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Modern Projection Planetariums as Media of Iterative Reinvention

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Abstract

In its history, the modern planetarium increasingly was subject to radical changes. In the early years (1923-1950) a planetarium's artificial horizon was shaped as a recognizable skyline. The handcrafted silhouettes with increasing frequency had been supplemented, and later replaced by projected panoramas. Not only rendered visual mismatch of fixed skyscrapers in front of projected (e.g. lunar-)panoramas—a '*(con-)fusion of horizons*'—handmade skylines disturbing, but also those no longer corresponding with the present true constantly changing city-skylines constituted incongruity. Even the horizon's horizontality was lost, since—due to the fusion of IMAX-dome-cinema and planetarium (first consolidated in San Diego, 1973)—the dome was *tilted*, entailing an tilt of the auditorium level: a truly *unstable platform*. A transition from concentric to unidirectional seating correlated with that to ascending seating. The *cinema-planetarium*-fusion then initiated a profound transition towards new program diversity far beyond astronomy. In a classical planetarium one also had to wait until the eye's *dark-adaption*-process transgresses the *transition* point from *cone-* to more sensitive *rod* photo-reception. The resultant dramaturgy of an uncircumventable *transition period* opposes instant gratification associated with many new media of immediacy. Recently, with significantly brighter fiber-optic-stars, waiting for dark-adaption became obsolete; the specific *aesthetics of transition* itself was subject to transition. Boston's Planetarium reopened as digital multimedia theater in 2011. With a video-full-dome-system complementing the new ZEISS star-projector, it is a 'melting pot' of disparate media technologies. Formerly labeled '*cultural dinosaurs*' confronting media competition, planetariums, more recently having turned from astronomical lecture halls into hybrid multimedia arenas, have overcome their *former antiquatedness*.

The only constant thing is change (ARTHUR SCHOPENHAUER)

Variation is the spice of life.

Tempora mutantur, et nos mutamur in illis.

Promising Beginnings

The trendsetting lightweight construction of the very first true, unsupported *geodesic dome*, enveloping a maximum of space with a minimum of material¹, was designed by German ZEISS-engineer WALTHER BAUERSFELD for the first tentative planetarium construction² on the rooftop of the *ZEISS Optical Company* in Jena in 1923, back then however not yet named *geodesic dome*³, but *ZEISS DYWIDAG dome*—even so three decades before architect, inventor, and futurist RICHARD BUCKMINSTER FULLER, *apparently independently*⁴, has (re-)invented, perfected, popularized, and U.S.-patented this constructive form in 1954⁵. BAUERSFELD's apparatus, which also included the invention of the unique ZEISS planetarium *projector*, evolved into the first permanent public modern projection planetarium on top of the tower of the *Deutsches Museum* in Munich in 1925.

There is a striking structural analogy between the conception of the reticulated dome and of the projector itself. JOACHIM KRAUSSE concludes: “There is thus nothing accidental about the correspondence between the projector and the projection wall; it derives rather from the concept of projective geometry.”⁶

Tentative Architecture for Heaven’s Tent

The media history of the modern planetarium can be further illuminated by studying unrealized, eschewed alternative concepts. The concept of the planetarium dome screen had nearly followed a different track of construction. BAUERSFELD pointed out in 1922:

“At first we thought of a construction along the lines of a circus tent. But that was ruled out because canvas, like all textiles at that time of very high inflation, was much too expensive. By contrast, steel, being a purely German product, was very low in price.”⁷

Pre- and Para-Planetariums

Nowadays, there are about 3000 projection planetariums all over the world⁸. ÉTIENNE-LOUIS BOULLÉE’s monumental, never built *Cenotaph* for ISAAC NEWTON, which would have been a 150 meter hollow-sphere, can be considered a planetarium *forerunner*. RICHARD SENNETT explicitly compared it to “a modern planetarium”⁹. This revolutionary proto-planetarium’s dome would have been pierced by “funnel-like openings”¹⁰, which embodied the artificial stars—which hence would have been illuminated by light from outside by a real star: the sun.

More direct historic antecedents of the modern planetarium had been hollow-sphere walk-in celestial globes served as media of the starry skies, like the *Gottorp copper Globe* (1654), ROGER LONG’s *Uranium* at Pembroke College, Cambridge, U.K. (1758) where stars were represented by tiny holes, and the *Atwood Sphere* of the *Chicago Academy of Sciences* (1913)¹¹.

While in Europe, since its inception in 1923 a downright boom of *projection planetaria* had commenced, the first planetarium of the U.S. (Chicago) opened in 1930: a seven year gap and transitional era with no U.S. ‘access to *virtual space*’. The first planetarium outside Europe, opened in Moscow in 1929. In the United States of America the first modern planetarium was the Adler Planetarium, Chicago in 1930, followed by, to name but a few, the Fels Planetarium, Philadelphia in 1933, the Griffith Planetarium, Los Angeles in 1935, the Hayden Planetarium, New York City in the same year, the Buhl Planetarium, Pittsburgh in 1939 and the Morehead Planetarium, Chapel Hill in 1949.

Yet, as early as in 1925 FRANK LLOYD WRIGHT, who also wrote “I was interested long ago in the planetarium as an architect’s problem”¹², has drafted the (as well unrealized) *Gordon Strong Automobile Objective*, intended to be erected on the top of Sugarloaf Mountain, Maryland, with a drivable spiral-ramp going round a planetarium building, a sort of precursor of his later New York *Guggenheim Museum* (1959). This automobile planetarium hence would have related the contemporarily still quite novel (auto-)mobility to the aimed-at utopian climax of mobility in the longing for space travel.

Fluent Passages: to See or Not to See Transitions of Stellar Positions

According to CHAD RANDL already in the Roman Empire there had been ‘media architectures’ *avant la lettre*, which simulated the starry skies inside a built dome: quoting SUETONIUS, RANDL reports on the supposed existence of a “banqueting room” inside of

Emperor NERO'S *Domus Aurea* which "was circular, and revolved perpetually, night and day, in imitation of the motion of the celestial bodies". Yet, then he confronts SUETONIUS'S early historiographic depiction to real finds:

"When a large octagonal hall was discovered [...], it was declared a likely candidate for the legendary rotating dining hall. This vaulted room surely was a showcase space [...]. Because nothing in the room suggests the former presence of rotating apparatus, some have suggested that the dome's wide oculus was covered by a lantern with constellations illustrated on its underside, and that this lantern rotated on wheels or rollers [...]"¹³

This pre-planetarium can be seen as a direct antecedent of the technique which the modern planetarium still principally uses for its *'fast' motion time lapse* simulation of the firmament's *apparent circumpolar rotation*. This is traditionally accomplished by a *rotating projection*, as the whole *magic-lantern-like* projector itself 'simply' *slowly rotates* mechanically. Hence the classic planetarium's *'moving image'* of the firmament's rotation technologically also more correctly should rather be called *'motorized image'*, as it is (still mostly) produced by means of an *already continuous* projection of the light, while the whole projector-system is 'simply' rotating mechanically rather than by the cinematographic *stroboscopic flicker* or the *'phi-effect'* (like e.g. accomplished by later full-dome video-projections).

Mostly this rotation is done only as 'fast' that it is very little above the edge of the motion threshold, close to the border between perceptibility and imperceptibility of motion. The perception of an artificially rotating projected firmament, when circling so slowly that one only can notice the transition of positions each time *ex post* but not the motion as a motion as such, then directly refers to and problematizes the temporal resolution capacity of the human experience of transition itself. This 'visual effect' makes aware the perceptual limitations of transition noticeability and simulates a sort of 'change blindness' which we also suffer from in view of the apparent circumpolar motion sequences of real celestial bodies (one full turn then lasting even 24 hours), being too slow for human motion perception.

Transition from Echoes to Cosmic Silence

Furthermore, disturbing echoes had been a basic problem in the early era of the modern planetarium. ALISON GRIFFITHS notes: "the first dome in Jena had poor acoustics [...]"¹⁴ Its interior just consisted of a concrete shell, painted white inside, and this brought about reverberation lasting up to 20 seconds: a serious problem when one wanted to give astronomical lectures under the dome. Brilliant imaging was confronted with miserable acoustics. The problem was finally solved by installing projection screen domes made out of sound-absorbing, perforated sheet steel plates, initially in Philadelphia in 1933, and subsequently in New York, Tokyo, Chapel Hill and Pittsburgh.

Beyond the reduction of reflections inside the dome, also the acoustic insulation against noise from outside of the building by sound-proofed walls was a constitutive factor of the altogether atmosphere. This also had a symbolic character. GRIFFITHS reports that after its opening in 1935, about the New York City's Hayden planetarium's acoustic ambience it was said: "Even if you don't like stars, you ought to come here, because it's probably the quietest spot in New York"¹⁵.

Planning Planetariums and the Necessity for a Chance for Change

“For the first time in history the *physical survival of the human race depends on a radical change of the human heart*. However, a change of the human heart is possible only to the extent that drastic economic and social changes occur that give the human heart the chance for change and the courage and the vision to achieve it.”¹⁶

—ERICH FROMM, *To have or to Be?*

Contrasting the in each case exaggeratory reactions and expectations in response to the advent of a new media technology, DAVID THORBURN and HENRY JENKINS conclude:

“Similar utopian and dystopian visions were a notable feature of earlier moments of cultural and technological transition—the advent of the printing press, the development of still photography, the mass media of the nineteenth century, the telegraph, the telephone, the motion picture, broadcast television.”¹⁷

All the same the advent of the planetarium as a new media technology also provoked enthusiasm as well as opposition and refusal. The initial European *planetarium euphoria* in some places very soon changed into its opposite. For instance in the case of the plan to construct a new planetarium for Hamburg (Germany) in 1929, the pros and cons, the promises and the expected perils of a new planetarium initially seemingly turned the scales against the planetarium (which though later was installed into the old Hamburg water tower). A group of conservatives voted against the intended planetarium construction in a note which is:

„Meine Freunde haben schon früher die Errichtung des Planetariums in Hamburg abgelehnt, weil wir uns eine solche Ausgabe nicht leisten können. [...]. Das Planetarium ist eine Modesache; in anderen Städten werden sie kaum noch besucht.“¹⁸

This argument of the planetarium opponents against the construction of a planetarium therefore basically was a capitalistic one, as their pamphlet purported that a planetarium was much too expensive and hence ‘unaffordable’, and that it allegedly was only an ephemeral ‘temporary fashion’, which ‘in other cities’ putatively was ‘hardly any more attended’ by visitors.

Hence, a similar principle like that which BRIAN WINSTON called the ‘*law of the suppression of radical potential*’¹⁹, and which already NORBERT WIENER once explained in another, broader context, was as well an obstacle for the implementation and spread of planetariums. WIENER likewise elucidated:

“Before inventions are made available to mankind at large, there must be a way to promote them. [...]. If the inevitable risks of a technical change are centered too closely about those people who originally make the change, and there are no countervailing means to protect these entrepreneurs, no one will dare take the risk. Under these circumstances [...] a new idea or new technique will become a will-o'-the-wisp, always just out of reach of the times.”²⁰

Adaption of the Simulation to the Metropolitan Transition to Light Pollution

But planetariums proved to be anything but a ‘temporary fashion’. They did not become transitory media as expected by the opponents in the Hamburg of 1929, but rather settled institutions, as until today about 3000 planetariums²¹ all over the world show an ideal artificial night sky while the real one is more and more opaque due to metropolitan *light pollution*²², “with clouds, haze, reflected city lights and refractive index gradients all degrading seeing on far too many nights.”²³

As a reactive response the artificial ‘horizon illumination’ in planetariums can again re-simulate nocturnal man-made metropolitan light pollution as well as it is also apt to simulate the gradation of the civil dawn, the nautical dawn, and the astronomical dawn (with the sun 18 degrees below the horizon), prior to proceeding to the perfect darkness of the artificial *night by day* in the planetarium: a re-enactment of the real gradual transition to nocturnal darkness. CHARLES HAGAR notes:

“The entire horizon [in a planetarium, *my addition*] can be illuminated by means of six projectors fixed to the instrument supports [...]. The illuminators for the eastern and western horizon are of course most frequently used so simulated twilight. [...]. All six can be used in unison to represent the horizon glow from a city at night, gradually tapering off to darkness at the zenith. [...]. Realism has come full circle, for now even the effects of man’s light pollution upon the night sky can be reproduced!”²⁴

JIM SWEITZER therefore also stresses a planetarium’s “opportunity to re-connect to the night sky from which modern light pollution has deprived them.”²⁵ Already WALTER BENJAMIN referred to the profound relation between unimpeded *vision* and the cosmos, when he wrote about “the exclusive emphasis on an optical connection to the universe, to which astronomy very quickly led [...]”²⁶ This modern, exclusively ‘optical connection to the universe’ itself, according to BENJAMIN, is again a result of a cultural transition, as „nothing distinguishes the ancient from the modern man so much as the former’s absorption in a cosmic experience scarcely known to later periods. [...]. The ancients’ intercourse with the cosmos had been different: the ecstatic trance [Rausch].”²⁷

Culturally Constant Conventions Shaping the Constellations

“*But I am constant as the Northern Star,
Of whose true-fixed and resting quality
There is no fellow in the firmament.*”²⁸
—William Shakespeare, Julius Caesar III, i, 60

While media culture in general nowadays may be seen as “a ceaseless spectacle of transition” (THOMAS PYNCHON, 1997) the *main subject* of planetarium shows (despite all newer program diversifications), the *everlasting firmament*, is the very contrary of all transitions and impermanence.

Contentwise, classical planetarium shows, addressing the brevity and finitude of human life and culture in contrast to the eternal cosmic timeframe and the infinity of universe, therefore explicitly bring to mind the relative instability of culture(s).

The constellations of the firmament by contrast are the very epitome of conceivable constancy and phenomenological persistence. In a human lifespan no (internal) transitions

can be observed in the uniform, unvariable, seemingly firmly established light-dot-patterns of the firmament. Not entirely coincidentally the term ‘*firmament*’, from the Latin *firmamentum*, itself means a ‘firm or solid structure.’ Not only that the visual appearances of the *asterisms* and *constellations* do not visibly change their locations and relations in a human life time, and even still not when observed for many centuries, but also the *cultural ascriptions* which lend the stellar light-dot-patterns their constellation-names (and the so-called ‘constellations’ indeed are nothing more than arbitrary attributions) remained consistent and unaltered for millennia.

Also the historical ascriptions of constellations are surprisingly stable; as DIETER BLUME explains, the constellations, being cultural positings and conventions, have been unaffected by historical transitions for more than 3000 years²⁹: they still are labeled identically as already in the ancient world. Also SIMON SCHAFFER explained that the imagined order, mentally projected into the stellar patterns, mentally and visually grouped together by cultural conventions to recognizable shapes like ‘Hunter Orion’, ‘Cancer’, or ‘Pegasus’ etc., were the very representation of changelessness, eternal validity and invariance³⁰, an utopian counterpart to the incomparably more volatile transitions of human culture. And as MICHAEL LYNCH and SAMUEL Y. EDGERTON remarked, the once established constellations “still persist in modern Western civilization, prejudicing our perceptions to this very day.”³¹

Yet, PETER SLOTERDIJK resumed in this context that one basic *cognitive change* in the 19th century then again was that with the general alphabetisation the constellations passed out of minds and so the *pictorial scripture in the night sky had from then on few readers any more.*³² Planetariums in return revitalize the ability to (mentally) see or ‘read’ the constellations. Of course one cannot place a simple equation between reading a text and analytically viewing images. The somehow misdirecting metaphor of reading the sky must not refer to a textual model of reading. The only so to speak ‘textual element’, really ‘readable’ in the sky would be the so-called ‘skies W’, composed of the five main stars of the ‘w’-shaped constellation *Cassiopeia*.

The Planetarium as Sanatorium for Metropolitans: A Cosmopolitan Distance Simulator or the Restitution of Remoteness

ABY WARBURG associated civilization is with the gain of distance. According to WARBURG, CHRISTOPH ASENDORF resumes, only he who withdraws from the sphere of immediacy obtains space for sovereign action³³. Maybe it is not entirely coincidental that in the same year when the planetarium was invented, in 1923, WARBURG accused the modern media (of communication) of being “ominous destroyers of the sense of distance”, and lamented that “Telegram and telephone destroy the cosmos.” He complained about the loss of “the space required for devotion and reflection: the distance undone by the instantaneous electric connection.”³⁴ Being established just in the *Roaring Twenties*, and first and foremost featuring the display of *stellar distances* beyond common reach, the planetarium, as it were, can be thought of as a counteragent, or compensation against the distance-threatening density and closeness of the contemporary modern metropolis, about which GEORG SIMMEL two decades earlier wrote:

“The mutual reserve and indifference, [...] are never more sharply appreciated in their significance for the independence of the individual than in the dense crowds of the metropolis because the *bodily closeness* and lack of space make intellectual distance really perceivable for the first time.”³⁵

The planetarium, at that time dedicated solely to the representation of the firmament and outer space, therefore also was the very medium of the *display of distance* per se: The appearance of an indistinguishable *distance* of all heavenly bodies *far beyond* stereoscopic visibility, this *trans-distant sight*, as I want to call it here, where all objects seem to be equally far away so that often “the planets in our Solar System are [...] mistaken for bright stars”³⁶—EDMUND HUSSERL called this phenomenon „*homogenization of celestial distances*”³⁷—is approximated in planetariums with large domes. This parallaxic invariance, which also means that one actually sees the firmament with *two eyes* indistinguishably in the very same way *as if* one would see it with only *one eye*, is also reflected in what GEORG SIMMEL wrote in 1908, pondering on the:

“fact that a sense which in practical life is so exclusive as the eye, [...], nonetheless does indeed have a content—the sky, the sun, the stars—that is absolutely not exclusive, and which offers itself *uniformly* to everyone.”³⁸

The Planetarium as ‘Aurarium’

While WALTER BENJAMIN relates his definition of ‘*aura*’ also to the horizon, saying that ‘*aura*’ is “*the unique apparition of a distance, however near it may be. To follow with the eye [...] a mountain range on the horizon [...]*”³⁹ then this also would be applicable to the *artificial horizon* in the planetarium, and *all the more* to the artificial stars, seeming immeasurably remote, though actually being nothing more than light dots only some meters away: indeed *an apparition of a distance however (physically) near*.

Fading Skyline Silhouettes

“We must prepare for parting and leave-taking
Or else remain the slaves of permanence.”
—HERMANN HESSE, *Stages*

“The stone that is rolling can gather no moss;
For master and servant oft changing is loss.”
—THOMAS TUSSEK, 1524?-80

In its history, the modern planetarium increasingly was subject to radical changes: In the early era of planetariums (1923-1950), *artificial horizons*, shaped as specific *city-skyline silhouettes* with recognizable *gestalt*, urban fingerprints, had been “a *standard feature*”⁴⁰. ALISON GRIFFITHS describes the interior of the *Hayden Planetarium* as follows:

“When the Hayden Planetarium opened in 1935, it featured a silhouette of the skyline of New York, which was cut out of the steel perimeter. The horizon was constructed from panoramic photographs taken in infrared light just inside Central Park and showed the AMNH on the west, Fifth Avenue buildings to the east, trees to the north, and skyscrapers of downtown to the south.”⁴¹

In retrospect, however, the history of the artistic design of artificial horizons in modern projection planetariums on the whole can be comprehended as a *history of losses*. Since the 1950’s, optically *projected panorama* horizons have begun to replace the physical, cut-out skylines. Dramaturgic and stylistic considerations led to an overturning

and omission of the artistic concretizations of the horizon, and with increasing frequency to a transition from handcrafted cut out silhouette skylines to replacing projected panoramas. ALISON GRIFFITHS elucidates:

“Some urban planetariums eschew ‘true city skyline’ panoramas, though, for the simple reason that an irregular skyline renders panorama projection difficult; others, such as the Fels Planetarium, [...] Philadelphia, believe that removing the skyline heightens the verisimilitude.”⁴²

And also CHARLES HAGAR makes clear the reasons for the sacrifice of the material embodiments of the planetarium horizon for the benefit of immaterial panorama projections:

“Many planetariums have a cut-out skyline silhouette along the horizon. [...]. In recent years, with the addition of multiple-effects projections and horizon panoramas, it has been discovered that the presence of a permanent skyline silhouette at the base of panorama will detract from the realism of the projection. It is somewhat incongruous to see skyscrapers, smokestacks and trees at the base of lunar mountains! The majority of the newer planetarium domes are left completely even at the base. If local skylines are desired, they are projected photographic panoramas.”⁴³

But not only the visual mismatch of fixed skyscrapers in front a projected panorama of the moon caused an inappropriate literal ‘*fusion of horizons*’, or rather a *confusion of horizons*, but already the lesser incongruity of *wrong time skylines*, *outdated* planetarium skylines which do not correspond anymore to the *present true city skyline*. For example GLENN A. WALSH, referring to the *Buhl Planetarium*, Pittsburgh, reports:

“For Buhl, which is located on Pittsburgh’s North Side a little less than a mile from the city’s Golden Triangle (Downtown), the part of the dome which usually displays the southern sky [...] had an etching of the Downtown skyline from 1939. By the 1950s, Pittsburgh was undergoing a building boom (known as ‘Renaissance I’) which radically altered the Downtown skyline. Eventually, Buhl removed a small section of the bottom part of the dome (around the entire 360 degrees) so the obsolete skyline would no longer be visible; panorama views of the city, as viewed from Buhl, were projected onto the dome from then on.”⁴⁴

The benefit of the handcrafted skyline’s abolition then also was to be independent from the ever quicker transitions of modern skylines. As GRACE GLUECK once said about the other vertical city: “New York’s skyline is, for better or worse the very definition of change.”⁴⁵

One less bewailing and regretful interpretation of this transition could be the perspective that the abandonment of the skyline silhouettes also is an expression of a renunciation of a sort of *horror vacui* in the earlier planetariums, compensatorily filling up the open space of the big picture of an empty universe by an in turn all the more densely packed pictorial skyline at the margin. Moreover, the horizon’s material concretizations by materially modelled skyline props at the dome’s lower edge also meant some kind of *secularization* and profanation of the overall picture of the heavens.

Even FRIEDRICH SCHILLER's line of thought, could be quoted for an apology of the abolition of the shaped horizon in contemporary planetariums. SCHILLER reasoned:

“if one removes all objects from the horizon which especially attract our attention, if one conceives of a wide, continuous plain, or an open sea, the horizon itself becomes an object, and indeed the most sublime which can ever appear before our eyes.”⁴⁶

Hence only the unadorned, naked artificial horizon then would be the very model of sublimity, and hence the transition to bald planetarium horizons esthetically ‘consistent’.

The Loss of Horizons *or* the Fusion of Cinema & Planetarium under one Umbrella:

Still more radical and paradoxical, even the *horizon's horizontality* was lost since—due to the technical requirements for compromises with the integration of a planetarium and an IMAX-dome-cinema under one dome—the whole dome screen, including its horizon, of many modern planetariums has become *tilted* as much as 30 degrees, for the first time at the *Reuben H. Fleet Space Theater*, San Diego, in 1973. This, ‘disequilibrated’ artificial horizon hence utterly expelled the horizon as a standard feature and an artistic subject from planetariums. The tilt of the dome consequently also entailed a tilt of the auditorium level, leading to ascending seating: a truly *unstable platform*.

Then, the historical transition from concentric to unidirectional seating also correlates with the transition from *untilted* to *tilted* dome screens and therefore with that to ascending seating.

The classical *concentric* seating arrangements of planetariums can be attributed to a *democratic dispositif*⁴⁷ how it is also found in many parliaments, and can be traced back to *ancient* circus, and theater seating. Historically the concentric planetarium seating, encircling the centered projector, often was abandoned in favor of *unidirectional* seating. Unidirectional seating by contrast can be correlated with the lineup of *modern* theater/cinema seating, originally tracing back to the array of church choir stalls.⁴⁸

JORDAN MARCHÉ goes into detail when he states that an important

“design innovation, which bore immense practical significance to the space science classroom, prompted traditional concentric seating patterns in planetaria to be abandoned. This development arose from a compromise struck between the planetarium's circular architecture and the pedagogical features of a standard classroom that emphasized a teacher-directed focus. [...]. The circular seating pattern, ‘so firmly entrenched in classic planetarium design[,] was increasingly recognized as a handicap to good instructional geometry and was replaced with a succession of ‘unidirectional’ seating patterns,’ which allowed all students to face in roughly the same direction.”⁴⁹

Unidirectional seating in the planetarium mostly aligns the spectators's viewing direction towards the *artificial south*, as the south is the astronomically most interesting direction of the firmament of the northern hemisphere. The artificial south of the planetarium sky not necessarily corresponds to the real south.

However the *concentric* seating and the *untilted* dome all in all though were more adequate for *astronomical* presentations.⁵⁰

The first actual combination of *film projection* and *planetarium projection* was experimentally tested with the inclusion of the *daytime sky* beneath a planetarium dome in the *Fleischmann Atmospherium-Planetarium* at the University of Nevada, Reno (UNR) in 1963, where for the first time a fisheye lens film projection of the daytime sky with time-lapse pictures of weather phenomena was applied. “Reno’s atmospherium-planetarium remained unique”⁵¹ as a planetarium which could simulate both, day and night phenomena and which applied film projection in combination with planetarium projection, until in 1973, the general fusion of planetariums and IMAX-dome-cinemas took its course as standard with the opening of the *Reuben H. Fleet Space Theater* in San Diego, also initiating a novel program variety and diversity beyond astronomy.

Yet, the initial distinction between cinema and planetarium ideologically, as it were, disguised its media theoretical shared identity as places of projected images. While *Early Film* often still was presented at different, partly unspecific hosting performance spaces like in vaudeville theaters and shop cinemas (‘Ladenkinos’), the planetarium from the very beginning had its own *special building* exclusively built for its own purposes. But nevertheless, in few instances as in the old *Berlin Planetarium* (1926-1945) already a culture of coexistence of cinema *and* planetarium shows *avant la lettre* occurred when frequently after each planetarium performance the dome screen was re-used for movie shows in order to increase the earnings⁵²: in those days an esthetic inconsequence as a consequence of capitalism.

1989: Transition Completed or a Preliminary End of Illusion Enhancement due to Reaching the ‘Absolute’ Maximum of Illusion in Imaging Artificial Stars

Comparing the representational characteristics of planetarium vs. film projection, one always also has to consider “how each phenomenon was discursively constructed as a superlative conveyor of illusion”⁵³. In the following it will be explained why the planetarium historically, although the “film projector was from its inception often referred to as nature’s ally”⁵⁴, as it were has won this *paragone*. SIEGFRIED KRACAUER’S prime example for realism or naturalism, i.e. that one of the film being able to capture ‘the ripple of leaves in the wind’ can e.g. be compared to planetarium *star scintillation* simulation: the naturalism of artificially twinkling stars is an even more subtle phenomenon reproduction than the cinematic representation of the ripple of leaves. Much more decidedly and necessarily than cinema, planetarium esthetics basically had been assigned to the ‘*realistic tendency*’ than to the ‘*formative tendency*’.⁵⁵

Even compared with VR-environments and IMAX dome systems the planetarium is the most illusive image technology ever, concerning the naturalism of the firmaments image.

The projected planetarium stars, alike the real ones minimal visual units, or as it were *pixel* ‘*avant la lettre*’, appear only in six discriminable brightness nuances (‘*apparent magnitudes*’ *m*) to the *naked eye*, which has a maximum visual resolving power of about 1 minute of arc as a perceptual bottleneck.

The historic main goal of planetarium technology has always been to minimize star diameters for perfect naturalistic illusion. Unlike the first ZEISS projector of 1923 with an angular resolution of about 25 minutes of arc for the brightest stars, still seen clearly as discs (coin-sized—*Pennies from Heaven!*), modern fiber optics (since 1989) can project “diameters subtending one minute of arc, so that all stars appear as needle-sharp, beaming points.”⁵⁶

Historically, to minimize star diameters, first *tiny holes*, at first *punched*, later *cauterized* into (copper foil) *star field plates*⁵⁷ for the projection, embodied and shaped the synthetic stars. Initially one tried to use astro-*photographs*⁵⁸, but because of the *emulsions*'s *insufficiency* of uniformity, opacity, and heat stability⁵⁹ subsequently planetarium stars were produced by a '*stencil of manufacture*', not by the "*pencil of nature*"⁶⁰. Thus mapping nothing more than location and brightness of light dots the *manufacture* of the photorealistic naturalism of the planetarium's firmament depicting is paradox: although the *perceptual result* is an entirely *photorealistic* impression, the *production method* is very different from photography's status as an indexical trace of light⁶¹.

As for the most natural impression, the apparent diameters of the artificial stars have to be below or in the order of the human eye's resolving power of about one minute of arc, the 1989 introduced fiber optics technology *changed the level of illusion* in planetariums *categorically*. The unmatched smallness of fiber stars even was tested successfully in the 100 m dome of the *Stockholm Globe Arena* in 1990.

JONATHAN GILMORE, referring to a theory of realism as resemblance and especially to its rejections by NELSON GOODMAN, notes, that the resemblance view of pictorial realism need only be committed to describing a relation in virtue of only certain optional features of a depiction and what it depicts "such as color, shape, and scale, but *not* felt texture or *absolute size*."⁶² However in the special case of the planetarium's image of each single star, the otherwise factored out criterion of *absolute size* is then fulfilled, as below the resolution threshold of the human eye, where the sizes of modern 'fiber-stars' do rank, there are no further relative internal size differences visible. Hence the visual appearance of the fiber-stars is always already '*true to scale*' and features *absolute size* for the eye, therefore complying an elsewhere in visual media rarely locatable criterion of resemblance.

One has to keep in mind that real stars (in contrast to other celestial bodies like planets)⁶³ due to the laws of physics and the limitedness of optical lenses *can never be* optically or telescopically magnified in terms of angular measure ever: they always appear as nothing but *punctiform*.

Furthermore the fiber-stars engender the typical optical diffraction phenomena *inside* the eyes of the beholders.⁶⁴ The actinoid appearance also of these artificial stars with *diffraction spikes* and/or *diffraction discs* emerges and is due first and only to the diffraction within the vitreous body of the beholders's eyes and also at the eyelashes.

With GERHARD SCHULZE, referring to the 'game of expansion' of technological progress and enhancement, has shown, using the example of *razor technology* that in some cases a technological climax⁶⁵ recently has been reached which cannot be increased any further. This is comparable to the fiber optics technology for projecting planetarium stars below the retinal resolution threshold. Just alike modern electric razors cannot increase their function and performance any further, as they cannot do more than shaving absolutely smoothly, so the planetarium projection technology, projecting perfectly illusive fiber star dots beyond visual resolution since 1989, cannot further enhance this peak of an already maximum visual illusion. The historical goal of this media technology as it were has been already reached in 1989, and media technological transition has come to an end at least in this respect.

Transition to Experimental Laboratories

But in fact the planetarium's artificial firmament even before this achievement of maximum illusion had reached a very high degree of deceptive visual quality: One of the first theoretical treatises on deception (by illusion and simulation) in history is the *Zeuxis-*

anecdote in Pliny the Elder's *Natural History*: "In a contest between Zeuxis and Parrhasius, Zeuxis produced so successful a representation of grapes that birds flew up to the stage-buildings where it was hung."⁶⁶ Just alike the fictional birds in this inauguration text of the discourse on illusion-theory, appropriately enough, of all creatures, it were real *birds*, which had been *deceived* by a planetarium projection in the history of science when their migratory orientation has been studied. Research observing the "abilities of migratory birds to use celestial cues for navigational purposes"⁶⁷, first on warblers in Freiburg and Bremen in Germany (1955), then at Cornell University's and at Longway Planetarium in Flint, Michigan, on indigo buntings (1964), has proven "by selecting an arbitrary bright star (Betelgeuse in the constellation Orion) as a fictitious celestial pole"⁶⁸ that the birds use "gestalt recognition of stellar patterns in the vicinity of the celestial pole."⁶⁹ While Astronomy itself was transformed from an observational field science to an image-processing laboratory science⁷⁰ with the introduction of the photographic plate and especially with the advent of charge-coupled device (CCD) chips (1976), it still has not become an experimental science. By deceiving and manipulating birds with visual representations, *Planetariums however indeed actually customized the heavens for experiment*⁷¹. Planetariums evolved into proper *experimental laboratories* for empirical research by deceiving birds with a virtual reality illusion—thus the discursive history of illusion/simulation (i.e. the *Zeuxis*-anecdote) has come full circle with perceptual reality.

The Transition from Straight Backed Chairs to Reclining Chairs

"In re-creating the created,
Lest fossilize the animated,
Aye, active power, is manifest"⁷²
—J. W. v. GOETHE, *One and All*

Formerly, in planetariums, straight-backed chairs were used regulatorily in order to prevent the visitor from *sleeping*⁷³. Yet, after planetariums designers realized that the constant neck-craning for itself was indeed *bodily fatiguing* and all too inconvenient, a concrete *re-regulatory practice*, influencing the interior design, was introduced: the installation of *reclining chairs* into planetariums. GRIFFITHS describes the historically changing *sit-uation* of problematizing the adjustment of the planetarium visitor's body, varying between a focus on comfort, and a focus on keeping away *sleep*, since 1935:

"[R]esearch was conducted on the best seating to install, chairs that would support the neck while not impinging upon the unobstructed view. [...]. Several prototypes were tested for the 742-seat Hayden Planetarium [...], 'all suggestions—and they ranged from the *chaise longue* [*sic*] through plain backless chairs, with head rests—were carefully considered."⁷⁴

It was realized that the constant neck-craning is quite inconvenient in the long run. The perils of forcing the audience to always rick their necks led to reconsidering new forms of seating arrangements. CHARLES F. HAGAR likewise describes:

"Seating comfort has recently been given careful thought by planetarium designers. The chair in which the planetarium visitor sits for about an hour has been neglected for far too long. In some of the earliest planetariums, straight-backed chairs were used! Perhaps it was thought that if the seats were too comfortable the visitor would

go to *sleep*. [...] In a planetarium [...] the center of interest can be *anywhere* on the dome. [...]. New chair designs included built-in headrests and backs that tilt. Also seats which have swivel capability in azimuth have successfully been used at a number of planetariums for some years.”⁷⁵

In this context, the process of *iterative re-invention* of the planetarium’s design was already triggered as early as in 1939. Already soon after its opening in 1935, New York’s Hayden Planetarium was in danger of becoming obsolete and outdated. As PHILIP GROCE explained,

“within a few years after its 1935 opening, the then new Hayden Planetarium was considered a failure with low attendance and a huge debt service. In a report, Robert Moses, Commissioner of Parks for New York City, outlined a number of solutions to trustees. Among the solutions seriously considered was closing the Hayden Planetarium forever.”⁷⁶

Thus the Hayden Planetarium appointed NORMAN BEL GEDDES, who designed the *General Motors Pavilion* for the *World’s Fair* of 1939, to give recommendations for re-inventing the Hayden. BEL GEDDES—who also voted against the circular, concentric seating—then analyzed the putative problems of the planetarium’s apparatus and design and declared:

“Obviously from a quarter to half of the entertainment which the audience is watching takes place directly over their heads or behind them. The cumulative effect of constant neckcraning is in conflict with a basic element of theatrical technique: the audience must be in a state of relaxation in order to give sway to their imaginations and emotions”.⁷⁷

Neglecting the constitutive role of that very *re-enactment* of the *upwards* viewing direction likewise under the artificial sky (be it reclined or not) for the illusion-intensifying altogether *reality effect*, BEL GEDDES furthermore made a quite eccentric proposal for reducing the incommmodity of constantly having to look up at the dome. He proposed “turning the dome upside down and putting a glass floor over it so that stargazers could merely look down between their legs.”⁷⁸ ALISON GRIFFITHS comments: “Not surprisingly, given the reverse direction of the gaze in this inverse dome (and a host of other logistical issues); Geddes’s proposal was rejected.”⁷⁹

Corpus & Cosmos

Not least the visitor’s reclined position in many newer planetariums is also an approximation of the “position of the body in zero gravity, sometimes called astronauts’ position”, with an “open angle ($128^\circ \pm 7.2^\circ$) between trunk and thigh.”⁸⁰

Lying reclined, compared with the unstable equilibrium of standing upright⁸¹, is a posture of stable equilibrium, but also defenseless, extradited, subjected. This additionally to the necessity to look upwards to the artificial sky further contributes to the constitutive humble mood of *immersion*⁸² in a planetarium. More generally the reclined position also is a relief, releasing perceptual capacity for exclusively focussing on visual perception.

And, there is also another original relation between sleeping, reclining and the planetarium idea. Pioneering American planetarium designer ARMAND N. SPITZ, who later, following an advice by ALBERT EINSTEIN concerning the ideal shape⁸³, developed a *low-*

budget planetarium projector, the dodecahedron shaped Spitz A-1 in 1947, according to JORDAN MARCHÉ, originally after “the birth of his daughter Verne, [...] wished to project the stars upon her bedroom ceiling as a means of providing entertainment and instruction”⁸⁴. This symbolically could be read as an anticipation of the eventually *reclaimed* ‘license to lie down’ (now on reclining chairs) in modern planetariums—after a long time of tacitly emulating (inappropriate) theatre and cinema seating conventions.

Night is for Sleeping: The Hypno-Narco-Cosmo-Nexus

Besides, one cannot avoid acknowledging the directly bodily sleep-inducing effect of a planetarium’s artificial *night by day*, especially when coming along with the newer reclining-chairs. JIM DWYER reported on the impressions of visitors of the new New York Hayden Planetarium:

“Leaning back in their semi-reclining chairs, the audience members [...] sat with their heads back, mouths half-open, a narcotic glaze in their eyes. [...] the epicenter of dozing would have to be the Hayden Planetarium”⁸⁵.

Here also the power of the deeply rooted “cultural prejudice against reclining”⁸⁶ (in public) finds expression, as many visitors typically with a guilty conscience admit that they got tired during the planetarium show:

“Ms. Thompson offered mitigating circumstances. [...] ‘We had a late night last night. [...]. Jonathan Dempsey [...] explained the hypnotic quality. ‘You’re lying back and it starts to go black,’ he said.”⁸⁷

Standing O(bservations)

Yet, there also is a planetarium, where one cannot sit at all, completely without seats, which invites the spectators to stroll about under the dome, which, to use words of WALTER BENJAMIN, as it were “becomes a dwelling for the *flâneur*”⁸⁸: The Saint Louis Science Center’s *James S. McDonnell Planetarium* (opened in 1963) with its central open area auditorium under the dome, without secluding surrounding walls, and without seating.

Boston’s Own Cosmos: Horizon-Set & Horizon-Rise

On February 13, 2011, Boston’s Charles Hayden Planetarium reopened as a digital multimedia theater with a full-dome video-system complementing the new ZEISS star-projector. It now ranks among the planetariums where the “resolution is so good that you can use binoculars”⁸⁹ for resolving some specific projected light dots, resembling stars to the naked eye, and when seen through real binoculars becoming discernible as highly compressed, projected extremely downscaled whole galaxies themselves: this new ZEISS projection technology makes it possible to project images of galaxies so extremely small that they cannot be distinguished from solely single stars by the naked eye, but actually can be seen resolved as images of whole nebulae and galaxies through binoculars⁹⁰. The application of binoculars under the planetarium dome is a media-reflexive *re-entry* of the telescopic instrument under the artificial sky, but also can be historically related to the theatrical apparatus integrating *lorgnettes*, or *opera glasses*.

The old Boston Planetarium was opened in 1958, and 30 years later, in 1988, the *HARVARD Crimson* quoted Professor of Astronomy OWEN J. GINGERICH, saying: “We don’t need [a planetarium] at Harvard, we have an excellent one right there”⁹¹. The old Boston

Planetarium once displayed the paradox phenomenon of *horizon-rises and horizon-sets*. While almost all other handcrafted planetarium skylines were made up of *silhouettes only*, Boston's planetarium horizon was a *solid and colored* model of the Boston-Cambridge skyline. According to GRIFFITHS, "using carefully modeled illumination and sixteen hydraulic cylinders, the three-dimensional horizon can be lowered out of sight when not in use."⁹² The Boston skyline, in particular, seems to be visually suitable and *apt* for this transition-aesthetics of ascension and descent, as the model then displays an intensified visual field of attention at the *top level* of the skyline, first *or* last visible when raised *or* lowered. This seems especially appropriate for Boston, considering KEVIN LYNCH's description:

"Most of Boston's distant landmarks, in fact, were 'bottomless'; they had a peculiar floating quality. The John Hancock Building, the Custom House, and the Court House are all dominant on the general skyline, but the location and identity of their base is by no means as significant as that of their top. The gold dome of Boston's State House seems to be one of the few exceptions to this elusiveness."⁹³

In|compatible and In|comparable Systems: The Planetarium *Dispositif* as a 'Melting Pot' or Grounded 'Constellation' of Disparate Media Technologies

As DAVID THORBURN and HENRY JENKINS also summarize: "In Jay David Bolter and Richard Grusin's influential formulation, all media engage in a complex and ongoing process of 'remediation,' in which the tactics, styles and content of rival media are rehearsed, displayed, mimicked, extended, critiqued."⁹⁴

Under the planetarium dome many different media technologies and artistic forms, instead of being historically, sophisticatedly *remediated*, rather are directly, simultaneously, and disparately combined to an almost post-modern patch-work aesthetics. In a planetarium—a therefore really 'universal medium'—the accumulation of diverse media technologies can be observed in pure culture. The *apparatus/dispositif* of the planetarium, showing the stellar constellations as projections on the dome screen, here, as it were, itself represents a sort of 'constellation' of heterogeneous media technologies in a complementary co-presence under the dome

Dispositif or *apparatus* here pragmatically and specifically means a spatial arrangement which positions the beholder in such way that his or her perception is defined and modified by this array and framing. Thus the concept of the *dispositif* or *apparatus* fittingly can be related to the notion of a *constellation*.

Ever since, the planetarium was an early place of intermedial synthesis *avant la lettre*. The Planetarium can be seen as the most integrative 'melting pot' (or rather:—explaining better the disparity—'salad bowl') of media technologies, compared with other media *dispositifs*. The sometimes indeed incompatible and esthetically unfitting single aesthetics of each used media technology nevertheless create the planetarium-specific ambience of medial diversity and undissolved side by side of most different media, a disparate clustering of *video projection*, *film projection*, multiple (panorama) *slide projection*, cut-out skyline *silhouette panoramas*, *live lecture*, *laser pointer*, *laser effects*, and the advanced modern high-end 'magic lantern' of the actual 'planetarium projector', the latter basically 'only' in charge for the projection of the firmaments light dots.

In the *constellation-dispositif* of the planetarium chamber it becomes evident that the integration of the different media by no means must automatically lead to an unquestioned dictate of esthetic compatibility or congruous convergence. Rather, as a consequence of the

obvious differences in the quality of illusion between the classical (Zeiss) planetarium projection of the firmament's light dots and the other projection technologies, be it slide panoramas or video full dome projection, this immense realism of the central planetarium projection becomes all the more *evident* by the direct and simultaneously visible 'paragonal' comparability. Here it also seems to be especially valid what KAY KIRCHMANN accented with regard to the enduring continuation of the classical esthetic '*paragone*' in modern media:

„While catchphrases like convergence, compatibility, and multimedia promise a peaceful union of formerly discrete media (or at least their uncontested and uncomplicated dissolution in the all-embracing binary code of the computer), the individual media themselves seem less than willing to stand by and observe how their dramaturgies and programs, genres, and modes of reception and perception, all of them distinct and with their own histories, are simply smoothed over. The opposite seems to be the case: they seem to insist on a re-evaluation of their merits and competence, and it is no mere accident that they revive the tradition of the *paragone*, and with it a discourse whose historical achievement of providing levels of differentiation is perhaps too readily negated in the current state of multimedia euphoria.“⁹⁵

Return to Traditional (Virtual) Virtues: The Digitization of Planetarium Programs and the Rediscovery of the Unique Characteristic of the Classical Opto-Mechanical Planetarium Projector

With the digitization of planetarium programs, at the latest triggered by the new era of the new New York Hayden Planetarium, opened in 2000, simultaneously a sort of reversion to the planetarium's classical key task, the precise and highest-resolution display 'only' of the *firmament*, was initiated. JIM SWEITZER hints at the fact that

“Ironically, before digital projection systems, planetariums could only accurately depict the geocentric model of the universe. But that has all changed with shows like those at the Rose Center's Hayden Planetarium, which fly people through a multi-scale, continuous data set from the earth to billions of light years in space.”⁹⁶

SWEITZER furthermore stresses specific advantages of the new digital video full-dome projection:

“Digital planetariums like the Rose Center's Hayden Planetarium and the Adler's Star Rider Theater use blended images from six or more video projectors to immerse audiences in 3D data sets. These data can be displayed in real time in both of these planetariums using high-end graphics computers.”⁹⁷

Yet, also SWEITZER again admits that beyond all new variety and the new limitless range of illustration facilities, seemingly paradoxically, a refocusing return to the traditional virtue of showing the artificial firmament with highest precision has become necessary:

“Planetariums immerse their audiences in panoramic views of outer space using dome-shaped theaters. As such, the experience is relatively unique, no matter what

the size of the planetarium or projection technology. Their traditional trump card for over seventy years has been simply showing the starry sky. All planetariums can do this and most audience members will say that this is one of the primary reasons they're there."⁹⁸

And so, even SWEITZER warns that planetariums should not forget to focus on this primary function while “unsuccessfully” trying to “imitate seemingly competitive media like PCs and television.”⁹⁹

Just because the possibilities of digital depictions ended up in a limitless range of options, the technologically unmatched precision of the classical planetarium projector was *revalued* precisely in times of high-end video full-dome projection, which despite all its technological sophistication could never compete with the precision and maximum resolution of opto-mechanical (fiber-)star planetarium projectors, concerning the firmament projection.

Also the director of the *Einstein Planetarium* in Washington D.C., CHERYL BAUER, noted: “Our traditional planetarium show guiding audiences through the nighttime sky with a pointer is still our most popular show.”¹⁰⁰

One basic characteristic of the transition from classical opto-mechanical planetarium projectors to video full-dome projection, to whatever extent with a high-resolution, is an extreme *regression* in realism of the representation of the firmament itself, in case it is projected by a video full-dome system. By far no digital projector can compete with the illusive quality of a classical fiber optics projector. And therefore, if also used for projecting the stars themselves, and not as a useful supplement to the classical star field projection, the ‘video-stars’ of new digital projectors like e.g. those of EVANS & SUTHERLAND *Digistar* projectors (since 1979) sometimes had mockingly been called “green fuzballs”¹⁰¹.

The most sensible solution chosen nowadays is to use the video full-dome projectors for all images except for the fundamental backdrop of the starry firmament: this remains reserved for the proper classical planetarium projectors, even though in these hybrid system combinations the classical star projector sometimes, compared to a permanent operation of the digital projectors, is used only for some seconds¹⁰²—then seconds of the “technological sublime”¹⁰³.

Transition from Didactical Lectures to Postmodern Entertainment

The planetarium also embodies a paradox place of secular sacrality/spirituality. Not least, according to GRIFFITHS, the “churchlike stillness and quiet of the planetarium”¹⁰⁴ furthermore contributes to this experience. She adds: “the upward ‘revered gaze’ is an extremely dense and potent sign, affirming the neo-spiritualist undercurrent of the planetarium as a quasi-temple of worship”¹⁰⁵. Planetariums constituted a virtual “shrine of the intellect”¹⁰⁶, as HORACE J. BRIDGES once formulated it. Likewise architect JAMES POLSHEK himself then rightly called his New York Hayden Planetarium “a ‘cosmic cathedral’”¹⁰⁷.

Besides, in Riga (Latvia), even a *real* church had been *converted* to a planetarium in 1964. A dome screen had been installed into one of the five cupolas of the deconsecrated Russian Orthodox cathedral (built in 1884)¹⁰⁸: a rather profane transition.

Similarly LORRAINE DASTON and KATHARINE PARK use the example of the planetarium for explaining a revived or still existing longing for *wonder* and *amazement* in the age of the ‘disenchantment of the world’ in terms of MAX WEBER:

“To be a member of a modern elite is to regard wonder and wonders with studied indifference; [...]. But deep inside, beneath tasteful and respectable exteriors, we still crave wonders. Sitting wide-eyed under a planetarium sky [...], we wait for the rare and extraordinary to surprise our souls”¹⁰⁹.

In this sense, also RAY BRADBURY’s criticism against one old planetarium show at the *Einstein Spacearium* at the *Smithsonian Institution*, Washington, D.C. (inaugurated on July 4, 1976), when asked to write a new program, must be understood.

BRADBURY bothered about the *boringness* of the old existing planetarium program there, and he criticized: “‘You’re *teaching* with this planetarium, instead of *preaching*.’ A planetarium is a synagogue, a church, a basilica [...] to celebrate the universe”¹¹⁰. BRADBURY’s polemic “You can’t shine the textbook on the ceiling”¹¹¹ can be correlated to an argument by JIM SWEITZER, who also hints at the difficulty of integrating (all that much) *narrative* into a planetarium performance which, maybe principally, as it were ‘by design’ is not really apt for ‘simply’ translating the big picture into *story-telling*:

“Although planetariums may not be the best medium for telling personal stories, they are the best for giving people the big picture and inspiring them with the vastness of space.”¹¹²

Also human spaceflight influenced the esthetics and programs of planetariums, such as the huge specific impact which the *Apollo 11* Mission in 1969 had on planetarium attendance: for instance the *Hayden Planetarium* NYC engaged air stewards dressed in spacesuit costumes and the “guests left with tray replicas of the plaque deposited on the moon and containers of space food”¹¹³.

Yet, particularly the *cinema-planetarium*-fusion then initiated a profound further transition towards new program diversity far beyond astronomy. The planetarium as an educational establishment originally for communicating astronomy with the public then historically more and more became an universal medium of general science communication, and consequently even of all kinds of performances (under the stars).

Housing both ‘hard’ scientific and ‘soft’ cultural programmes under one dome planetariums also helped pooling the *Two Cultures*¹¹⁴ of science *and* the arts/humanities.

Today planetariums have completely renounced from the monopoly of astronomy and offer programs ranging from so different contents like *Orchids*, DARWIN’s theory of evolution, as well as SF-trash-shows like *Alien Action*, or musical Laser Shows like *Queen Heaven*, *Pink Floyd*, or *Rock on Demand*: anything goes!

But already in the former times of restriction to astronomical topics it was true that, as CHARLES F. HAGAR summarizes, „there is no typical planetarium [...] Similarly there is no specific ‘method’ for producing a planetarium show. Each director has its own approach and philosophy.”¹¹⁵ Prior to the digitization and equipment of planetariums with full-dome video-shows, an internal recycling of images, i.e. of the panorama slides was a common custom.

Having to Wait for Vision: The Experience of Transition as a Dramaturgic Necessity

Moreover, planetariums address a completely different system of vision than all other visual media. One never can see all stars at a planetarium’s dome at once but inevitably has to wait for minimum 7 minutes until the less bright stars—albeit already

projected—become visible, because only then the time-course of dark adaption transgresses the so-called rod-cone-break¹¹⁶, the retinal duplex receptor system's transition point between detection via *cone-* and the more sensitive *rod photoreceptors*.

The resultant *retarding* dramaturgy of an uncircumventable *transition period* opposes instant gratification associated with many new media of immediacy. Hence the planetarium sight contributes to a (re-)establishment of a time-aware visual culture of *deferred gratification*, as simply *instant gratification* of the scopic desire here is physiologically impossible previous to dark adaptation. This dramaturgy of '*just wait and see*' could act as a beneficial counteragent against an excessive focus on instant gratification promoted by many new media where prompt perceptual accessibility is anticipated as a matter of course.

As for instance JOHN MAEDA, considering *simplicity* in media design stated, "the average person spends at least an hour a day waiting in line. [...]. Some of the waiting we do [...] can often be tense or annoying: waiting for a Web page to load [...]. No one likes to suffer the frustration of waiting."¹¹⁷ And, he goes on: "when forced to wait, life seems unnecessarily complex. *Savings in time feel like simplicity*."¹¹⁸ Hence the necessity to wait for one's own eyes to become dark-adapted before one is able to see the artificial planetarium stars seems to be an obsolete, untimely complex, but also at the same time all the more relaxing and subversive aspect of media culture.

The retro charme of the planetarium as a solitaire in our contemporary mediascape (which is focussed on efficiency and time saving) then also consists in this offering of an oasis of slowdown.

Rite of Passages or the Experience of Transition and Cosmic Travel

The internal bodily limitation of the uncircumventability of the dark-adaption's duration necessitates a synchronized dramaturgy of the planetarium performance's opening, often fulfilled by introductorily presenting the gradually darkening simulation of nightfall, as mentioned in the passage about 'horizon illumination'.

Alternatively, the visitor in the New York Hayden Planetarium, before being allowed to enter the proper planetarium chamber is led into an *anteroom*, a "darkened lobby", or "transition zone"¹¹⁹, which already is barely illuminated in order to acclimate the visitor's eyes to the darkness in advance. GRIFFITHS also describes the symbolic significance of such transition zones beyond the mere physiological requirements:

"In the same way that panorama designers created darkened corridors prior to entering the dome exhibiting the circular painting so as to enhance the illusion of spatial (and possibly) temporal relocation (and dislocation), so too did some planetarium architects use ramps upon entry into the dome to 'create the illusion of traveling up to see the stars.'¹²⁰

The Loss of the Need to Wait

Yet, recently, with significantly *brighter* fiber-optics-stars, this necessity of waiting for dark-adaption again became obsolete. The specific *aesthetics of transition* itself was subject to transition, and hence an important aspect of perceptual realism has been lost, since the new ZEISS *Skymaster* projector's fiber-optics stars are so bright that ZEISS can advertise: "Forget about dark adaptation times. The stars remain to be visible even during events requiring a certain level of ambient light."¹²¹

Built to Last for Eternity Instead of Planned Obsolescence

Formerly labeled ‘*cultural dinosaurs*’¹²², having been confronted to media competition with IMAX-cinema and VR-rides etc., planetariums more recently have turned from astronomical lecture halls into hybrid multimedia arenas, and therefore, seemingly paradoxically, have overcome their *former antiquatedness*.

In the face of all mentioned, attributed outdatedness and putative obsolescence of planetariums the projection technology itself never had really become obsolete. Just the opposite is the case.

The planetarium *projector* itself, the so called ‘*Wonder of Jena*’, is a prime example of the ‘*technologically sublime*’¹²³ as well as a kind of a technological fetish. The preciousness of a *planetarium projector* not least is associated with its *costliness*, after all so expensive that it was possible that its desired renewal could become a controversial subject for a Presidential Debate, as recently between President (then Senator) OBAMA and Senator MCCAIN, concerning a new projector for Chicago, in 2008¹²⁴. The *Adler Planetarium* officially commented on this debate:

“The Adler’s Zeiss Mark VI projector [...] is nearly 40 years old and is no longer supported with parts or service by the manufacturer. It is only the second planetarium projector in the Adler’s 78 years of operation.”¹²⁵

Even though the need for a new projector for Chicago’s planetarium emerged in 2008, this information after all also means that the old projector was in operation for a time span which by far outlasts the service life of almost all other media technologies. Which TV set or cell phone would last properly for 40 years without becoming really obsolete? The really significant aspect here is that the old planetarium projector did last for so long and still, although now after all having to be replaced, has been appropriate and functional for almost 40 years.

1957-1975: The Sputnik Crisis as a Trigger for a Transition in Planetarium

Usage: Planetariums Became Centers for Navigation Training for Astronauts

Last but not least planetariums had also been subject to changes in their alternative function and use as concrete educational institutions and as downright training institutions for pilots, navigators and astronauts.

According to JORDAN D. MARCHÉ II, caused by the “‘crisis of confidence’ which was triggered by *Sputnik*”¹²⁶, since 1957 the “largest period of growth” of the American planetarium community commenced in 1958. “Long-standing resistance to federal support of education was overturned by passage of the National Defense Education Act (NDEA) of 1958”¹²⁷. After President “Eisenhower became convinced that training future scientists and engineers had become the nation’s ‘most critical problem’”¹²⁸, MARCHÉ concludes “planetariums moved to the forefront of educational theory and practice.”¹²⁹

In order to “built redundancy into spacecraft component systems”¹³⁰, last-minute celestial review in planetarium simulations became a convenient means of preparation for the unknown, as manned spaceflight, according to MARCHÉ, “posed many new risks and uncertainties” so that “NASA took every precaution that might insure the safety of its crews and the success of its missions.”¹³¹

Due to the everlasting reliability of the stars as orientation aids in case of emergency one of these precautions was the thorough training of celestial navigation for astronauts in modified planetariums. Therefore, between 1960 and 1975, sixty-two NASA Mercury-,

Gemini-, Apollo- and Skylab-astronauts exercised celestial navigation and star recognition at the *Morehead Planetarium* Chapel Hill¹³², then a place for *projecting* the space missions in a double sense of the word. Between *Apollo 1* and *Apollo 9* NASA-astronauts were also trained at *Griffith Planetarium* Los Angeles.

For *Gemini* a mock up was constructed mounted on two barber's chairs. NASA astronauts had already logged over 1700 hours of training at the *Morehead* in 1969¹³³. *Gemini* astronaut WALTER CUNNINGHAM specified the purpose of the endeavor: "our intention in studying here at the planetarium is to be able to locate ourselves at all times in space. If all else fails, we will use the stars as our only reference."¹³⁴

The most significant examples of the life-saving benefit of preparation in the planetarium are: first, the *Mercury-Atlas 9* mission (1963), where "Gordon Cooper had to use the stars to guide his reentry into the Earth's atmosphere"¹³⁵, as along with electricity the automated navigational controls failed. It is said that his thus star-led "splashdown eventually proved to be the most accurate in mission history."¹³⁶ Second off, according to a listing by the Morehead Planetarium, "when the rocket launching *Apollo 12* into space (1969) was hit by lightning during take-off, astronauts had to reset their navigational equipment by sighting key stars."¹³⁷ Finally the history of the *Apollo 13* mission (1970) clarifies the impact of planetarium training on spaceflight. According to MARCHÉ, "command module pilot, John L. Swigert performed visual star field alignments only hours before their crucial reentry"¹³⁸ in order to ensure the safe return of *Apollo 13*.

After 1975 planetarium astronaut training was dropped, mainly due to NASA's shift to the *space shuttle* with more reliable navigational computers. Optimistic prognoses such as by *Morehead Planetarium* director ANTHONY JENZANO or by CHARLES HAGAR who expected that "the planetarium will continue to be a significant space simulator as astronauts train for the space shuttle and missions to the moon and beyond"¹³⁹ did not come true.

However, the advent of GPS contrary to all appearances was no factor for rendering planetariums completely dispensable for navigation training. Even in times of computer controlled (space-)flight the highly developed expertise of star recognition and celestial navigation has not at all become useless but especially in *emergencies* maintains its justification and then turns out to be crucial even for saving lives.

As also former U.S. Air Force Academy planetarium director MICKEY D. SCHMIDT clarified, the advent of the Global Positioning System (GPS) was *not* a reason for a fading of the usefulness of the planetarium, but rather reversely another new topic and application for cadet instruction there:

While we did discontinue teaching the process of celestial navigation with sextants, and ephemeris we did not abandon the teaching principle of celestial navigation. It evolved into Theory and use of GPS.¹⁴⁰

Hence, in some cases planetarium astronaut training was continued: at the *USAFA Planetarium*, Colorado Springs, one "used a mock up of the space shuttle window in the door and gave star identification lessons"¹⁴¹, or even new facilities have been built: for example at *Star City* near Moscow a training planetarium with a dome extended -15° below the mathematical horizon¹⁴² was installed in 1981.

Tradition & Transition: From Commencing Conventional Constructions to a Limitless Range of Designs

“Change is the process that obliterates the rules of the past.”¹⁴³
—HEINZ VON FOERSTER

In an article for the first volume of the *Werkbund* journal *Die Form* ADOLF MEYER wrote already in 1925:

“The dome buildings of the ZEISS planetariums are, because of the audacity and grace of their construction, among the most remarkable phenomena in the field of the architecture and engineering of the age, and their influence on architecture as a whole cannot yet be foreseen.”¹⁴⁴

What he certainly couldn't foresee is the heterogeneous diversity in planetarium exterior design which emerged in the decades that followed.

Only in the early days most planetariums did still hide the dome structure behind conventional forms, like e.g. the design of the *Morehead Planetarium* Chapel Hill (1949), which was influenced by the *Jefferson Memorial* (and also built by the same firm), which “in turn, based on the Pantheon in Rome.”¹⁴⁵

Moreover, JOACHIM KRAUSSE reports on an ahead of the times and hence unrealized design proposal for the later, then permanent ZEISS-Planetarium in Jena in 1926, submitted by *Bauhaus* architect MEYER:

“While Meyer parabolically superelevates the shell slightly and thereby emphasizes it as a shape (association: egg in eggcup), the more conventional design of the building actually erected [*architects*: Schreiter & Schlag] [...] makes allusion to the Roman model of the Pantheon.”¹⁴⁶

Transition to Ex-orbitant and Extra-terrestrial Designs

The planetariums of Sao Paolo 1957, Bochum 1964, Vancouver 1968, Boulder, Colorado 1975, and Stuttgart, Germany 1977, then represent a breakthrough of artistic audacity. They look like just landed flying saucers, UFOs, *unidentified* flying objects, whereas the Stuttgart Planetarium rather resembles a clearly *identifiable* flying object: the *Apollo Lunar Module*. The *Fleischmann Atmospherium-Planetarium*, Nevada-Reno (1963), and the St. Louis *McDonnell Planetarium*'s hyperboloid structure (designed by GYO OBATA in 1963), also architectural *UFOs*, are representatives of *Populuxe Style*, or *Googie architecture*, featuring aero-dynamic shapes influenced by space age culture. In the context of *Googie architecture*, CHAD RANDL, in his study on revolving, rotating architectures, also reports on an unrealized planetarium plan: in an early draft for the *Space Needle* in Seattle, the “designers dropped proposals to include a full-sized planetarium in the head” of the tower, as architect John Graham, Jr. “encouraged them to ‘keep it saucer-like.’”¹⁴⁷

The Planetarium as Planet

Equally, and terminologically fitting, there are also planetariums with an exterior resembling planets! The Silesian Planetarium in Chorzów/Königshütte, Poland (1955) is modeled on the shape of Saturn with its visible ring. Likewise the Indira Gandhi

Planetarium in Lucknow, India (2003) is a colored model of Saturn. And also the planetarium in Buenos Aires (1967) symbolizes Saturn.

The Planetarium as Galaxy

Nothing is impossible: currently a building with a planetarium inside as a centerpiece is under construction, which will look like the *M51 spiral galaxy*¹⁴⁸. The building that will be completed in Heidelberg, Germany, in 2011, and be called *House of Astronomy* (architects: BERNHARDT + PARTNERS).

Pyramidal Planetariums

Moreover, pyramids constitute a frequent manifestation of planetarium architecture: again the Stuttgart Planetarium has to be mentioned here; and also the planetariums of Atlanta (1967), the new one in Mannheim, and the planetariums of Baroda, India, and of Colombo, Sri Lanka, are such pyramidal planetariums.

Organ(ic) Anthropomorphic Architecture

In Valencia, Spain, architect SANTIAGO CALATRAVA VALLS has created a planetarium which in fact emulates the human eye itself, and „with movable ripped covering”¹⁴⁹ “even includes a moving ‘eyelid’.”¹⁵⁰

Big Apple: Sphere & Hemisphere or Heavens & Hell

The very hemisphere of the new *New York Hayden Planetarium*, an eclectic¹⁵¹, “ball-in-a-box”-like building, opened in 2000, is “nestled in the sphere’s top half”¹⁵², located directly above the ‘Big Bang Theater’, an underneath inverted sphere which displays blazing color fields, symbolizing the Big Bang. This confrontation of two differently sized spheres could also be identified as an architectural reference to and remediation of ETIENNE-LOUIS BOULLÉE’s *Temple of Reason* or *Temple of Nature* (1793)¹⁵³, which had been composed of a “smaller, lower [reverse] half-sphere, laid out within as an artificial landscape”, a *grotto*, which again was “covered over by a larger half-sphere.”¹⁵⁴ MUSCHAMP also tracks a visitor’s pathway when inspecting the building, following bridges, ramps and corridors. It becomes evident that the Hayden’s architecture creates the impression as if the visitors’s bodies, strolling along the spiral ramp that “corkscrews one and a half turns around the sphere”¹⁵⁵, themselves become celestial bodies, circling around the globe.

Transition of Design Prototypes: a Reversal of the Direction of Reference

The Hayden Planetarium actually became a reference model or prototype for Hollywood design, too: while the 1951 movie *The Day the Earth Stood Still* (dir.: ROBERT WISE) had shown UFOs in the vintage shape of flying saucers (which, as discussed had been design paragons for several planetarium exteriors of the 1950s and 60s), its 2008 remake, directed by SCOTT DERRICKSON, quite contrary to its cinematic ancestor, featured a big UFO in the shape of an almost whole sphere, a big shimmering globe which, to top it all, as well has landed quite at that location in Manhattan’s Central Park where the Hayden Planetarium was erected in 2000. The design of the fictional spheric spaceship in the movie now in reverse obviously followed and refers to the design of the real spherical planetarium construction.

Notes

¹ Cf. Christoph Asendorf, *Super Constellation: Flugzeug und Raumrevolution: Die Wirkung der Luftfahrt auf Kunst und Kultur der Moderne*, ed. Bazon Brock (Vienna, Austria; New York: Springer, 1997), 110-115.

² Cf. Tony Rothman, "Geodesics, Domes, and Spacetime" in id., *Science à la Mode: physical fashions and fictions* (Princeton, NJ: Princeton University Press, 1989). See also Tomaso Aste, Denis Weaire, "Buckyballs", in id., *The pursuit of perfect packing*, 2nd ed., 161-164 (New York: Taylor & Francis, 2008), 164.

³ Cf. Felicity D. Scott, "Fluid Geographies: Politics and the Revolution by Design", in Hsiao-yun Chu & Roberto G. Trujillo (Eds.), *New Views on R. Buckminster Fuller*, 160-175 (Stanford, California: Stanford University Press, 2009), especially 173.

⁴ Cf.: Clifford A. Pickover, *The math book: From Pythagoras to the 57th Dimension, 250 Milestones in the History of Mathematics* (New York: Sterling Pub., 2009), 346.

⁵ Cf. Mirko Baum, Form Follows Science. Himmel des Aristoteles und Kohlenstoff C 6, in, Andreas Beyer; Markus Lohoff (Eds.), *Bild und Erkenntnis. Formen und Funktionen des Bildes in Wissenschaft und Technik* (Aachen: Deutscher Kunstverlag/RWTH Aachen, 2005), 22-29; cit. in http://ke.arch.rwth-aachen.de/ke_03/archiv/mirko/science/science.html. Also cf. Tony Rothman, "Geodesics, Domes, and Spacetime" in id., *Science à la Mode: Physical Fashions and Fictions* (Princeton, NJ: Princeton University Press, 1989).

⁶ Joachim Krausse: *The Miracle of Jena*, trans. by Peter Norman, in, Joachim Krausse; Marc Fester; Sabine Kraft; Nikolaus Kuhnert; Günther Uhlig (Eds.), *ARCH⁺: Zeitschrift für Architektur und Städtebau, Nr. 116: Gebaute Weltbilder von Boullée bis Buckminster Fuller*, 81-84 (Aachen: Arch⁺ Verlag, 1993), 82. Also cf. Dick Kovan, *The popular history of science*. Review of Tony Rothman, "Geodesics, Domes, and Spacetime" in id., *Science à la Mode: physical fashions and fictions* (Princeton, N.J.: Princeton University Press, 1989), in *New Scientist*, Vol. 123, No. 1676, 5 August 1989, 60:

"For Rothman, it is not coincidental that the first architectural application of geodesics should be in a structure so intimately connected with cosmology where the concept of a geodesic is essential."

⁷ Cit. in Joachim Krausse 1993, 82.

⁸ Cf. Carolyn Collins Petersen, "The unique role of the planetarium/Science Centre in science communication", in *Communicating Astronomy with the Public 2005*, eds. Ian Robson and Lars Lindeberg Christensen (Munich, Germany: ESA/Hubble, ESO, ESA, IAU, 2005), 102.

⁹ Richard Sennett, *Flesh and Stone: The Body and the City* (London: Penguin, [1994] 2002), 265.

¹⁰ Ibid.

¹¹ Cf. Alison Griffiths, *Shivers Down Your Spine: Cinema, Museums, & the Immersive View* (New York & Chichester, West Sussex: Columbia University Press, 2008), 122-124. Cf. also Charles F. Hagar, *Planetarium: Window to the Universe* (Oberkochen, Germany: Carl Zeiss, 1980 [Geislingen/Steige, Germany: C. Maurer Verlag, 1980], and cf. also Henry C. King, with John R. Millburn, *Geared to the Stars. The Evolution of Planetariums, Orreries, and astronomical Clocks* (Toronto, Buffalo: University of Toronto Press, 1978).

¹² Cit. in Donald Hoffmann, *Frank Lloyd Wright's Fallingwater: the House and its History* (New York: Dover Pub., 1993), 12.

¹³ Chad Randl, *Revolving Architecture: a History of Buildings that Rotate, Swivel, and Pivot* (Princeton, NJ: Princeton Architectural Press, 2008), 15.

- ¹⁴ Alison Griffiths 2008, 126-128.
- ¹⁵ Cit. in Alison Griffiths 2008, 128.
- ¹⁶ Erich Fromm, *To Have or to Be?* (New York: Continuum, 2007 [1976]), 8.
- ¹⁷ David Thorburn and Henry Jenkins, "Introduction: Toward an Aesthetics of Transition", in David Thorburn, Henry Jenkins, Brad Seawell (eds.), *Rethinking Media Change: The Aesthetics of Transition*, 1-16 (Cambridge, Mass./London: The MIT Press, 2004), 1-2.
- ¹⁸ „Einbau des Planetariums in den Stadtpark-Wasserturm. Ausschußbericht im Hamburger Fremdenblatt vom 22. Juni 1929, *Clauß* (D[eutsch]n[ationalen])“, in Aby M. Warburg, *Bildersammlung zur Geschichte von Sterngläubigkeit und Sternkunde im Hamburger Planetarium*, Uwe Fleckner, Robert Galitz, Claudia Naber and Herwart Nöldeke (eds.) (Hamburg: Dölling und Galitz, 1993), 72.
- ¹⁹ Cf. Brian Winston, *Technologies of Seeing: Photography, Cinematography and Television* (London: British Film Institute, 1996).
- ²⁰ Norbert Wiener, *Invention: The Care and Feeding of Ideas* (London, England/Cambridge; Mass.: The MIT Press, 1996 [1954]), 9.
- ²¹ Cf. Carolyn Collins Petersen 2005, 102.
- ²² Cf. Verlyn Klinkenborg, "Our Vanishing Night", in *National Geographic Magazine*, November 2008 "The End of Night: Why We Need Darkness", 108.
- ²³ Walter A. Lyons & Mickey D Schmidt, "The Discovery of red Sprites as an Opportunity for Informal Science Education", <http://ams.confex.com/ams/pdfpapers/65547.pdf>, accessed 10 August 2009.
- ²⁴ Charles F. Hagar, *Planetarium: Window to the Universe* (Oberkochen, Germany: Carl Zeiss, 1980), 71.
- ²⁵ Jim Sweitzer, "Understanding Planetariums as Media", in Narasimhan, Beck-Winchatz, Hawkins & Runyon (eds.), *NASA Office of Space Science Education and Public Outreach Conference 2002, ASP Conference Series*, Vol. 319, 2004, 165-168, on <<http://adsabs.harvard.edu/full/2004ASPC..319..165S>>, 166, accessed 4 May 2011.
- ²⁶ Walter Benjamin, "To the Planetarium [from One-way Street]", in id. *The work of art in the age of its technological reproducibility, and other writings on media*, M. W. Jennings, B. Doherty and T. Y. Levin (eds.), trans. E. Jephcott et al. (Cambridge, Mass.: Belknap Press of Harvard University Press, 2008), 58.
- ²⁷ Ibid.
- ²⁸ William Shakespeare, *Julius Caesar*, in *The Complete Works of William Shakespeare* (New York: Random House, 1975), III, i, 60.
- ²⁹ Cf. Dieter Blume: „Sternbilder und Himmelswesen: Zum Bildgebrauch des Mittelalters“, S. 73-85 in Horst Bredekamp; Franziska Brons, *Imagination des Himmels. Schriftenreihe: Bildwelten des Wissens 5,2* (Berlin: Akademie Verlag, 2007), 73.
- ³⁰ Cf. Simon Schaffer: „Himmlische Mächte“, in Bredekamp; Brons 2007, 40.
- ³¹ Ibid.
- ³² Cf. Peter Sloterdijk, *Sphären II, Makrosphärologie: Globen*, in *Sphären I-III* (Suhrkamp, Frankfurt am Main, 1999), 78.
- ³³ Cf. Christoph Asendorf, *Entgrenzung und Allgegenwart. Die Moderne und das Problem der Distanz* (München: Wilhelm Fink, 2005), 9-11.
- ³⁴ Aby Warburg, "Images from the Region of the Pueblo Indians of North America" [1923], in Donald Preziosi, ed., *The art of art history: a critical anthology*, 162-188 (Oxford; New York: Oxford University Press, 2009), 188.

³⁵ Georg Simmel “The Metropolis and Mental Life” (1903), in *The Blackwell City Reader*, Gary Bridge, Sophie Watson (Eds.), 103-110 (Chichester, West Sussex: Wiley-Blackwell, 2010), 108.

³⁶ Anthony Fairall, ‘Seeing beyond the naked eye in a planetarium’, in *Communicating Astronomy with the Public 2005*, I. Robson and L. L. Christensen (eds.), ESA/Hubble, ESO, ESA, IAU, Munich, 2005, 119.

³⁷ Cf. Edmund Husserl; M Farber, *Philosophical essays in memory of Edmund Husserl*, Harvard University Press, Cambridge, MA, 1940, 320.

³⁸ Georg Simmel, “Sociology of the Senses” (1907), in Frisby, David; Featherstone, Mike (eds.), *Simmel on Culture: selected writings*, (London, Thousand Oaks: Sage, 1997), 116-117.

³⁹ Walter Benjamin, *The work of art in the age of its technological reproducibility, and other writings on media*, Michael William Jennings, Brigid Doherty (Eds.), trans. Edmund Jephcott et al. (Cambridge, Mass: Belknap Press of Harvard University Press, 2008), 23.

⁴⁰ Alison Griffiths 2008, 136.

⁴¹ Ibid.

⁴² Ibid.

⁴³ Charles F. Hagar 1980, 154-155.

⁴⁴ Glenn A. Walsh, “The Buhl Planetarium and Institute of Popular Science”, <<http://buhlplanetarium3.tripod.com/BuhlZeissII.htm>>, accessed 9 March 2010.

⁴⁵ Grace Glueck, “Art in Review; ‘New York Night and Day’, ‘Vintage Photographs by Paul Woolf, circa 1932-39’, March 21, 200; a version of this review appeared in print on March 21, 2003, on page E40 of the New York edition of The New York Times, <<http://www.nytimes.com/2003/03/21/arts/art-review-new-york-night-day-vintage-photographs-paul-woolf-circa-1932-39.html?pagewanted=1>>., accessed 2 February 2010.

⁴⁶ Friedrich Schiller, “Scattered Remarks on Different Aesthetic Objects” [1793]; translated by Susan Johnson, in *Friedrich Schiller, poet of freedom* (New York, N.Y.: New Benjamin Franklin House / Schiller Institute, 1985), 454. Quoted from: <http://www.schillerinstitute.org/transl/Schiller_essays/magnitude.html>.

⁴⁷ Cf. Wolfgang Meisenheimer, *Das Denken des Leibes und der architektonische Raum* (Köln: Verlag der Buchhandlung Walther König, 2006), 58.

⁴⁸ Cf. Eickhoff, Hajo: „Sitzen“, in Wulf, Christoph (Ed.): *Vom Menschen. Handbuch Historische Anthropologie: Kosmologie – Welt und Dinge– Genealogie und Geschlecht – Körper –Medien und Bildung -- Zufall und Geschick – Kultur*, 489-500 (Weinheim und Basel: Beltz, 1997), 492.

⁴⁹ Jordan D. Marché II, *Theaters of Time and Space: American Planetaria, 1930-1970* (New Brunswick, NJ, London: Rutgers University Press, 2005), 128.

⁵⁰ Cf. <http://www.zeiss.de/C12567B00038CD75/Contents-Frame/D4641F9EEF38D362C1256FC1002DA806>, accessed 6 May 2011.

⁵¹ Jordan D. Marché II 2005, 145.

⁵² Cf. Hartmut von Hentig, *Der technischen Zivilisation gewachsen bleiben: Nachdenken über die Neuen Medien und das gar nicht mehr allmähliche Verschwinden der Wirklichkeit* (Weinheim: Beltz Taschenbuch, 2002), 247.

⁵³ Alison Griffiths 2008, 125.

⁵⁴ Ibid.

⁵⁵ Cf. Siegfried Kracauer, *Theory of Film: the Redemption of Physical Reality* (New York, Oxford: Oxford University Press, 1960).

⁵⁶ ‘Planetarium Technology: Shrinking of Apparent Star Diameters’, <<http://www.zeiss.de/planetariums>>, accessed 28 May 2009.

⁵⁷ Cf. Charles F. Hagar, 98, and see also Henry C. King, 347.

⁵⁸ Cf. Ludwig Meier, *Der Himmel auf Erden: die Welt der Planetarien* (Leipzig: Barth, 1992), 80.

⁵⁹ Cf. *Ibid.*

⁶⁰ Cf. W. H. F. Talbot, *The pencil of nature* [1824], *anniversary facsimile*, L. J. Schaaf, ed. (New York: Kraus, 1989).

⁶¹ Cf. William Henry Fox Talbot, *The pencil of nature* [1824], *anniversary facsimile*, L. J. Schaaf, ed. (New York: Kraus, 1989).

⁶² Jonathan Gilmore, ‘Pictorial Realism’, in *Encyclopedia of Aesthetics*, Volume 4, Michael Kelly, Ed. (New York, Oxford: Oxford University Press, 1998), 109.

⁶³ Cf. Johann Wolfgang Goethe, who wrote in his novel *Wilhelm Meister’s Journeyman Years* regarding the view through a telescope:

“*I do not know whether I should thank you for bringing this star so very much nearer to me. When I saw it before, it stood in its proper relationship to all the other countless bodies of the heavens and to myself. But now it stands out disproportionately in my imagination, and I do not know whether I should want to bring the remaining hosts closer in the same fashion. They would crowd me, make me anxious.*”

in: Johann Wolfgang von Goethe: *The Collected Works. Volume 10. Conversations of German refugees ; Wilhelm Meister’s Journeyman Years, or The Renunciants*, translated by Krishna Winston, ed. by Jane K. Brown (Princeton, New Jersey: Princeton University Press, 1995), 178.

⁶⁴ Thomas W. Kraupe, „*Denn was innen, das ist draußen*“. *Die Geschichte des modernen Planetariums*. (Hamburg: Caelum Publikation Planetarium Hamburg, 2005), 79.

⁶⁵ Cf. Gerhard Schulze: „Steigerung und Ankunft. Über die Endlichkeit des Fortschritts“, in Heinrich v. Pierer, Bolko v. Oetinger (eds.), *Wie kommt das Neue in die Welt?* (Reinbek bei Hamburg: Rowohlt, 1999), 363-386.

⁶⁶ Pliny the Elder, “Extract from Natural History: A Selection”, in *Visual Culture: Critical Concepts in Media and Cultural Studies*, Vol. I-IV, Vol. II: Histories, Archaeologies and Genealogies of Visual Culture, eds. Joanne Morra and Marquard Smith (London, New York: Routledge, 2006), 16.

⁶⁷ Jordan D. Marché II 2005, 146.

⁶⁸ *Ibid.*, 147.

⁶⁹ *Ibid.*

⁷⁰ See Karin Knorr-Cetina, *Epistemic cultures: how the sciences make knowledge* (Cambridge, MA: Harvard University Press, 1999), 27/28.

⁷¹ Cf. Joachim Krausse, „Architektur aus dem Geist der Projektion. Das Zeiss-Planetarium“, in *Wissen in Bewegung: 80 Jahre Zeiss-Planetarium Jena*, eds. Ernst-Abbe-Stiftung, Hans-Christian von Herrmann (Jena, Germany: Ernst-Abbe-Stiftung, 2006), 59.

⁷² J. W. v. GOETHE, “One and All”, in Paul Carus, *Goethe: with special consideration of his philosophy* (Open Court Pub. Co., 1915), 243.

⁷³ Cf. Charles F. Hagar 1980, 154.

⁷⁴ Alison Griffiths 2008, 129.

⁷⁵ Charles F. Hagar 1980, 154.

⁷⁶ Philip Groce, “Designing a Planetarium for the 21st Century”, in *Proceedings of the Texas 2000 Joint Conference of Southwest Association of Planetariums, Great Plains Planetarium Association, Pacific Planetarium Association, and Rocky Mountain Planetarium Association*, 31-37 (Dallas, Texas: 4-8 October 2000), 37, on <sites.csn.edu/planetarium/PPA/Proceedings-TX2000.pdf>, 36, accessed 3 May 2011.

⁷⁷ Cit. in *Ibid.*, 37.

⁷⁸ Alison Griffiths 2008, 129.

⁷⁹ *Ibid.*

⁸⁰ Leon Chaitow, Joseph Pizzorno, Jr., *Naturopathic Physical Medicine: Theory and Practice for Manual Therapists and Naturpaths* (Philadelphia: Churchill Livingstone Elsevier, 2008), 256. Also cf. Jesco von Puttkamer, *Der Mensch im Weltraum – eine Notwendigkeit* (Frankfurt am Main: Umschau 1987), 168.

⁸¹ Cf. Helmut Milz, *Der wiederentdeckte Körper: Vom schöpferischen Umgang mit sich selbst* (Munich: Dtv, 1994 [Munich: Artemis & Winkler, 1992]).

⁸² Cf. Oliver Grau, *Virtual Art: From Illusion to Immersion* (Cambridge/Mass.; London: The MIT Press, 2003)

⁸³ Jordan D. Marché 2005, 92.

⁸⁴ *Ibid.*, 91.

⁸⁵ Jim Dwyer, “An Eye-Opening Show. Eye-Closing, Too. NAPS O.K. But no snores were heard at this planetarium film”, February 19, 2010, on http://www.nytimes.com/2010/02/21/nyregion/21about.html?_r=1&ref=hayden_planetarium. A version of this article appeared in print on February 21, 2010, on page MB1 of the New York edition.

⁸⁶ Galen Cranz, *The Chair: Rethinking Culture, Body, and Design* (New York, W. W. Norton & Co, 2000), 158.

⁸⁷ Jim Dwyer, 2010.

⁸⁸ Walter Benjamin cit. in Giuliana Bruno, *Streetwalking on a Ruined Map: Cultural Theory and the City Films of Elvira Notari* (Princeton, NJ: Princeton University Press, 1993), 47.

⁸⁹ Scott Kirsner, “View is worlds better at renovated planetarium”, February 14, 2011, on http://www.boston.com/business/technology/articles/2011/02/14/view_is_worlds_better_at_renovated_planetarium/.

⁹⁰ Cf. ‘Planetarium Technology: Watch Star Clusters and Nebulae through Binoculars’, <<http://www.zeiss.de/planetariums>>.

⁹¹ Anon., “Boston’s Hayden Planetarium Celebrates 30th Anniversary”, in *The Harvard Crimson*, October 04, 1988, on <http://www.thecrimson.com/article/1988/10/4/bostons-hayden-planetarium-celebrates-30th-anniversary/>.

⁹² Alison Griffiths 2008, 136.

⁹³ Kevin Lynch, *The Image of the City* (Cambridge, Mass.: The MIT Press, 1960), 81-82.

⁹⁴ David Thorburn and Henry Jenkins, 2004, 10.

⁹⁵ Kay Kirchmann, “Marilyn: A paragone of the camera gaze”, translated from German by Gerd Bayer and Christian Krug, in Winfried Nöth, Nina Bishara (eds.): *Self-Reference in the Media = Approaches to Applied Semiotics 6*, S. 107- 121 (Berlin, New York: Mouton de Gruyter, 2007), 120.

⁹⁶ Jim Sweitzer, 2004, 165.

⁹⁷ *Ibid.*, 166.

⁹⁸ *Ibid.*, 165.

⁹⁹ Ibid.

¹⁰⁰ http://www.zeiss.de/_c12567b00038cd75.nsf/Contents-Frame/163e672efad0e575c125722e00286e06?OpenDocument&Click=, accessed 6 May 2011.

¹⁰¹ Thomas W. Kraupe 2005, 90.

¹⁰² Cf. Ibid., 99.

¹⁰³ Cf. David E. Nye, *American technological sublime* (Cambridge, MA: MIT Press, 1994).

¹⁰⁴ Alison Griffiths, 128.

¹⁰⁵ Ibid., 143.

¹⁰⁶ Jordan D. Marché 2005, 45.

¹⁰⁷ Cit. in Max Frankel, "The Way We Live Now", March 19, 2000, on http://www.nytimes.com/2000/03/19/magazine/the-way-we-live-now-3-19-00-word-image-heresy-on-81st-street.html?ref=hayden_planetariu&pagewanted=print

¹⁰⁸ Cf. Ludwig Meier, *Der Himmel auf Erden: die Welt der Planetarien* (Leipzig: Barth, 1992), 127.

¹⁰⁹ Lorraine Daston, Katharine Park, *Wonders and the Order of Nature, 1150-1750* (New York: Zone Books; Cambridge, MA: distributed by the MIT Press, 1998), 368:

¹¹⁰ Ray Bradbury, *Commencement Speech to the Caltech Class of 2000*, "The Great Years Ahead", on: http://commencement.caltech.edu/00/bradbury_speech.html.

¹¹¹ Ray Bradbury, "Foreword: Going A'journey", in Launius, Roger D.; McCurdy, Howard E. (eds.), *Imagining Space: Achievements, Predictions, Possibilities, 1950-2050*, 13-15 (San Francisco: Chronicle Books, 2001), 14

¹¹² Jim Sweitzer 2004, 168.

¹¹³ Alison Griffiths 2008, 146.

¹¹⁴ Cf. C. P. Snow, *The Two Cultures and the Scientific Revolution* (Cambridge: Cambridge University Press, 1959).

¹¹⁵ Charles F. Hagar 1980, 19.

¹¹⁶ Cf. S. H. Schwartz, *Visual perception: a clinical orientation*, 3rd ed. (New York: McGraw-Hill, Health Pub. Division, 2004), 37.

¹¹⁷ John Maeda, *The Laws of Simplicity: Design, Technology, Business, Life* (Cambridge, Mass: The MIT Press, 2006), 23.

¹¹⁸ Ibid.

¹¹⁹ Charles F. Hagar 1980, 151.

¹²⁰ Alison Griffiths 2008, 145.

¹²¹ Cf. [http://www.zeiss.com/C12567B000352701/EmbedTitelIntern/06_Schorcht_Products/\\$File/06-07_Schorcht_Product-Spectrum.pdf](http://www.zeiss.com/C12567B000352701/EmbedTitelIntern/06_Schorcht_Products/$File/06-07_Schorcht_Product-Spectrum.pdf).

¹²² Jordan D. Marché II, *Theaters of Time and Space: American Planetaria, 1930-1970* (New Brunswick, NJ, London: Rutgers University Press, 2005), 173.

¹²³ Cf. David E. Nye, *American technological sublime* (Cambridge, MA: MIT Press, 1994).

¹²⁴ Cf. <http://www.adlerplanetarium.org/pressroom/pr/2008_10_08_AdlerStatement_aboutdebate.pdf>

¹²⁵ Ibid.

¹²⁶ Jordan D. Marché 2005, 135.

¹²⁷ Ibid.

¹²⁸ Ibid., 122.

¹²⁹ Ibid., 127.

¹³⁰ Cf. Ibid., 139.

¹³¹ Cf. Ibid.

¹³² Cf. Ibid. 137-141.

¹³³ Cf. Eric M. Jones (ed.), *Apollo 15, Lunar Surface Journal, Post-landing Activities, Corrected Transcript and Commentary* by Eric M. Jones, 1996, last revised 15 January 2006, <<http://history.nasa.gov/alsj/a15/a15.postland.html>>, accessed 7 August 2009.

¹³⁴ Jordan D. Marché 2005, 139.

¹³⁵ <<http://www.moreheadplanetarium.org/index.cfm?fuseaction=page&filename=history4.html>>, accessed 11 August 2009.

¹³⁶ Ibid.

¹³⁷ Ibid.

¹³⁸ Jordan D. Marché 2005, 140.

¹³⁹ Charles F. Hagar 1980, 133.

¹⁴⁰ Mickey D. Schmidt, Email to the author, 16 August 2009.

¹⁴¹ Id., Email to the author, 12 August 2009.

¹⁴² Cf. Ludwig Meier 1992, 136.

¹⁴³ Heinz von Foerster, "Perception of the Future and the Future of Perception", in Id. *Understanding Understanding: Essays on Cybernetics and Cognition*, 199-210 (New York: Springer, 2003), 206.

¹⁴⁴ Cit. in Joachim Krausse 1993, 84.

¹⁴⁵ <http://www.moreheadplanetarium.org/index.cfm?fuseaction=page&filename=history2.html>.

¹⁴⁶ Joachim Krausse 1993, 84.

¹⁴⁷ Chad Randl 2008, 160.

¹⁴⁸ Cf. <http://www.archicentral.com/house-of-astronomy-heidelberg-germany-bernhardt-partners-1282/>.

¹⁴⁹ Philip Jodidio, *Architecture now!* (Köln: Taschen, 2009), 136.

¹⁵⁰ Ibid., 143.

¹⁵¹ Cf. Herbert Muschamp: "It's Something New Under the Stars (And Looking Up)", February 13, 2000, on http://www.nytimes.com/2000/02/13/arts/it-s-something-new-under-the-stars-and-looking-up.html?ref=hayden_planetarium&pagewanted=print.

¹⁵² Ibid.

¹⁵³ Cf. Susanne von Falkenhausen, *KugelbauVisionen: Kulturgeschichte einer Bauform von der Französischen Revolution bis zum Medienzeitalter* (Bielefeld: Transcript, 2008), 17-20.

¹⁵⁴ Hanno-Walter Kruft: *A History of Architectural Theory: from Vitruvius to the Present*, Princeton, NJ: Princeton Architectural Press, 1994, 161.

¹⁵⁵ Cf. Herbert Muschamp, 2000.

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