension that creators of the show deal with each day.

What is missing from this significant body of research is any consideration of how 'planetarium professionals' consider their own work, how they relate to the education-entertainment tension, and how they navigate the constantly shifting social demands and revolutions in technology chronicled in the research cited above. The question explored in this paper, while central to so many others, is always on the far horizon. The current proposed research aims to fill this gap.

Methods

For this study I gathered a sample of seven Planetarium Professionals selected according to the following criteria:

- I was eager to speak with individuals whose experience with Planetariums represented the breadth of the field itself. To this end I cast a wide net in terms of the types of institutions (museums, universities etc.) contacted.

- Many individuals are involved in the production and presentation of a planetarium show, so I interviewed individuals performing different functions within their specific institutions.

- Finally, one of the benefits of working within a relatively small field is the opportunity to gather the insights of some of the most respected voices, who represent or have worked within the most significant institutions. Therefore I ensured that I asked each participant who they would recommend I speak to, and I assiduously followed up on those 'leads'. I began to feel that my sample had been successfully selected when the people I was interviewing recommended those I had already spoken with.

I interviewed three Planetarium Directors (who are involved in all aspects of running the planetarium, including producing and presenting shows), and two show presenters and producers who were not yet in leadership roles. In addition, I spoke with one individual who has worked with many different Planetariums in overview or consultancy roles, and with the organizer of a large annual Planetarium convention. Details of the participants are recorded in Appendix A. In total, five different Planetariums are represented, of which three are based in universities, and two in museums. Two of the planetariums were located in Massachusetts, one in New Mexico, one in California and one in Minnesota.

It is important to note at this point that my desire to speak with individuals at the top of the field may have introduced an element of bias to the study. Those

working within highly-respected institutions may have more flexibility to pursue paths not open to institutions which need to struggle more to raise attendance. Likewise, individuals recognized as leaders in the planetarium field may wield influence that enables them to sidestep common constraints and problems. These issues must be kept in mind when considering the conclusions of the current work.

I conducted semi-structured interviews with all of the participants. The interviews were scheduled to last between forty-five minutes and an hour. During the interviews I asked each individual a series of questions designed to explore the various tensions implicit in their work in Planetariums. The interview protocol used (Appendix B) benefited from suggestions and revision by faculty and teaching fellows at the Harvard Graduate School of Education.

The completed protocol first asked participants to describe their routes into Planetarium work, and their general 'philosophy' of the role of the Planetarium within their institution. They were then asked to describe the process of creating a Planetarium show, including an explication of the different tensions they have to navigate and difficulties they face while doing so. Participants were then asked how they measured the effectiveness of their shows, and for their views on the educational and affective impact their shows had on audiences. Finally, participants were asked about the relationship between the planetarium and the other educational elements of the institution in which they worked, such as IMAX theatres or museum exhibits.

These interviews were recorded and coded in relation to a number of key themes, some of which I had determined in advance and some of which emerged from early discussions with the first participants. I was listening hard for statements or anecdotes that highlighted the key tensions that the professionals felt they faced in their work, and their strategies for successfully resolving them. All participants referred to in this paper have been given pseudonyms.

Results

My initial hypothesis was that planetarium professionals would be under strong pressure to make their shows 'more entertaining' and 'less educational' in order to meet the significant financial demands of a planetarium[1]. This expectation was informed by my knowledge of recent high-profile planetarium closures due to budget constraints and a perceived waning interest in space. Examples include the McLaughlin Planetarium in Toronto, closed in 1995, and the London Planetarium, which now hosts shows about a different kind of 'star' altogether – celebrities.

My results show, however, that resisting the 'gravitic pull' of the entertainment-world is not the most significant pressure felt by planetarium professionals. In actuality, the opposite is the case: the individuals in my study found it far more challenging to make the scientific concepts they are trying to communicate intelligible and meaningful to their audience within the medium of the planetarium. When a planetarium show is not successful in the eyes of the

[1] See Figure 1

planetarians, it was rarely because it was 'too entertaining': much more frequently it was too *detailed*, insufficiently relevant to the audience's level of understanding and interests, and failed to take account of the unique aesthetic approach the planetarium dome requires[2].

Also, I found an unexpected but, among my participants, universally acknowledged 'existential' component to the work of planetarians: they all see part of the main responsibility of planetarium shows to be the posing of 'big questions' about the meaning and value of human existence – examples include "Is there life elsewhere in the universe?" and "How did the universe begin?". This finding was strongly related to the unique 'aesthetic' of the planetarium space, which was another aspect mentioned by the entire sample. Through their insights I have been able to incorporate this new information into a model of effective planetarium work which highlights the different pressures acting on planetarians.

'Don't Try to be Funny!' – The Entertainment / Education Tension

Contrary to my initial expectations, the planetarians I spoke with did not feel that they were unduly pressured towards creating programs that prioritize entertainment value over astronomical-education. All of my participants recognized that such a tension potentially existed in their work, but none felt it was the most significant of the problems they faced, and all were able to overcome it. When this tension was mentioned, most spoke of it in terms of a pressure to increase

[2] See Figure 2

attendance, and at a time when Omnimax and Imax Theatres offer audiences a wider range of experiences than in the past, this was pressing for all of the participants currently working within a specific planetarium (five of the seven participants). Deana, a planetarium show producer, expressed this tension most clearly, saying "I think there is some pressure to change – we always have people pressuring us to build up our attendance." Some were very clear that their institution or work did not succumb to this pressure: Mandy, the planetarium director newest to the field, said "We don't have any shows at all that have too much entertainment and not enough content", while John, a veteran planetarium consultant, joked "We were rarely accused of being too entertaining." However, he conceded "It did happen occasionally."

The planetarians overcame this difficulty through two mechanisms: an extremely strong commitment to what they saw as their core educational mission, and ingenuity in incorporating the popular and the educational. John made the strongest statement of the former, declaring "There are places I would not work… If someone just expected entertainment programs… I couldn't do them, and I just wouldn't do it." Deanna described a situation that exemplifies the latter:

> What we're really good at is incorporating those ideas without changing what we want to do. So someone will come and say "we need to do a show…about Pluto" – we have been told we have to do something to bring in the public… We want, of course, our attendance to go up, but we don't want to do it by sacrificing our values in

> production... So, for example, the Pluto subject... we're certainly going to talk about Pluto, but what we're really going to do is talk about the entire solar-system. Not just Pluto. If we told the powers-that-be that we were doing a show about the solar-system they would say "No, Don't do that. That's too standard, too traditional." But by putting it under the name of Pluto we can do good science and do good teaching and keep people interested.

Moreover, events in the wider culture sometimes conspire to eliminate this tension altogether, and allow planetarians to construct shows to combine neatly education and entertainment. John, remembers that when "*Star Wars* had just been released in theatres, and Carl Sagan's *Cosmos* was just starting to be on television, and the Voyager spacecraft were launched, it was a very exciting time for space programs." Particularly, popular Science Fiction shows seem to serve as a catalyst that enable planetarians to fuse the worlds of entertainment and education. Deanna described a show based around *Star Wars* as "a perfect blend of entertainment and science", while Nadine, a former planetarium show producer and current member of the Optical Infrared Division at the Harvard/Smithsonian Center for Astrophysics, talked about a show inspired by *Star Trek*: "They were going into a nebula, looking at pulsars and different types of stars, supernovas and novas."

It can be seen, then, that planetarians consider the pressure to be 'more entertaining' as part of the wider issue of the interest of society in space at a

particular time. When cultural factors converge to make interest in space high, there is no need for them to make any concessions in their programming to bring in an audience. When interest wanes, they find more pressure (often from the parent institution in which they are housed) to move towards the 'entertainment' end of the spectrum. Regardless of the cultural climate, planetarians seem to keep a strong grasp on their educational ideals, and exercise ingenuity in packaging their educational content so that it remains attractive.

However, two of the planetarians I spoke with foresaw a potential shift towards a different type of programming. Mandy spoke of a recent conference where "they are doing some really exciting work... that is more entertainment and artistically oriented than science oriented. And I think that is an aspect that would be very important for us in the future in order for us to get people in the planetarium." Daniel (the organiser of the conference and a planetarium director) agreed, making a strong case for expanding the scope of the planetarium medium. Discussions of the potential of the planetarium to be a space for more than astronomy-education centred around the unique aesthetic experience the planetarium offers: the topic of a later section.

Bringing the Stars to Earth – The Devil's in the Details

The single biggest tension experienced by planetarians in my sample was the struggle to make complex scientific concepts understandable to their audiences within the aesthetic medium described above. All of my participants, when

describing planetarium shows that were *not* successful, described situations in which they had not been able to convey the scientific ideas they had hoped to at the outset. Deanna described one such show:

> We went with a topic that isn't traditionally done in the planetarium [the weather]... we alternated presenter-recording-presenter-recording – which sounds great but it's very jarring. We tried using demonstrations with props and carts... it's hard to get some difficult concepts to come across. And although the dome is a good space for immersing people, as we discovered it isn't a good place for demonstrations as not everyone has a good vantage point. A combination of Show Topic, Show Name, Format of Live Presenter/Recording, it didn't work out very well.

Daniel outlines another potential pitfall, remembering that "The mistake we always made was trying to do too much...trying to convey too many messages rather than saying something significant about one message." Ben described similar difficulties, saying "We have a real problem in our profession of being too enthusiastic, and expecting the public to rise to that level."

A final trap was outlined by John, who described the difficulty of effectively visualising certain concepts:

> The Big Bang... is one [area] where I had a few problems. Scientists like the microscopic scale… They talk about the microphysics that's going

> on at the beginning of the universe. The number of times I've tried to do that – I don't think the average person can get to the microscopic scale and be comfortable, and understand the nuclear physics that's going on there... I'm very careful not to get people into realms that are unimaginable

A number of difficult considerations that must be weighed for a planetarium show to achieve its goals – the show's topic, name, format and content are mentioned as hurdles that must be overcome. Mistakes in any of these areas can derail a show, affecting its potential for engaging the audience or conveying its scientific messages.

More than simply conveying certain concepts during the show, however, all the planetarians with whom I spoke saw the planetarium as a place in which people would be inspired to want to know more. The planetarium was seen as a *starting point* for future discoveries, rather than the end goal. Nadine stressed this capacity, saying she wanted the audience to think "Oh my God I didn't know about that!" and "Oh my God I want to know more!" Daniel, similarly, wanted to "change people's attitudes and motivations about science" as well as communicating specific pieces of scientific information. Finally, Ben suggested that "If a show's good enough, it gets them to appreciate science, want to learn more and see how it connects to their lives." The planetarium was therefore seen as a place to initiate a love of and interest in science that extends beyond the dome

itself, made possible by the immersive environment and other aesthetic qualities previously discussed.

One particular concern stood out above the others, however: all the planetarians with whom I spoke recognised the need to simplify their scientific messages for a general audience, and sometimes had difficulty deciding how, and how much, to simplify. Indeed, while the planetarians considered maintaining scientific accuracy to be an important, even vital, component of their task, they nonetheless all recognised that absolute accuracy must occasionally be sacrificed in order to aid the understanding of those without a science background. Daniel stated "My judgement was always not accuracy so much as the clarity of the statement. You *can't* be literal in this stuff...you always have to take some liberties." Both Nadine and Mandy agreed: Nadine explained "Science is 'pointy', with lots of details. As educators, we need to be able to do a good review that's understandable by the lay-people. To put it in terms that everybody can understand" while Mandy said "We definitely have to simplify things." Deanna was likewise concerned with "getting the gist across. We can't present it exactly… we have to exaggerate a few things." Likewise, Ben describes how "you try to find a way, while keeping it scientifically correct, of making it palatable – a kernel of understanding. This is the main challenge of making a show... [but] sometimes you do have to throw in the towel and say 'It's the best I can do in the time I have.' There are things not absolutely correct with that, but did it teach this concept? Yes, it gets it across."

This process of 'simplification' and 'exaggeration', combined with the limitations and possibilities of the planetarium as a medium as explored previously, that gave the planetarians the greatest trouble. We turn to this conflict in the next section.

'In-Betweening' – the Many Roles of the Planetarian

When speaking of the process of creating a show, many of the planetarians recognised a tension within their institutions between those who understood how to convey scientific messages to a general audience, and those who didn't. In these situations the planetarians saw themselves acting as a bridge between their colleagues and the layperson. Indeed, far from feeling the pull of the entertainment world, as explored earlier, many of the participants in this study described the opposite: they felt the tug of scientists trying to make their shows more scientifically detailed than they felt their audience would be able to understand. Daniel described this situation most clearly: "I had research astronomers as my steering committee. So it was effectively five against one... I had a huge battle with the astronomers teaching them the rules and principles of informal scientific education... I had to fight them tooth and nail." John described similar battles, saying "Sometimes it's over the content 'Oh it can't really be like this! Pluto doesn't really look like this! Pluto is not really a planet!'" Experienced planetarians drew on their past mistakes and successes to resist these pressures, and often had to fight hard for their vision to be realised.

In addition to these conflicts, three of the planetarians also strove to bring their less educationally-astute co-workers towards a more audience-friendly position. Nadine, for example, told of how she had to work hard to convince her colleagues to think from the perspective of the audience rather than the perspective of a trained scientist. Similarly, Daniel described how, through collaboration over the creation of astronomy-related museum exhibits, he educated his astronomer-colleagues towards prioritising clarity over absolute accuracy.

In general, it seems that planetarians are successful in this leadership role, making educators out of their co-workers. Indeed, John described a striking phenomenon which he had observed a number of times: "I've had this happen – almost a role-reversal, where all of a sudden the designer's so wedded to the content that they won't budge, or the scientist is defending aesthetic decisions. I wound up trying to pull the designer off the science concept and trying to convince a scientist they're not really a film-maker. And it was my job to stand in the middle."

John went on to describe this 'in the middle' role with characteristic insight:

> "I'm a bit of a hybrid... what I call 'in-betweening' – someone who can be in both worlds... I can go out into the experiment lab and talk to the people doing experiments on neutrinos, and turn around and work on a children's book... I think as professionals we are in-between, hybrid people."

This concept of 'in-betweening' seems to me central to understanding the work of the planetarian. The most effective shows, as described by the participants in this study, are those which have a strong grasp of the science allied with a deep understanding of the audience's current levels of understanding and potential misconceptions. The planetarian, to be effective, must play three roles: those of a scientist, an educator and to a certain extent an entertainment-artist – and it is indeed striking that six of the seven planetarians considered themselves, in certain respects, to be artists when creating their shows. This conception, as planetarian as 'professional in-betweener' moving between *three* worlds, comes close to articulating the full, extraordinary range of the work planetarium professionals perform. To understand the artistic side of the planetarians' work, however, the aesthetic of the planetarium must first be considered.

Starry Sublime - The Planetarium Aesthetic

The planetarians included in this sample expressed remarkably similar ideas about the 'aesthetic' of the Planetarium. Themes that occurred repeatedly, and that would seem to be key to this aesthetic, were: the immersion offered by a planetarium dome; the central role of music; the importance of taking the audience on a 'journey'; the presence of a live presenter; and a peaceful and relaxing environment, aided by the slow pace of planetarium shows.

Deanna describes the immersive aspect, explaining that the planetarium "is not like watching something on TV or reading something on the internet when you can't become part of the experience…you can really bring people into the experience." Mandy echoed the same principle when she said "It's an immersive medium. When you're in the dome, and the lights are out it's totally different from watching a movie. A movie has clear rectangular boundaries. And you're clearly outside it....But when you're in a planetarium the show is all around you – you're inside it." The feeling of 'really being there' beneath the stars, aided by the theatre's domed shape, was a touchstone that all the planetarians referred to repeatedly. Nadine was referencing this immersive quality when she said "I want to give them the experience as if they were in space."

John spoke to the importance of music. Not only does he "pay a lot of attention to music", but he sometimes uses musical forms as inspiration for the pace of a show: "I do take a lot of models directly from music. I often think of the movements in a symphony – you have to have some quiet movements, along with

some louder ones." He even recalled one occasion in which a whole show was ruined by a score that "sounded like 'Phantom of the Opera'. Kids came out of the show walking like Quasimodo! It was a wonderful, spectacular failure."

All the planetarians expressed a desire to take their audiences on a journey, and many of the titles of their shows encapsulate this: consider *Passport to the Universe* and *Into the Unknown*, for example. Daniel describes this aspect well, saying "We began with what they had in front of them – the night sky. Then we go further and further out into the sky to see different things, and communicate different scientific principles on the way." But of central importance to the planetarians was bringing the audience back to Earth before they left – four mentioned this specifically. Daniel continued: "The important thing for me has always been to ground them. To say 'This is all effectively available to you if you look up'. I always bring it back to relevance." Indeed, the desire to relate the planetarium experience back to everyday life was frequently expressed, and it seems that this is metaphorically represented in the show itself by bringing the audience back to earth at the end. Ben, an experienced planetarium director, expresses the same sentiment, saying "We generally try to bring them home. A solar-system show will end back on earth. You always want to connect it back to earth, and humans, and our journey." It is striking that of the many shows I heard described by the planetarians, none of them ended out in space – they *all* returned home.

Daniel also spoke about the last aesthetic element, the peaceful environment, eloquently, saying "Part of the great benefit [of a planetarium show]

is that it's relaxing and quiet...trying to mimic the qualities of naked-eye astronomy or telescope astronomy in a dark, quiet place is definitely one of its strengths." Deanna agreed, suggesting that the planetarium's "pace is a lot slower" when compared with other forms of entertainment. This slow pace was often contrasted with the faster pace of an Imax or Omnimax movie, and with the pace of society as a whole. The planetarium was seen as a space in which people could slow down for a while, and engage in a more subdued setting.

The most forceful expression of the planetarium's unique aesthetic came from John, who likened the experiences offered under the dome to the Kantian idea of the sublime:

> Immanuel Kant wrote about the 'sublime', and it does match and it really guides my programs. I think it's one of the keys to moving people emotionally... and the planetarium can play into that very well. One is called...the mathematical sublime, and that is where there's a kind of infinity. The starry sky fits into that, because you can't count all the stars, and yet they seem to go on, and everything seems big. You have a kind of mathematical or geometric infinity when you look at the stars. There's another type of sublime, called the dynamical sublime, of when you have a lot of power, as when you watch thunderstorms and hurricanes. This is the dynamical sublime and planetariums can evoke that as well. I actually think about these things when I produce and

make [planetarium shows] because this is one way to touch people. But it's not a narrative way... It's based on the power of the universe.

It is clear, then, that the planetarium offers aesthetic capabilities that are in many ways beyond other educational and entertainment media. The environment of hushed awe this aesthetic promotes is quite unique, and perhaps offers insight into why the planetarians in my sample felt a strong responsibility to pose questions probing the relationship between humankind and the universe.

Towards the Boundary – Posing Big Questions

To me the most surprising element of the ways in which the planetarians in this study described their work was their unanimous commitment to asking (and trying to answer) 'big questions', and to helping audiences come to a fuller appreciation of the beauty of the natural world. Each and every one of them articulated this as one of the central goals of the Planetarium:

John: I think people come to Planetariums for an 'off the earth experience', often dealing with the biggest questions... I think discussions of the Big Bang, which is an edge or a boundary, and questions of extra-terrestrial life, which come up routinely, are about the limits of life and life as we know it...where we are in the Universe is a boundary question too.

Nadine: Astronomy's important because it answers the questions of who we are, what are we doing here, where are we going?

Daniel: [The planetarium is] a place you can go and get some Truth, get some quiet, be part of a group of people, some you know and some you don't know, and be immersed in something that is a story that's told a bit more slowly that's filled with beauty.

Mandy: To me [working with the planetarium has] been a wonderful, eye-opening experience... I look at the sky a lot more now than I ever did before, and that's something I also hope to encourage students to do...I really hope this will change their lives too.

Deanna: We can take people into space and explore these huge questions that people have... Are we alone? How did everything come to be? Do the laws of physics apply everywhere? ...We can learn more about ourselves by looking at these other places...If you go to the Planetarium it makes you think about these deep questions you may not otherwise have a chance to.

Ben: [I wanted to work in planetariums] to be close to those issues like 'Where does the Universe come from?' and 'Is there extraterrestrial life out there?'

William: The planetarium is an inspiration. It reminds people of these questions. Without the Planetarium people wouldn't think of these things on their own.

It is seems to me that this final element of the work of the planetarian is fundamentally *existential* in nature. The questions described in the above

quotations are ones of human significance within the unimaginably vast universe that have been posed by philosophers, theologians and scientists alike.

The planetarium, with its unique aesthetic allied to an astronomy-education goal, is an extraordinarily powerful space within which to pose and confront these perennial dilemmas of humankind. That the planetarians in my sample universally realised and testified to this speaks to their deep understanding of the potential of their institution, and their remarkable skill as professional hybrids.

Discussion

The planetarians in my study spoke with striking agreement on the key issues and conflicts that infuse their work each day. Where there were disagreements they tended to be minor - but some stand out as potentially significant. The relationship between the planetarium and other 'entertainment-education' spaces (like IMAX cinemas) was seen differently by different participants, for example. Some, such as Deanna and William (based in a museum), did see the IMAX as a competitor with the planetarium for audiences, and wished their institution would allocate the same level of resources to promoting the planetarium as the IMAX. Mandy, on the other hand (also based in a Museum), felt that the presence of an IMAX cinema in her institution would be *beneficial* to the planetarium, as the IMAX could provide more entertainment-oriented shows for those who wanted them, freeing up the planetarium to focus on more-purely educational content: "If we had an Imax cinema, that is already a big eye-candy sort of a venue [but] We are

never going to have the funds to have an Imax cinema here, so the planetarium really has to do double duty for us – almost like an Imax-lite." This disagreement neatly encapsulates differing attitudes towards the IMAX and other, newer technologies that could be seen to be encroaching on the planetarium's space.

The second area of significant disagreement concerned the use of the planetarium dome to provide non-astronomy content and experiences. While both Mandy and Daniel were extremely positive about using the dome in a wider range of ways, John expressed greater scepticism, suggesting that the domed space was simply not well-designed to offer certain content. Strikingly, while Daniel talked with enthusiasm about work he had seen exploring subatomic particles in the planetarium, John stated that this would not be something he would work on without being convinced beforehand that it could be done effectively. These differences of views have implications for Brill's (1982) concept of the 'space theatre' – it seems that the debate over what range of experiences planetarium domes can best offer is as current now as it was then.

Finally, various levels of enthusiasm were expressed towards the shows which mixed pop-culture references with science-education, such as the *Star Wars* and *Star Trek* shows discussed above. While all my participants recognised that such shows could be both popular and educationally useful, Nadine suggested that they should not be too frequent a part of a planetarium's program, while Mandy called for a balance of more 'popular' shows with more 'educational' ones. Such concerns did not seem to hold sway at Deanna and William's institution, however:

the *Star Wars* show developed there has been brought back over a number of years and is frequently offered.

Even with these disagreements, though, from the insights of the seven participants in my study, a clear picture of how planetarians conceive their own work emerges. Their shows succeed, and the true vocation of the planetarian in this setting is fulfilled, when they are able to harness the unique aesthetic medium of the planetarium to present accurate, current scientific concepts in a way that is meaningful and relevant to a general audience, while posing 'boundary questions' that spur viewers to think deeply about their place in the universe – this model of successful planetarium work is represented graphically in Figure 3.

Crucially, Planetarians do not see their role to be the conveyance of completely accurate scientific information – they recognise that they must make allowances for their audience and are willing to sacrifice absolute conceptual fidelity in favour of greater clarity. They hone their ability to decide how much detail to relinquish over years of experience, taking note of occasions when they have not been entirely successful and ensuring they do not make the same mistakes twice. Perhaps this finding can alleviate some of Fisher's (1997) concerns: the primary goal of planetarium shows, according to the participants in this study, is not to convey specific astronomical concepts. Instead shows are considered a success if they inspire audience members with a desire to find out more, and imbue them with a greater reverence for the cosmos and the scientific process in general.

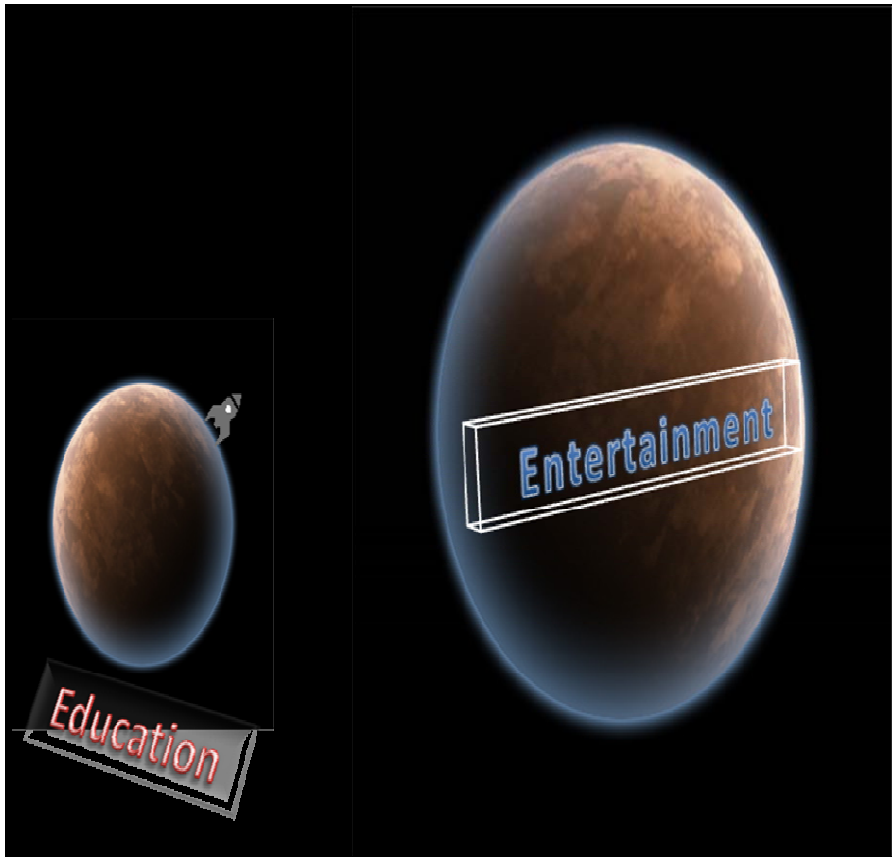
Finally, the planetarians in my study see themselves as professional 'in-betweeners', who straddle *three* professional domains: they are scientists, educators and artists working within a unique artistic medium - Figure 4 represents this concept.

These requirements are by no means lax, but when planetarians are successful in navigating these treacherous and complex demands, the rewards are great. John, describing his favourite of the shows he had worked on, gives powerful voice to this potentiality:

> I thought the show was successful because a lot of people... were really emotionally moved. One woman was in tears, and one woman wrote me this letter about how it changed her life. How many people can say a program they've worked on has done that?

How many, indeed?

Figure 1 – The Initial Hypothesis



My initial hypothesis predicted that the planetarians would face strong pressures to make their shows entertaining, with possible negative ramifications in terms of educational content.

Here the gravity-field of the smaller planet represents the planetarians' desire to create sound educational content, while the relatively stronger gravity-field around the larger planet represents financial and cultural pressures (such as a lack of interest in space) which encourage them to make flashier, less scientifically-accurate productions.

The spaceship represents the planetarium show, initially conceived as an educational experience, destined to orbit around 'Planet Education'. However, during the process of production, the stronger gravity around the larger 'Planet Entertainment' would pull the ship into its orbit, the end result being more entertainment-orientated than first intended.

Figure 2 – A Reversal of Expectations

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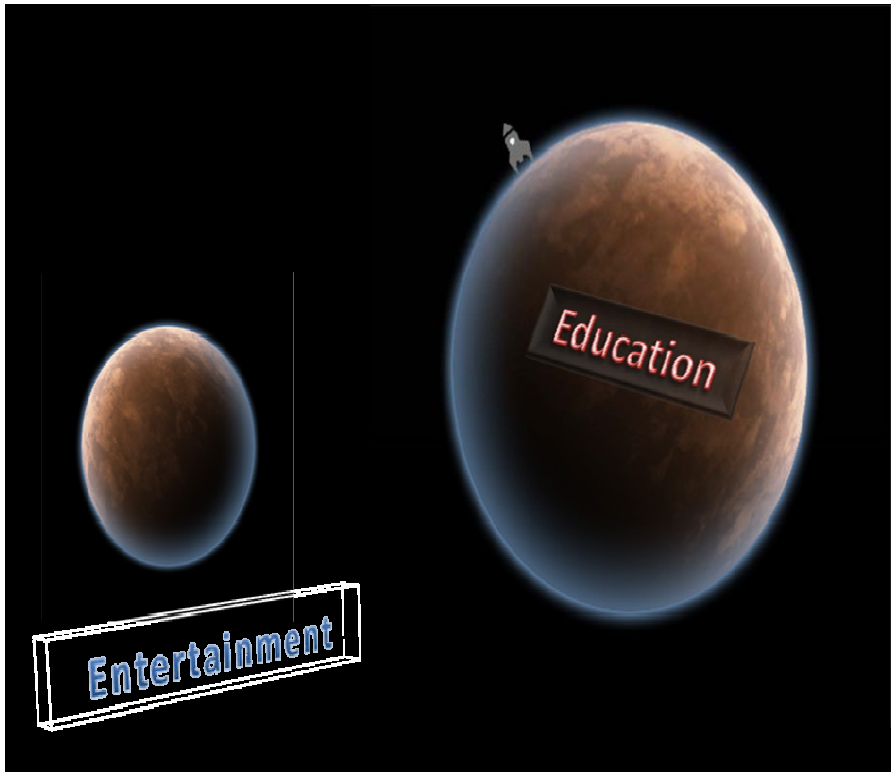
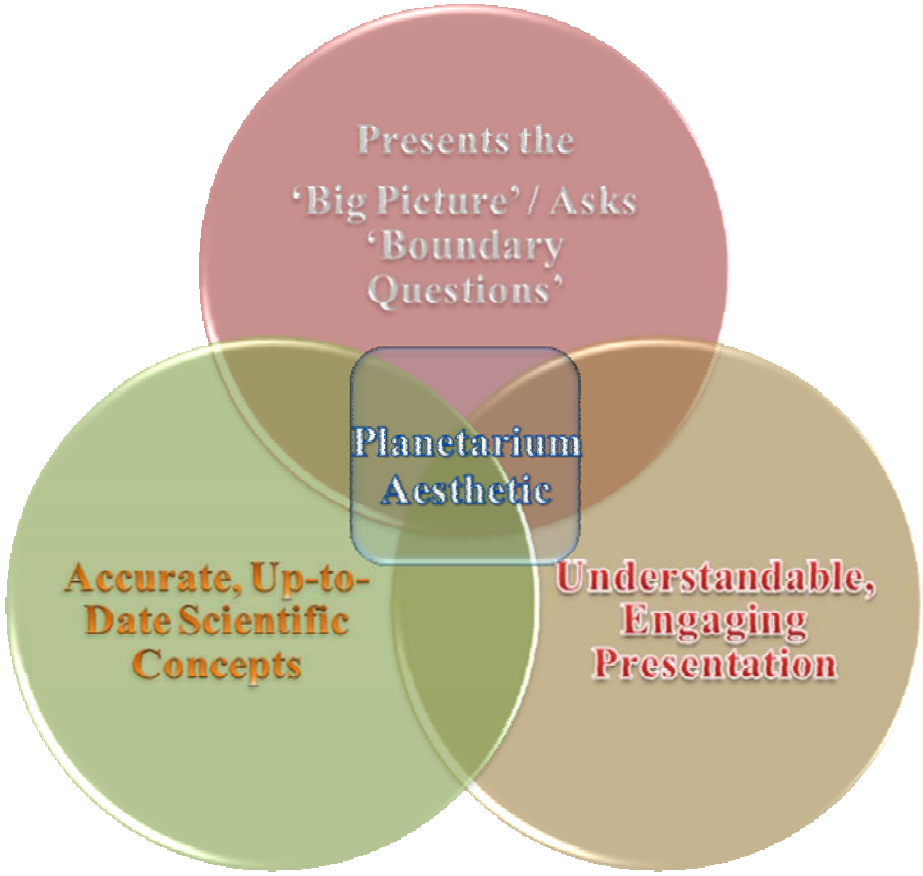


Contrary to my hypothesis, I discovered that planetarians had an extremely strong commitment to their educational mission, which they conceived in broader terms than I had anticipated: they saw their role as essentially an *inspirational* one, and they hoped to encourage visitors to appreciate science in a deeper and more meaningful way.

When shows were unsuccessful it was not, generally, because they were 'too entertaining', but because they failed to take into account the audience's current level of understanding and failed to convey their central scientific concepts effectively. Often this was a consequence of attempting to be *too detailed*.

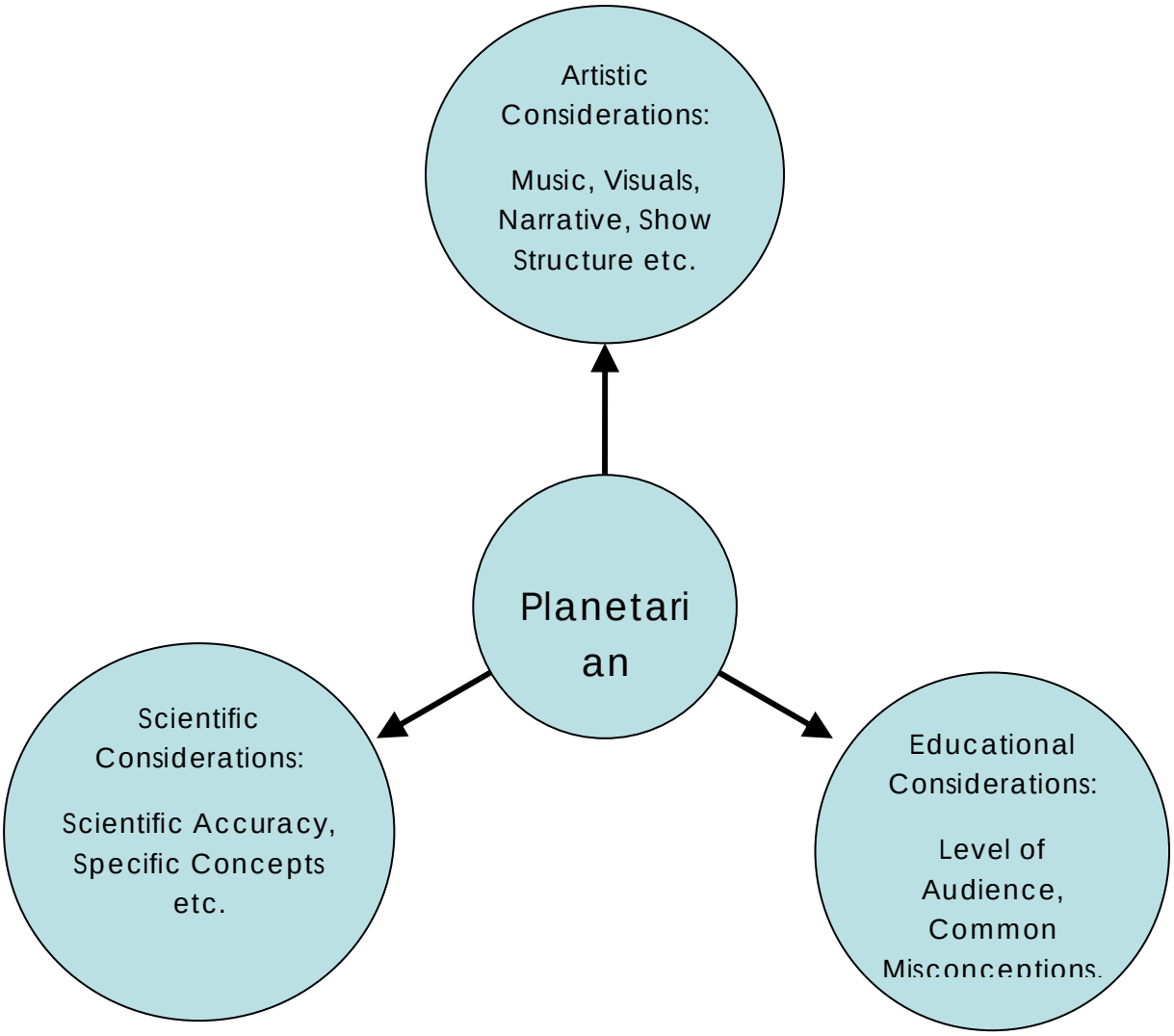
'Planet Education' turned out to be the larger, with planetarians keeping strong hold of their educational goals, but sometimes their shows would focus too much on scientific detail – the spaceship is not launched far enough from the planet, and spirals in to 'crash land'.

Figure 3 – A Model for Effective Planetarium Shows



Successful Planetarium shows, as described by the participants in my study, present accurate, up-to-date scientific concepts in a way which is understandable and engaging for a general audience while posing 'big picture' questions about the place of humanity in the universe. All this must be achieved within the unique esthetic of the planetarium dome.

Figure 4 – 'Professional In-Betweeners'



Appendix A

Participant Information

Participant Name (Pseudonym)	Institution	Role	Level of Planetarium Experience
Ben	University Planetarium	Planetarium Director	Veteran
Daniel	University Planetarium / Fulldome Convention	Planetarium Director, Convention Organiser	Veteran
Deanna	Museum Planetarium	Planetarium Show Producer	Experienced
John	Various	Consultant / Science Advisor	Veteran
Mandy	Museum Planetarium	Director of Planetarium Shows	Beginner
Nadine	Previously University Planetarium / Currently at the Harvard-Smithsonian Centre for Astrophysics	Planetarium Show Producer	Experienced
William	Museum Planetarium	Planetarium Show Producer	Experienced

Scale:

Beginner (0-5 yrs) ⟶ **Experienced (5-15 yrs)** ~~⟶~~ **Veteran (15yrs +)**

Appendix B

Interview Protocol

1. What drew you to work in Planetariums?
2. What do you consider the central role of the Planetarium?
3. What factors do you take into account when you're creating / presenting a new Planetarium show?
4. Which Planetarium show did you enjoy working on the most?
    a. Why was that?
5. How do you measure the impact of your shows?
6. Does everyone involved evaluate the shows the same way?
    a. Can this create tension?
7. Which has been your most successful show here?
8. Why do you think that show might have been more successful than others?
9. What does a successful Planetarium show look like?
10. Which elements are essential to such a show?
11. Have there been any shows that you're not happy about or that didn't turn out as planned?
    a. What happened?
12. Have you seen/ been involved in shows that were ‘too entertainment focused’, and which didn’t have much educational content?

13. Have you seen / been involved in shows that were too scientifically complex, and that people didn't understand?
14. Do you have to 'simplify' scientific concepts to help the audience understand them?
    a. If so, how do you decide when you've simplified them enough, and ensure you don't go too far?
15. What can people learn from a Planetarium show?
16. Which show was the most educational?
    a. Why?
17. What do you want people to be feeling when they come out of the Planetarium?
18. What does the Planetarium offer that other venues (Museum exhibits, IMAX Theatres etc) do not?
19. What would the world be missing without planetariums?

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