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Is Seeing Believing? The Experimental Production of Technical Standards for HDTV

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Abstract This paper uses the history of television to show that there is a need for greater attention to the roles of carefully staged demonstrations in the (re)creation of technical standards if we are to understand more fully innovations and the (re) creation of markets as collective processes of experimentation and recombination. Specifically, the author examines the emergence of "high definition television" (HDTV) as a new movement of experimentation and standardization in the 1970s and 1980s, spanning East and West in terms of sites, actors and issues. The paper offers a history of a particular Japanese experimental program and then discusses, in greater detail, a series of HDTV demonstrations carried out in the US in 1981 and how these (and a related demonstration in Europe 1982) were conceived and used at the time and later by parties involved in designing, operating, and controlling (HD) TV systems. Based upon this analysis, the paper concludes by showing that close empirical studies of demonstrations have much to tell us about the growth, (de) stabilization, and standardization of movements of innovation, including how their repertoire of founding stories, heroes, and standards expands and evolves.

Keywords High-Definition Television (HDTV) · Innovation · Demonstration · Technical standards · Standardization

Abbreviations

ATSC	Advanced Television Systems Committee
BBC	British Broadcasting Corporation
BSE	Broadcasting Satellite for Experimental Purposes
CCIR	Comité Consultatif International de Radio Communication International Radio Consultative Committee

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DBS	Direct Broadcasting (by) Satellite
EIA	Electronic Industries Association
EBU	European Broadcasting Union
FCC	Federal Communications Commission
IEEE	Institute of Electrical and Electronics Engineering
NAB	National Association of Broadcasters
NCTA	National Cable Television Association
ITU	International Telecommunication Union
IWP	(CCIR) Interim Working Party
HDTV	High-Definition Television
MAC	Multiplexed Analog Components
MUSE	Multiple Sub-Nyquist Sampling Encoding
NHK	Nippon Hoso Kyokai
NTSC	National Television System Committee
PAL	Phase Alternative Line
SECAM	Séquentiel Couleur avec Mémoire
SMPTE	Society of Motion Picture and Television Engineers
UHF	Ultra High Frequency
VHF	Very High Frequency

That the creation and eventual agreement on technical standards is never a question of "pure technical" coordination and synchronization is widely recognized. Historians and sociologists of science and technology, among others, have noted that the setting of technical standards is always the outcome of contextual contingencies, struggles of credibility, negotiations, and compromise (see, for instance, Abraham and Reed 2002; Hanseth and Monteiro 1997; Hughes 1983; O'Connell 1993; Schmidt and Werle 1998). At the same time, a growing body of science and technology studies (STS) scholars has shown that staged demonstrations, performances, or shows of experimental work have long since been powerful resources for persuasion in the development of "modern" science and technology (for example: Collins 1988; Gooding et al. 1989; Schaffer 1994; Shapin and Schaffer 1985; Smith 2009). So far, however, surprisingly little scholarly attention has been paid to the roles and dynamics of carefully staged demonstrations in the setting of technical standards.

Nevertheless, several authors (for example: Shapin 1984; Barry 1999; Callon 2004) have called attention to the importance of studying demonstrations not only as local events where an object (for instance, the reality of a claim) is rendered tangible to circumscribed audiences but also as parts of a range of devices through which this object may travel across time and place. They have pointed to the potential of demonstrations to help open and (re)construct as well as restrict or close an enlarged space of experimentation in which can be diagnosed, disputed, tested (possibly by other demonstrations), negotiated, and decided as to whether the object articulated through a demonstration can be accepted and framed as a broader legitimate common concern. Taking this a step further, I wish to show that there is a need for greater attention to the dissemination, framing, and marketing of experimental work through demonstrations in the setting of technical standards if we are to understand more fully the dynamics of innovations and the (re)creation of markets as collective processes of experimentation and recombination.

To pursue this line, I will deal with material selected from a field of little prior interest to STS scholars: the history of television. Specifically, I focus on the emergence of "high-definition television" (HDTV) as a new movement of experimentation and standardization in the 1970s and 1980s, spanning East and West in terms of sites, actors, and issues. The HDTV case is interesting as it gave rise to a much publicized "battle" over standards and is frequently mentioned in scholarly discussions about the problems of reaching agreement on technical standards. Here, it brings into scrutiny issues which are often discussed in terms of, for instance, local–global, government, and truth, while making clear the cultural specificity and path dependent character of "technological" choices. I am inspired by Barry (2001:175) and others in approaching demonstrations as well as technical standards as part of "a set of practices and technologies of governing which operate across distinctions between state and market." How the (re)creation of technical standards is incorporated into practices of governing, and, in reverse, how practices of governing influence the (re)creation of technical standards, will be my central theme.

I begin by briefly discussing three concepts central to my paper: innovation, technical standards, and demonstrations. I then move on to a short history of a specific Japanese program of experimentation, pointing to some of the ways in which something called "HDTV" began to circulate in a broader, transnational, space during the 1970s and 1980s. I then turn to discuss a series of HDTV demonstrations carried out in the US in 1981 and how these (and a related demonstration in Europe 1982) were conceived and used at the time and later by parties involved in designing, operating and controlling (HD)TV systems. Based upon this analysis, I conclude by showing that close empirical studies of demonstrations have much to tell us about the growth, (de)stabilization and standardization of movements of innovation, including how their repertoire of founding stories, heroes, and standards expands and evolves.

1 Innovation as the Carrying out of New Combinations

In this paper, I follow Schumpeter (1934/2007:14 f., 65 f.) in his definition of innovation as "the carrying out of new combinations": to do new things, or the same things differently, by combining "materials and forces within our reach' in a new way. As I hope will become clear, Schumpeter's notion of innovation as 'the carrying out of new combinations" conforms well with STS approaches addressing how people interact with each other as well as with other "things" such as, for instance, "nature" and artefacts. Reflecting a similar concern with "new combinations" STS approaches have referred variously to "heterogeneous engineering," "sociotechnical systems," "actor-networks," "assemblages," "associations," and "compositions."

According to Schumpeter (op. cit. 15), "all possible kinds of objects and 'forces'" may be combined in innovation, material as well as immaterial, including "natural forces." As defined by him, *entrepreneurs* are those individuals and groups of individuals who hold a particular function in relation to the carrying out of new combination by acting as *leaders* (or "captains of industry"); diverting the means of

production into new channels and new "circular flows" beyond the boundary of routine (op. cit. 78 f., 89). For Schumpeter, innovation is never exclusively or purely "technological" but is the result of the recombination of different types of "things"–none of which have to be new at all. He also tells us that a "new combination" always encompasses attempts at "changing the existing state of the satisfaction of *our wants*, of changing the reciprocal *relations* of things and forces, of *uniting* some and *disconnecting* others" (op. cit. 14; my emphasis). One of the interesting analytical features of innovation is the question: How is it possible that many disparate entities, relations, and processes may come together in a new relatively large and stable combination, which retains its collective identity across time and space and local contingencies? Among the many social strategies that provide for predictable and durable connections—as well as disconnections—are technical standards and the work associated with some kind of written agreement about such standards.

2 A Specific Type of "Rules": Technical Standards

In the parlance of the research engineers identified in this paper, "a standard" is commonly referred to as a set of parameter values that can be adhered to by a collective, either tacitly, or in accord with some formal agreement that defines the design, material composition, processing, or performance characteristics of a technical system or product (David and Steinmueller 1992:2). I also invoke Joerges' (1988:30 f.) definition of "technical standards" as norms that "regulate what technical artifacts are allowed to do and forced to do, and how they are allowed to interact among themselves, with people and nature." Technical standards are thus some of the regulatory devices that define what can be connected to what and what cannot, what counts as boundaries and contents, what counts as legitimate and correct, and so on. Seen from this perspective, technical standards can be described as *rules* guiding or governing various kinds of interaction and relations. Such rules are sometimes called *institutions*, referring to that something (typically a practice or activity) has been established as a convention or norm in a society or some part of society.

Defined as "rules of the game," both formal and informal institutions set boundaries indicating what kinds of behavior and interaction are appropriate and acceptable (North 1990).[1] Institutions provide continuity and contribute to stability by constraining the number of choices people can make and by providing information about how others can be expected to act. Without institutions, there can be no remembrance, no repetition, no continuity, no unity, no stability, no prediction, and hence no control of interaction.

At the same time as the evolution and behavior of entrepreneurs results (partly) from the boundaries set by established rules and routines, they in turn have to break, alter, and establish such boundaries to be able to ensure the growth and stabilization

[1] Following North (1990), institutional opportunities and constraints are set by both *formal* rules—such as written political and judicial rules, economic rules, official standards, and contracts—and *informal*—such as unwritten customs, habits, norms, traditions, praxis, and codes of conduct.

of their recombinations. Thus, a crucial aspect of entrepreneurship can be seen as the work of actively using and (re)shaping not only formal regulations but also regulatory authorities, opinions, beliefs, and behavior.

3 Demonstrations as Multifaceted Phenomena

The (HD)TV research engineers identified in this paper join the ranks of "magicians," "experimentalists," and "scientists" who before and since the seventeenth century have developed and used artefacts in theatrical performances, demonstrations, or shows before spectators supposedly witnessing something new, strange, or abstract *directly*, as opposed to merely being informed about it indirectly. Now as before, such staged demonstrations are a highly heterogeneous activity that depends upon and incorporates a range of existing "materials and forces" to help (re) frame, enact, and extend an object articulated through a locally staged demonstration to other contexts across time and place.

For instance, it is evident that staged demonstrations and shows are tied to deeply rooted general norms and conventions about the bodily basis of testimony and the hierarchy of the human senses (the precedence of eyes over ears) in the processing and evaluation of experience. Linked to an amazingly subtle array of familiar devices, an act of witnessing has long been institutionalized in a number of practices to secure and propagate various types of experience as "facts" and "truth" (Peters 2001). These devices include ways of opening, handling, and resolving disputes and value judgments arising out of various types of interactions and relations: "who said what and did what to whom" or "what can be connected to what and what cannot."

A body of evidentiary principles and procedures based on the testimony of witnesses who have themselves seen or heard the act in question has, for instance, long been at the core of the legal tradition. As Shapin and Schaffer (1985) have shown in their seminal work on an emerging new or experimental natural philosophy in seventeenth century England, this once new movement of recombination involved the recreation of rules and routines ("standards") for acquiring and judging truth, facts, and credibility linked to witnessing which already had a well-established home in the (English) legal tradition. Shapiro (1994:252) suggests "that the English legal tradition provided a respected, readymade technology of fact-finding that was adopted and adapted by naturalists seeking to legitimize empirical observations and experiments and to give observed and experimentally derived natural matters of fact the status of 'knowledge.'"

In the hands and minds of Francis Bacon (1561–1626), Robert Boyle (1627–1691), and other contemporary figures associated with the promotion of a new natural philosophy, existing approaches to truth, facts, and credibility were successfully adapted to natural phenomena observed and, in particular, experimentally created by means of instruments designed to enhance the senses. For example, the "new"[2] air pump constructed by Boyle and his assistants was routinely used in

[2] As Shapin (1984:486 f) points out, when Boyle presented his original machine to the Royal Society of London in the 1660s, it represented a new version of a limited number of experimental air pumps that existed in the decade after its invention.

experimental performances that were conducted in a variety of venues, such as the coffeehouses, the royal palace, the meeting places of the Royal Society, or various residences (Shapin 1984, 1988). However, as noted by many, sense-enhancing instruments (such as the air pump, the telescope, and the microscope) had existed in earlier versions and been used as part of what was called "natural magic" (in contrast to "black magic") before experimentally minded natural philosophers put such devices to new and different uses, renaming them "philosophical instruments."[3] The pre-Baconian "scientists" called "natural magicians" used instruments to perform effects that once had been thought of as essentially invisible or miraculous by means of staged performances at specific times and places.

"Natural magic" can be recognized in an increasing number of new tricks and applications related to the development of the nineteenth and twentieth centuries' new building blocks, such as electricity, mechanics, optics, wireless, and digital technologies. Among all these disparate skills and tricks appear the telegraph, the facsimile machine, and the telephone, which in the second half of the nineteenth and the beginning of the twentieth centuries awoke interest in the possibility of also generating phenomena which were talked about in terms of "seeing by electricity" or "seeing by wireless." We no longer consider television magic, but in the 1920s, when it first made its public appearance, it was.[4] The "magic" instruments of our time tend to lose their magic as they move from one-of-a-kind instruments toward routinized, and sometimes mass-produced, tools.

This is not the place to explore the long history of puzzlement and prescription about something called "demonstration," tracing its origin back to Aristotle and delving into all the ways and settings by which it gradually has become transformed and associated with an expanding number of applications, meanings, and traditions. But it seems that the word had found a home in the vocabulary, rules, and devices of English experimental natural philosophers in the seventeenth century, carrying with it mathematical resonances and Aristotelian principles of absolute certainty, before it eventually took on meanings associated with theatrical showmanship and the display of dramatic phenomena.[5] Now as then, organized collective acts of witnessing—today known as demonstrations or demos—are used in attempts to mobilize, sustain, and enlarge support for the "stabilization" or "destabilization" of what can, should, or might be done in processes of experimentation and recombination.

The general drive for visual and tangible proof—to show/see/touch how things are, even when things cannot actually be seen or touched—is institutionalized in the nonverbal schemes, procedures, and apparatuses as well as in the jargong of contemporary (HD)TV research engineers, reproducing the importance of letting spectators "see for themselves" and saying such things as "seeing is believing." Note also the links to stage magic and theatrical showmanship in the promotion of an HDTV demonstration in the US in 1989: "It's going to be a hell of a show./…/It is

[3] See, for instance, Hankins and Silverman 1995, Chapter 1.

[4] The word television entered the English language in 1911, but it was not until the mid 1920s that "televising" of moving images by means of experimental "televisors" began to be widely promoted in England as a reality: the instant transmission and reception of moving images at some distance (Geddes and Bussey 1986; Moss 1991).

[5] See, for instance, Hankins and Silverman 1995:38–43.

going to be practical as well as theatrical. We are going to show what this baby can do, to be a little more imaginative than before."[6]

Through their experimental work and recombinations, (HD)TV research engineers in the historical present develop and extend norms, procedures, techniques, and instruments that are an inheritance of previous attempts at promoting, governing, or opposing various new combinations. The HDTV case shows that the links between demonstrations and the (re)creation of technical standards (and other social rules) must be understood in relation to this complex inheritance.

My paper places the links between demonstrations and technical standards in the context of narratives, including my own narrative account. This is not strange: as Czarniawska (2004:5) points out, in order to understand and impute meanings and legitimacy to one's own—or others'—action, people put them into words often using the narrative form—that is, the construction of a referential chain of actions and events carefully organized into a story of some kind of whole whose meaning is greater than its parts—be it a story of an individual or a story of some type of collective, such as a nation, mankind, the EU, or (HD)TV.[7] My HDTV study confirms what others have argued before me (for example: Curtis 1994; Czarniawska 2004; Golinski 1998; Rouse 1990; Silvers 1995): that a large part of experimental techno-scientific work and innovation, like any other professional practice, consists of the production and use of narratives. As Shapin (1984) has shown, narratives were explicitly exploited in the service of the building of a new or experimental philosophy in seventeenth century England.[8] Whether conducted in seventeenth century England or twentieth century US, it is clear that demonstrations or shows of experimental work always are part of and interact with the production and spatialization of narratives. This complex interaction constitutes a central strategy in the (re)creation of "rules," "facts," and "truths" through innovative attempts that use and manipulate the human senses/nature while simultaneously (dis)assembling, (re)configuring, (re)naming and governing various "materials and forces" into more or less durable combinations.

Boyle's air pump of the 1660s has this in common with the HDTV equipment demonstrated in 1981: it produced a visual experience that helped ideas, words, images, rules, and action to move and become materialized, embodied, inscribed, or objectified—in a person, in an artifact, and in other technologies of communication. From this also follows that technical standards and other social rules may be efficiently inscribed in material "things" and as such may help freeze inscriptions, knowledge, values, money, relations, and actions inside "black boxes," where they become invisible, transportable, and powerful as parts of various sociotechnical arrangements in society, whether called nuclear power, medical services or (HD)TV (Joerges and Czarniawska 1998; Star 1991).

[6] *HDTV Newsletters*, 1989, vol 3. No 7.

[7] Like many others, I here use Polkinghorne's (1988:18) definition of narrative as a point of departure: "Narrative is a meaning structure that organizes events and human actions into a whole, thereby attributing significance to individual actions and events according to their effects on the whole … Narrative provides a symbolized account of actions that includes a temporal dimension."

[8] This point is clearly illustrated by the quote from Boyle in Shapin 1984:492 f.; Shapin and Schaffer 1985:62.

4 Shaping the Future in Relation to Existing Routines

The "founding story" of HDTV, as told in mainstream histories, begins with the birth of a particular research and development project at Japan's national public broadcasting corporation Nippon Hoso Kyokai (NHK) in Tokyo. According to the writings of one of the insiders in 1980, a group research engineers at the Science and Technical Research Laboratories at NHK (NHK Labs) started research in 1968 into a future TV system which would deliver cinema-quality pictures, capable of display on considerably larger screens than at present used for television (Fujio 1980).[9]

When NHK began experimental work with wider and sharper images of TV, the movie industry had already moved to larger screens with wider aspect ratios and to (35 mm) films with higher resolution. The NHK experimental TV system was early endowed with an identity related to the routines and standards of the cinema, and, for instance, the opportunities of digital technology and the demands of future post-industrial societies. As formulated by one of the NHK engineers involved in 1980:

> At one point in the history of the cinema, at the beginning of the 1950's, Hollywood started to develop wide-screen techniques which were capable of producing breathtakingly impressive images. Since then, there has been a steadily-growing demand for systems that can provide increasingly realistic images. Viewers will certainly not remain content with what they had thirty years ago in the field of television neither. Especially since large-capacity memory devices and digital technology have been put to practical use, it has become possible for broadcast engineers to produce a wide variety of processed images using TV signals./…/So, today, when it seems likely that what may be called an 'image-oriented society' of the future will be formulated on the basis of a continually developing television technology in an information-oriented age, it is clear that there is a great need for the development of higher-precision and higher-quality television technologies. It follows that a wide-screen high-fidelity television system adequate to the social demands of post-industrial societies of the future is a prime target. (Fujio 1980:113)

In defining and seeking credibility for *any* new TV system, one had to endow it with an identity related to the existing routines and standards for TV. These have always been split concerning the standards used for encoding, broadcasting and receiving TV signals. All three of the co-existing TV systems (and their subvariants) had been originally developed and designed for conventional terrestrial (i.e., earthbound) transmissions of color TV, and they were all compatible with earlier monochrome TV equipment. The German *PAL* was used in most West European countries. The French *SECAM* was used by francophone countries, much of the third world, the former Soviet union, and some of its Eastern European satellites. The Central and North American countries had followed the USA and Japan with the American

[9] However, following Hart (2004) and the NHK Labs' website (copyright 2002 NHK), the NHK Labs initiated studies on HDTV in 1964. Moreover, whether the Japanese were the original pioneers has been questioned (see, for instance, Inglis 1990:475).

NTSC. South America was divided between PAL and NTSC.[10] All three TV systems were united in the *aspect ratio*, that is, the ratio of the TV screen's width to its height: 4:3. All three systems also relied on the old "trick" of *interlaced scanning*.[11] But NTSC operated on the standards of 525 scanning lines and a 59.94 Hz field rate whereas both PAL and SECAM used 625 lines and a 50 Hz field rate.[12] It is worth noting that almost all movies developed for the cinema and a significant amount of program material developed for TV have traditionally initially been shot on film. Except for a few special cases, the display rate traditionally used for film is 24 frames/second (24 Hz).

By 1972, the new NHK laboratory concept had become marketed as HDTV.[13] *Nota bene*, it was not the first time this particular combination of Anglo-Saxon words was used in attempts to mobilize broader support and establish an identity for a new, "improved," TV system of tomorrow. Ever since the time of John Logie Baird's experimental TV broadcasts in the 1920s, almost every effort to improve the quality of the TV picture and, in particular, the detail of the image, has been heralded as bringing "high definition"—and the number of scanning lines has increased from 30 lines/picture to, for instanccne, 405, 625, and 819 lines. Like many others before them, NHK borrowed and reused the term "high-definition" to make visible descriptions and assumptions of what was the rule, that is, existing routines, and what would constitute a normal future of arrangements known as television.

Compared to the "old" standards and transmission technologies used for current TV systems, the huge bandwidth required for NHK's experimental (HD)TV system was quickly identified as a significant obstacle hindering its translation into commercialization. No matter what existing transmission medium was used—satellites, terrestrial broadcasting networks, or cables—it did not allow for unlimited

[10] At the same time as the three TV systems were a source of path dependence, they were themselves resulting from specific historical processes of innovation and research focus guided by the particular circumstances that led to the standards agreement arrived at in the 1930s (monochrome TV) and the standards agreement arrived at for color TV in 1953 (on NTSC) and in 1965 (PAL and SECAM) (Inglis 1990:237–276). Since the 1950s, when European engineers coined the expression, in some circles NTSC has been jestingly or derisively referred to as an acronym for *Never Twice the Same Colour*. SECAM has also been referred to as *Système Européen Contre l'Amerique*.

[11] In short, the method of interlace scanning (2:1) can be compared with the reading of a text but with the important difference that here only half of the lines are displayed on each pass of electron-beam scanning (or equivalent techniques), both in cameras and displays. In a first round (a first field) is every odd numbered line (of pixels) scanned and the even lines omitted, in a second round (a second field) is every even line scanned and the odd numbered omitted.

[12] "Fields" are groups of scanning lines that are scanned together at any given time in the imaging process. The *field rate* is twice the *frame rate* (i.e. the number of complete pictures—frames—that are transmitted per second). The traditional PAL, for instance, divides each 625-line frame into two separate fields (even- and odd-numbered lines). These two fields are then scanned separately and interlaced. Each 625-line frame is thus a composite of two fields (a field=1/2 frame). This reduced the "flicker" the viewer would otherwise see if only 25 fields (each representing a complete 625-line frame) were flashed each second. Thus PAL (like SECAM) has a 25 Hz frame rate and a 50 Hz field rate. NTSC, however, utilizes a 30 Hz frame rate and a 59.94 Hz field rate. As those familiar with power systems may observe, the field rate is in accordance with half the standard power source frequency used in the countries in question.

[13] References in Fujio 1980 tell us that the term 'High Quality Television System' is used in a NHK Technical Report from 1971 (Othani and Kubo) and that the term 'High-Definition TV' is used in NHK Technical reports from 1973 (Hamasaki et al. 1973; Kusaka and Nishizawa 1973).

bandwidth.[14] In line with internationally agreed frequency spectrum regulation, each terrestrial UHF and VHF TV service was (and is) allocated a standard bandwidth of 6, 7, or 8 MHz, depending on the region of the world.[15]

To be able to transform their laboratory concept into a real-world (HD)TV system that is part of daily routines, the NHK Labs depended, in part, on various institutionalized ways of mobilizing support and creating legitimacy in the everyday practice of research engineers involved in the (re)creation of TV systems. In the present text, this is most evident in some of the ways the ITU, the EBU, national governments and a number of other bodies and organizations were brought into play when different parties started to act upon the still underdetermined identity of HDTV. The practices and technologies associated with bodies such as the ITU and the EBU allowed networking, communication and change—as well as government, opposition, and competition—to occur on a larger scale when NHK and their partners sought to mobilize broader support for having their particular Japanese experimental system proposed and preferably also accepted as the basis for a worldwide agreement on a single HDTV standard.

A matter of intense practical concern for an emerging experimental HDTV community was what Schumpeter (1934/2007:71) called *the problem of detaching*: how to detach means ("already employed somewhere") from the established way of doing things and allotting them to new combinations.[16] A related problem in need of attention was *the issue of protection*, that is, how to ensure that people and different things assembled in the carrying out of new combinations would remain "loyal" to the path of innovation they had been recruited? The vocabulary, boundaries, and content of an emerging new experimental HDTV community needed to be defined, communicated, and securely institutionalized. Existing technical standards and other social rules had to be changed or removed as well as new ones created in order to create space for the new TV system.

Before exploring further the reconstruction of a new (HD)TV system in the NHK Labs, a few additional points need to be made. First, although the NHK research engineers who began working on a new (HD)TV system probably had not read Latour (1996:44), they knew that before any technological system can be inscribed into the nature of things, the revolutionary enthusiasm shared by a number of strangers and friends supporting its realization has to be inscribed on paper, requiring the construction of some kind of broadly based agreement. Nor had they probably read North (1990:3–6); yet, my sources indicate that they were well aware of his

[14] To be able to transmit any kind of information (speech, music, text or images) by means of electric waves—via cables or over the air—a certain frequency space is needed. The width of this spectrum space is termed *bandwidth* (measured in hertz, Hz) and is dependent upon the complexity of the signal. The width of the bandwidth is on the one hand dependent upon what kind of information signals that is transmitted. A telephone call, for instance, does not require far as much bandwidth as a TV program. The bandwidth is also dependent upon how the signals of information are transmitted (i.e., the speed by which the information is transmitted and the mode of modulation). For instance, frequency modulation (FM) requires greater bandwidth than amplitude modulation (AM).

[15] The standard bandwidth allocated for existing terrestrial TV services in the USA and other countries using the NTSC system is 6 MHz; in Europe and other parts of the world using PAL or SECAM, each TV service is allocated a bandwidth of 7 or 8 MHz.

[16] Cf. Callon's (1998) notion of the double process of "entanglement" and "disentanglement" in relation to the concepts of embeddedness, framing, and overflowing.

finding that a primary function of technical standards is to reduce uncertainty by providing a stable ("but not necessarily efficient") guiding structure for everyday life, giving predictability to interaction.

5 Mobilizing Support in Japan

Returning to the received story of HDTV: the NHK research engineers started their innovative activities by studying the characteristics of human visual perception in relation to, for instance, viewing distance, picture quality, picture format, and number of scanning lines in order to determine their options for improving the picture quality and fixing the parameters of a future TV system. After detailed investigations and "subjective evaluation tests," the NHK researchers concluded that the new TV system would have a doubled screen area and adher to a 5:3 aspect ratio—that is, wider than the 4:3 aspect ratio used in current television and closer to the "widescreen" display used in the cinema—because of the more "realistic and powerful picture representation" produced. They also calculated that the goal of producing a subjective better picture quality on an almost doubled screen area would require that the number of scanning lines be increased from the standard 525-line of the TV system used in Japan and North America (NTSC) to more than 1,100 scanning lines (Fujio 1980:114).

To mobilize broader support in order to transform the Japanese society as a whole into their enlarged house of experiment, the NHK engineers had by the early 1970s successfully wooed the support of not only the Japanese Government but also an expanding coalition of Japanese electronics manufacturers, among them Ikegami, Matsushita, and Sony. Among other things, NHK and their allies set out to (re)build an infrastructure necessary for linking their, still experimental, system to a national public. By the end of the 1970s, the experimental HDTV program had been married to a Japanese experimental program directed towards the development of so-called *broadcasting satellites* or *direct broadcasting satellites* (*DBSs*). In contrast to the first generations of communications satellites which had been used since the mid-1960s, such DBSs would allow satellite transmissions of TV *directly* to individual homes, without using traditional terrestrial transmission networks.[17]

In 1978, Japan launched what is often described as the first genuine DBS: the BSE satellite (Broadcasting Satellite for Experimental Purposes), also known as

[17] Satellite technology has been a relatively fixed and routinely used device in real-world arrangements for basic telecommunications services ever since the time of the establishment of Intelsat and the launch of its first satellite, Intelsat I ("the Early Bird"), in 1965. For a long period of time, communications satellites were only used for worldwide point-to-point communications, relaying primarily telephone calls and facsimile and data services, with long-distance point-to-point relays of TV signals being but an occasional service. Long before any communications satellite had been successfully launched into orbit, a boundary had been drawn between the usage of (1) satellites for such *point-to-point* communications, that is, between a limited number of earth-stations (used for both reception and transmission) located at "specified fixed points" on the globe, and (2) satellites for *broadcasting* directly to the individual households receiving TV signals from satellites on small (receive-only) dishes. By 1971, this boundary had been translated and enshrined in the ITU procedures in the form of a distinction made between *fixed satellite service* (*FSS*) and *broadcasting satellite service* (*BSS*) (Ewertsson 2001).

Yuri.[18] One of the aims of this experimental DBS was to test different technical systems for future national satellite broadcasting. Recognized for pioneering both HDTV and DBS, the NHK in league with other Japanese companies began HDTV test transmissions at this time, using Yuri and new HDTV equipment. As told in 1980:

> In November 1978, March 1979 and October 1979, transmission tests of the HD-TV were carried out using the Japanese experimental broadcasting satellite 'YURI'. In June 1980, a further transmission test was carried out during which an EHF link in the 38 GHz band was established between the Technical Research Laboratories and the NHK Broadcasting Center, at distance of about 8 Km, and the received picture was publicly exhibited for 3 days as part of the activities marking the 50th anniversary of the laboratory's 'open house'. (Fujio 1980:113)

Throughout the 1980s, the Japanese continued to explore this particular combination vigorously: HDTV transmitted via DBS. By 1985, transmissions of NHK's experimental HDTV systems had been combined with *MUSE*, a new bandwidth reduction system designed to transmit HDTV signals via satellites, which was also under development in Japan.[19] MUSE offered a solution to the problem of the huge bandwidth requirement of HDTV by making it possible to "squeeze" the 30 MHz of NHK's HDTV signal through a single 24–27 MHz satellite channel (Hatori and Nakamura 1989). In the 1980s, it became increasingly clear that the NHK and their allies were eager to win further support for the particular combination of HDTV, MUSE, and broadcasting satellites. For instance, in a report from the Japanese Ministry of Post and Telecommunications in 1987, we are told that:

> The HDTV Fair which consisted of an international symposium and demonstration of HDTV broadcasting was organized by the Broadcasting Technology Association (BTA) from May to June this year. In this demonstration, experimental satellite broadcasting of MUSE transmission by means of BS-2b satellite launched in February 1986 was carried out for 11 days. About 111,000 persons attended the demonstration in 14 cities. (Okai 1987:5.4.3)

6 Entering the Domains of Various Collectives Outside of Japan

At an early stage, the NHK engineers and their growing coalition of allies also began to seek support for their new (HD)TV system outside of Japan. During the 1970s, it became increasingly clear that the NHK were interested in winning support for Japanese HDTV as a new worldwide standard.

Disseminated through written accounts of experimental work carried out in Japan and demonstrations before various audiences, something called HDTV began to

[18] In January 1984, Japan launched the first commercially available DBS in the world: BS-2A, also known as the Yuri-2A (Ewertsson 2001:220).

[19] During its development, MUSE spawned several variants, for instance, MUSE-T, MUSE-E; MUSE-6, and Narrow-MUSE.

move across territorial and other boundaries in the 1970s. This transnational movement was aided and abetted by Japanese attempts at transplanting their experimental work on HDTV into the concerns of the *CCIR*. Headquartered in Geneva, the CCIR was a regular "club" of national network operators[20] and a creature of the governance structure that had evolved for an expanding range of telecommunications services since the mid-nineteenth century. It was a sub-unit of the ITU, an agency of the United Nations (UN), which was responsible for the regulation and planning of telecommunications worldwide.[21] At the time, the CCIR was still the only organization capable of (re)creating international technical standards for wireless (radio) communications systems, TV systems included. Its roles also included managing the allocation and use of frequencies in the electromagnetic spectrum and satellite orbit resources for radio communications. Given its monopoly position, the CCIR acted as what Callon and Law (1982) have termed an "obligatory passage point" for individuals and groups who wanted to be able to influence the development of international agreements on technical standards (*Recommendations*) for radio communications systems.[22]

Following a NHK proposal in 1972 for a new CCIR study program on HDTV, work on this subject in the CCIR began in 1974, with the adoption of Question 27/11.[23] The intense studies, tests, and experimentation carried out in Japan on the development of a new (HD)TV system had thus been given a framework for international standardization. By promoting their experimental work on a future TV system as "high definition" in relation to existing TV systems—NTSC, PAL, and SECAM—and by bringing it to the procedures of the CCIR, the NHK Labs and their allies had established an incontrovertible link between local action and transnational, if not global, change.

It can be mentioned that the annual "open house" exhibitions at the NHK Labs also seem to have been effective at introducing HDTV to a wider engineering and business audience in Japan and beyond. Every year, the NHK Labs in Tokyo hold an exhibition of research achievements which is open to industry and the general public. Several commentators associated with bodies such as the EBU and the American-based SMPTE remark that they quickly started following the development

[20] All telecommunications administrations that were members of the ITU were automatically members of the CCIR. Broadcasting and telecom operators may become members by forwarding a request through the respective administration and paying an annual fee. Participation in an advisory capacity was open to scientific and industrial organizations (e.g., laboratories, manufacturers) on the same basis, and related international organizations (e.g., regional broadcasting and telecommunication organizations) might participate in an advisory capacity. By the mid-1980s, the CCIR consisted of about 150 nations.

[21] In 1865, 20 countries established the *International Telegraph Union* (*ITU*). In 1932, the ITU merged with the *International Radio-telegraph Union* (*IRU*), established in 1903, to form what became reorganized as the *International Telecommunication Union*. The *CCIR* was established as a permanent subcommittee of the ITU in 1927. In 1947 the ITU achieved the status of a specialized agency within the UN. As part of the reorganization of the ITU in 1992, the CCIR was superceded by the *ITU-R*, the ITU Radiocommunication Sector, and the so-called Interim Working Parties (IWPs) were replaced by Task Groups.

[22] ITU/CCIR standards are referred to as *Recommendations*. The CCIR Recommendations were not binding in a legal sense. Implementation was voluntary, but, nevertheless, complience was high. An informal rule of consensus–a vote was taken only as a measure of last resort–ensured that standards were generally acceptable by all parties concerned.

[23] Krivocheev 1999:69, with reference to CCIR Document 11/31, 17 March 1972.

of HDTV in Japan and that they attended the NHK Labs' open houses "to see it for themselves" in the 1970s.[24]

We may assume that both the actions of the CCIR and the NHK Labs' annual "open houses" had a role in the decision taken by the SMPTE to set up a Study Group on HDTV in 1977. The results of this HDTV Study Group, with initial recommendations, were published in the February and March issues of the *SMPTE Journal* in 1980 (Hopkins and Davies 1990). The same year, in December, a paper concerning the "Present State of the Study of HD-TV Systems in Japan" was published in a technical journal belonging to the public domain of yet another large club of authority in the worlds of TV engineering: the American-based *IEEE*. The paper was authored by Takashi Fujio of the NHK Labs. Shortly after its publication, in February 1981, it was presented by him together with a demonstration of the NHK's experimental HDTV system at the SMPTE Annual Television Conference.

7 A Demonstration in 1981

As told in many HDTV histories, at the beginning of 1981, NHK demonstrated their experimental HDTV system for the first time outside of Japan to a wider engineering and business audience. On the initiative of the SMPTE, so the NHK story goes,[25] this international première took place at the society's 15th Annual Television Conference, held at St. Francis Hotel, San Francisco, on February 6–7 in 1981. Unfortunately, I was not among the participants or spectators. Yet, through written traces and photos, I will in this section seek to answer questions such as: What was the topic of this conference? How many people, and who in particular, attended the conference and the NHK demonstration? Why was the Japanese experimental HDTV system displayed at this particular conference? How were the HDTV demonstrations organized and perceived? Why has this particular demonstration gained a privileged position in narratives dealing with the history of (HD)TV?

Based in the USA, but with members all over the world, the SMPTE is a potent but heterogeneous collective of technically informed specialists who are skilled and experienced in film, video, and TV engineering. Founded in 1916 to advance theory and development in the emerging motion picture field, the work of the SMP(T)E[26] is indispensible for those who want to influence the design, working, networking, and control of TV and other motion-picture-based arrangements. Here, I must introduce a new thread into the story. In the USA, technical standards for television have traditionally been developed by five organizations: *the IEEE*, *the SMPTE*, *the EIA*, *the NAB*, *the NCTA*. As described in 1987:

> The Engineering Vice-Presidents of these groups make up the Joint Committee on inter-Society Coordination (JCIC) which monitors the standards work of

[24] NHK's first experimental HDTV system was exhibited at the NHK 'Open House' in 1969 (http://www.nhk.or.jp/strl/aboutstrl/evolution-of-tv-en/p16/index.html, access 080924).

[25] http://www.nhk.or.jp/strl/aboutstrl/evolution-of-tv-en/p16/column/index2.html (access 080924).

[26] The "T" was added to the Society in 1950 to embrace the emerging television. Membership in SMPTE committees is open to any interested and affected party. In 2008, SMPTE had members in 64 countries (http://www.smpte.org/about/, 080926).

> each group to avoid duplication and resolve any jurisdictional disputes. Each organization has responsibility for a portion of the total standards work; no one organization has total responsibility.[27]

Long accredited by the American National Standards Institute (ANSI) as responsible for a portion of the development of US voluntary national standards for television, the SMPTE has become a globally respected standards-setting body, connected with a network of like-minded peers. Although the sites in North America have varied from year to year, the Annual SMPTE Television Conference is an institutionalized fora to present, demonstrate, judge, and discuss what is on the horizon for television. Thus, the Annual SMPTE Television Conference is an obvious place for trying to extend experimental findings, claims, and objects to "significant others" designing, constructing, and controlling television and related motion-pictures arrangements.

At the time of its 15th Annual Television Conference, the SMPTE had already began to act upon and direct the still highly uncertain and flexible identity of HDTV, as illustrated by the setting up of its HDTV Study Group in 1977. Moreover, the CCIR's 1978–1982 study period was drawing to an end; discussing and demonstrating HDTV at the 1981 SMPTE Conference may have been seen as an efficacious means to influence discussions at the next CCIR Plenary Assembly to be held in 1982.[28] Moreover, in the fragmented world of television, Japan and North America had for decades been united in using the 525-line transmission and display color-TV system known as NTSC. Whether the early HDTV experimentalists wanted to rebuild all existing TV markets in the world or just the more limited American/Japanese (NTSC) markets, it was essential to struggle to gain or maintain credibility in the eyes of members of a "society" and affiliated groups that were important for things they needed to do to be able to (re)build a broader market for their new (HD)TV system, such as changing the institutional shaping and management of many types of connections and interactions that ensured the working and continuity of television.

The earliest account of the 15th Annual SMPTE Television Conference that I have found is a SMPTE Report published in April 1981.[29] Reading the introduction of this report, we are immediately confronted with the role of this conference as heralding the dawn of "The Digital Decade." The 1981 conference is described as "particularly significant because of the Society's increasing role in the possible formulation of world-wide standards for digital television." Besides the papers and demonstrations given during the conference, there was "a series of exciting and important tests and demonstrations given earlier in the week" (2–5 February) at the KPIX studios "to give viewers a factual basis to aid them in establishing appropriate standards" for such a worldwide digital system.

[27] Robert Hopkins: "HDTV, Past and Present," paper presented at IEEE Electro/87, Electronic Show and Convention, Session 33 High Definition Television Applications, April 7-9, 1987, New York.

[28] The work of the CCIR was organized into 4-year study periods with an intermediate and a terminating meeting period. Its highest organ, the Plenary Assembly, met every 4 years to set standards and identify future standardization needs. In between, work was carried out by *Study Groups* of technical experts from the member administrations and from industry. In addition, activities could be going on in temporary working groups—*IWPs*—composed of a limited number of technical experts investigating specific issues.

[29] If nothing else is mentioned, this section is built upon this SMPTE Report: "Production and Post Production in the Eighties; The 15th Annual SMPTE Television Conference," pp. 296–316, 320–324.

Several working groups, committees, and study groups met before, during, and after the conference to discuss issues relating to the various specialized topics. These groups represented not only the SMPTE but also members from other associations around the world, such as the IEEE; the EBU, and the BBC. To complement the presentations and group discussions, "23 companies exhibited equipment, which exemplified the major topics of the conference." Following the SMPTE report, "the important topics (and the exciting location)" attracted a total of 846 people from all over the world to attend this particular conference in 1981, "with the paid registration reaching a total of 773." From the writing and photos in the SMPTE Report, we may assume that a veritable Who's Who of the equipment manufacturing, broadcasting, and film industries was gathered in San Francisco these particular days.

Clearly, the NHK demonstration of HDTV was only one of a number of demonstrations that had gained access to the limited space of the relatively public rooms and setting of the conference. But this particular demonstration was the only one on HDTV, crowning a series of papers given on HDTV in the session on "future directions." Although not explicitly addressed as a turning point in history, this demonstration is nevertheless portrayed as a privileged moment in SMPTE's own contemporary report. In the first sentences of this 13-page report, we are told of "an impressive HDTV demonstration." A few pages later, we can read that this particular demonstration served to complement the paper presentation of Dr. Takashi Fujio of NHK Technical Research Laboratories: "Present State of the Study of High-Definition Television System in Japan." It may be of interest to note that the same Fujio, here obviously addressed as "doctor," also presented another paper at the conference, in the session "New Camera Technology and Digital Techniques."[30] After a short summary of Fujio's paper presentation on HDTV, we are told about the unique nature of this NHK demonstration:

> After Dr. Fujio presented his paper, he invited the audience to step next door to observe the NHK demonstration of HDTV. The developed system is a 1125-line color television system, and its presentation at the conference is *the first showing of the system in North America*. The equipment on display included a special broadband color camera with unique two-inch Saticon pickup tubes and a large screen, and also a direct-view picture-tube display device with a high-resolution face-plate. Prior to this demonstration the equipment had been seen by only a small number of people who had recently visited the NHK laboratories in Japan. *The picture quality was judged by many to be excellent*. The demonstration continued for several hours in the afternoon and then resumed again later that evening to give all interested parties an opportunity *to see for themselves* what is on the horizon for high definition television. (p. 314 f, not italics in the original)

However, according to Fujio, he did not himself belong to those who judged the picture quality of NHK's experimental HDTV system "to be excellent" at the time:

[30] This paper was titled "Super Camera Using Saticon and Built-in Computer Control System." Takashi Sueoka of NHK was the senior author of this paper, coauthored by K. Wakui, K. Murakami, T. Mochizuki, T. Kawai, and K. Ohzeki.

> However, the resolution and contrast of the final picture are neither yet satisfactory, and HD-TV with 1,125 scanning lines has not yet been fully realized by this means. Continued effort aimed at better performance of video projectors is still necessary. (Fujio 1980:119 f.)

Through Fujio's paper presentation and the complementary demonstration, a particular fact became visible: NHK and a growing coalition of Japanese allies had taken the initiative in developing a new widescreen experimental HDTV system based upon the following provisional standards: 1,125 scanning lines, a 5:3 aspect ratio, a 2:1 line interlace ratio, and a 60 Hz field repetition frequency (Fujio 1980:115). A range of prototype production and consumer equipment had already been developed. Since 1978 real-world transmission tests, experiments, and demonstrations had been carried out, using the new equipment and a Japanese experimental broadcasting satellite.

Apparently, by drawing attention to what the experimental HDTV system *could* do,the paper presentations and the demonstration at the SMPTE Conference also made visible to an enlarged audience what it could *not* do. The standards of the 1,125-scanning line large-screen experimental system were, for instance, not compatible with, nor readily convertible to, any of the existing "normal-definition" standards: NTSC, PAL, and SECAM. A related problem was the huge signal bandwidth that was required for transmission compared to current TV systems. Because of the huge amount of additional picture information, an HDTV signal of the Japanese experimental system required a bandwidth of approximately 30 MHz. If existing over-the-air, cable, and satellite technologies should be used, the HDTV signal of the NHK system would require about four to five times more bandwidth than the 6–8 MHz bandwith of the transmission channel available to any existing TV service. As one of my interviewees described the situation at a later time: it was an issue of how to get a camel to go through the eye of a needle.[31]

Recognizing the huge bandwidth required and the state of the art of existing transmission technologies as part of the problems of HDTV, Fujio's paper nevertheless revealed that NHK was considering several possible alternatives for transmitting future HDTV signals to the homes of the general public: satellite broadcasting, optical fibers, and digital transmission systems utilizing digital signal processing techniques. However, at the same time, the paper presented at the SMPTE conference helped make it clear that NHK, and its allies had began to explore, in particular, the new combination of HDTV and satellite broadcasting (that is, DBS) as the privileged means of distributing HDTV services to the general public. Fujio claimed that:

> The most economical and practical system for the proposed HD-TV service may be transmission by satellite broadcasting and reception by common-use antenna or by home antenna. (Fujio 1980:121)

Fujio's paper presentation and the HDTV demonstrations at the SMPTE conference also aided some other claims to be put into broader circulation,

[31] Sven Olof Ekholm, interview 2006-11-06.

indicating the importance of, among other things, taking action towards "unified world standards" for tomorrow's HDTV:

> However, in order to constitute a practical HD-TV broadcasting system, the development of a high-resolution large-screen video display, a high resolution pickup tube and a video recorder may be the principal problems to be solved. With increasing interest in the advent of high-definition wide-screen television systems in several countries, it is expected that unified world standards for picture aspect, signal standards and transmission standards will be established for the promotion of rapid development of HD-TV systems. (Fujio 1980:123)

In another paper presentation given in the session of "Future Directions for Television," an alternative program of development was suggested. This paper—"High Definition Television Studies on Compatible Basis with Present Standards"—was written by Broder Wendland of the Universität Dortmund, West Germany. As formulated in the SMPTE Report, the author of this paper was of the opinion "that before any new standard for high definition television (HDTV) systems is defined, the possible improvements within the given standards should be considered." The SMPTE Report also draws attention to the paper presented by Joseph Polonsky, Technical Director of Thomson-CSF,[32] France, in the same session. As formulated by the SMPTE's reporter in 1981:

> He [Polonsky] called attention to three areas in which additional research is needed: marketing, bandwidth compression, and compatibility. He concluded that we have approximately eight to ten years to optimize the future standards of professional and consumer HDTV systems. To illustrate the dynamic nature of this technology, the author posed the question, 'How does one select the correct size of shoe for a growing child?'

The SMPTE Report on the 15th Annual SMPTE Television Conference embraces 29 pictures in total. Both in number of photos and in rhetorics, the NHK demonstrations of HDTV are here competing with the mentioned SMPTE digital video demonstrations (which actually took place prior to and outside the locale of the conference) as being represented as the most high profile event or action. *Talk and discussions* (not material objects) related to *HDTV* are represented by two pictures. One portrays the aforementioned Joseph Polansky presenting his paper on HDTV. The other one catches the serious faces of at least 15 people at the meeting of the SMPTE Working Group on HDTV. The *scenes* at the NHK demonstration are represented in three photos, each showing people and technical equipment. One is an image of a crowded room of (at least ten and exclusively male) "viewers" attempting to see three "high-resolution" CRTs[33] with a wide aspect ratio.

The other two photos catching the NHK demonstrations in the SMPTE Report include the presence of named men in the scenes over which Fujio of NHK presides. In one photo, we see the well-known Francis Ford Coppola in action behind the

[32] Thomson-CSF (Compagnie Générale de Télégraphie Sans Fil) was a major electronics and defense contractor. In December 2000, it was renamed Thales Group.

[33] Alongside efforts to replace the cathode ray tube (CRT) by alternative display techniques, the previously offered monitor and projection systems used for experimental HDTV were initially equipped exclusively with this type of tube.

NHK high-definition color camera, while Fujio looks on. Besides the image, we are told that Coppola, "the renowned Director and Producer," studies the picture quality attainable with the NHK high-definition camera. In the other photo, we see Fujio standing close to the same NHK camera, flanked by three named men whose presence do not reflect any direct action besides smiling: Joseph A. Flaherty, vice-president of the Engineering and Development Department at CBS (that is, Columbia Broadcasting System, one of the three largest TV networks dominating broadcasting in the USA) and, again, the aforementioned Coppola and Polonsky.

My sources do not establish the exact circumstances and links between Coppola, Flaherty, or Polansky in relation to SMPTE, Fujio, and the NHK demonstrations. They do not tell me, for instance, whether, or when, Coppola might have become recruited to act as a representative who spoke in the name of experimental HDTV. But my sources do tell me that by the time of the 1981 SMPTE conference not only Fujio but also Flaherty and Polonsky had began to act as such spokespersons of HDTV in the public fora of certain communities.

In the case of Polonsky, this can be confirmed by his already mentioned paper presentation on HDTV at the conference. In the case of Flaherty, he was in the process of becoming a high profile spokesperson of both HDTV *and* the interests of the American domestic terrestrial broadcasters. In a technical journal from 1992, Flaherty is advertised as "responsible for opening the HDTV debate in the United States in 1981" and that he "has been an influential figure in this field ever since" (Flaherty 1992a:70). A more contemporary commentator remarks that it was "Joseph Flaherty of CBS, one of the great champions of HDTV," that organized the demonstrations of NHK's HDTV system at the SMPTE Television Conference in 1981 (Wood 2007:2/6). Another source (*ITU News* 2007/10) tells us that Flaherty also was present at the first demonstration of HDTV in Europe, in 1982 at the General Assembly of the EBU in Killarney, Ireland. In a scholarly work (Hart 2004:96), we are told that Flaherty "became a key player" in a new organization formed in the USA in 1982, the *Advanced Television Systems Committee* (ATSC). From Flaherty's own writing and CV, we understand that he became a high profile member of a number of other organizational inventions setup to help stabilize and accelerate the growth of an American HDTV market in the 1980s, such as the FCC *Advisory Committee on Advanced Television Service*, established in 1987, and the private *Advanced Television Test Center*, set up in 1989.[34] We may also assume that the same Flaherty had a prominent role in organizing the particular demonstration of NHK's HDTV system that was hosted by CBS in Washington, D.C. some weeks after the SMPTE conference (see below). Gradually, Flaherty acted as a spokesperson of *(digital) terrestrial* HDTV transmissions, linking the promises and threats of HDTV to the survival of existing American terrestrial TV broadcasters, as reflected in his speech at a CBS meeting in January 1988:

> Recognizing that VCRs, video disks, cable, and future DBS services will be able to deliver HDTV with fewer spectrum (or bandwidth) constraints than broadcasting, we must ensure that terrestrial broadcasters have a pre-eminent position in the HDTV-landscape, however difficult that may seem today. We

[34] Flaherty (1991, 1992a, b)

> must achieve competitive parity at the outset and, equally important, we must maintain that parity as my HDTV evolves and improves with time. (Flaherty 1992a:68)

In the case of Fujio, his role at the 1981 SMPTE conference and his role as author of the paper published in *Broadcasting*, *IEEE Transactions on Broadcasting* in December 1980 tell us that he, by then, had begun to appear as a transnational public spokesperson of an experimental HDTV system and, for instance, a new Japanese experimental program as well as the demands of future societies. Whether or not Fujio himself had written the mentioned paper is not my concern.[35] But I want to underline that by signing this paper and by presenting it at the SMPTE conference in 1981 in relation to demonstrations of prototype equipment, he more than any other early HDTV experimentalist at the time *appeared* as a spokesperson of HDTV in the public fora of certain specialist "societies" outside of Japan, spelling out, exemplifying, and diagnosing the matter, form, and direction in English.

The HDTV demonstrations in 1981 remind us that the potential effects of any demonstration depend in large part upon its site and setting, including the ability of the organizers to mobilize relevant persons as witnesses. As other socio-historical studies of new (or renewed) programs of research and experimentation have shown (for example: Elam 2004; Shapin and Schaffer 1985), first-hand witnesses who have the means and generally the skill to deliver and publicly signal sensory experience as well as images of trust, celebrity, honor, competence, and modesty in some type of society may act as powerful resources for gaining wide recognition and other resources in efforts to mobilize broader support in the setting of that society.

When SMPTE's own reporter, Gerald C. Engbretson, assisted by SMPTE Technical Editor, Arthur Biderman, and freelance photographer Donna Foster-Roized, composed his report on the 15th Annual SMPTE Television Conference, the photos of Coppola, Flaherty, and Polansky were probably chosen in order to attract attention and certify the importance of the HDTV demonstration by measuring this event or action against the knowledge, skills, and positions of these particular men, who already had gained a wide and reputational status as respected professionals, experts, virtuosi, or leaders among SMPTE members. Certainly, the reputation and positions of Coppola, Flaherty, and Polansky in SMPTE and other relevant institutionalized collectives as well as the opportunity to face-to-face interaction constituted valuable resources in the production and spatialization of stories that could help expand the public sensory experience of the HDTV demonstrations as concrete observable illustrations of "how things really are." So did the materialization of the (HD)TV experimental program into demonstrable, highly visual and tangible, "real," HDTV equipment. As Shapin (1984:508) has pointed out in his analysis of Boyle's experimental work in seventeenth century England, artefacts have a particular role in relation to staged performances and verbal schemes as parts of the production of matters of fact: "The machine constitutes a resource that may be used

[35] Thanks to some of the many interviews I have carried out throughout my various studies, I have been able to learn that the person signing an article or a report does not necessarily be the person who has written it. See also Shapin (1994:361) who discusses the question: "Why was Boyle the author of Papin's text?"

to factor out human agency in the intellectual product: 'it is not I who says this; it is the machine that speaks,' or 'it is not your fault; it is the machine's.'"

8 Towards a Single Worldwide HDTV Standard?

What has happened in the transit through time and space from the HDTV demonstrations held at St. Francis Hotel, San Francisco, on February 6–7 in 1981? Faced with a number of HDTV narratives, we now know that these demonstrations helped open up for multiple interpretations and the development of a larger movement of recombinations that soon diverged into a range of competing (HD)TV projects, systems, and names,[36] each of which was shaped by local contingencies. Indeed, in the 1980s, a growing body of friends and enemies all over the world were rushing in to help mark, modify, contest, or reject the boundaries as well as diagnose, shape, and fill the content of something called HDTV.

The CCIR Study Group 11 (on broadcasting) had dealt with HDTV since 1972, but it was not until 1983 that it was becoming clear that moves were taken towards standardization. It was also clear that HDTV standardization had become a matter of immediate concern for many individuals and collectives. In March 1983, at the Fourth World Conference of Broadcasting Unions, held in Algiers, the nine members adopted a recommendation that they should work toward a single worldwide HDTV production standard.[37] In 1983 (or 1982 according to more contemporary sources), the ATSC was formed in the USA to coordinate and develop voluntary national technical standards for "improved NTSC, enhanced 525-line and high definition" TV systems and to develop a national position within international standards organizations.[38] Also in 1983, the CCIR set up an Interim Working Party (IWP 11/6) to study and prepare a draft Recommendation for a single, worldwide HDTV studio production standard before the next CCIR Plenary Assembly (1986).[39]

The possible formulation of a worldwide HDTV *studio* standard[40] was widely discussed at the final meetings of IWP 11/6 and the whole Study Group 11 in 1985 before the 1986 CCIR Plenary Assembly. The USA, Canada, Japan, and Brazil (all

[36] In addition to HDTV, the increasing number of projects which from the early 1980s were directed towards the introduction of a future TV system were also variously referred to as, for instance, ATV ("advanced TV") and EDTV ("enhanced" or "extended TV").

[37] Streeter 1987:1108; Wassiczek 1987:5.5.3.

[38] The ATSC was established as a private sector organization by the Joint Council on Intersociety Coordination (JCIC). The five members of the JCIC were the charter members of the ATSC: *the EIA*, *the IEEE*, *the NAB*, *the NCTA*, and *the SMPTE*. Altogether, there were 51 member organizations and 12 observer organizations in the ATSC (Kennedy 1989; Streeter 1987; Robert Hopkins, "Panel Discussion Montreux Television Symposium," Montreux, Switzerland, June, 1985.) As an organizational invention, the ATSC was not dissimilar to the first NTSC that served from July 1940 to March 1941 and developed the US standards for black and white TV, or the second NTSC that served from January 1950 to February 1953 and developed the US standards for color TV (Robert Hopkins, "Advanced Television Systems," speech at Consumer Electronics Show, Washington, DC, January 1986).

[39] IWP 11/6 was chaired by Mr. Tadokoro of the Japanese NHK (Streeter 1987:1108).

[40] The initial emphasis in the CCIR on achieving a single world-wide standard for production and international program exchange (that is, a *studio* standard) obviously followed a pattern: "In the CCIR, at least in the past, there has been no movement to establish emission standards before studio standards" (Ninomiya 1991:17).

belonging to a 525-line/60 Hz NTSC milieu) were pushing the CCIR to adopt a worldwide HDTV production standard involving the provisional HDTV standards that had been specified at the NHK by 1978: 1,125 scanning lines, 60 Hz field rate, interlaced 2:1 scanning, but with the aspect ratio originally proposed by NHK (5:3) widened to 16:9.[41] However, participants from, in particular, some governments and major corporations in Western Europe (using the 625 line/50 Hz standards of PAL/SECAM) were strong opponents to the only proposed (1,125/60) HDTV standards. A footnote attached to the 'Proposal for a new Recommendation' that IWP11/6 presented to the CCIR Plenary Assembly in May 1986 reads:

> A number of administrations using the 625/50 standard have reservations about the parameter values above, and at this time are not able to accept these as a basis for a single world-wide HDTV studio and international exchange standard.[42]

In the memory of a US delegate:

> It all came to a head at the CCIR Plenary Assembly in Dubrovnik in 1986. Dubrovnik, the old walled, now bombed city. About two weeks after Chernobyl! And about 500 miles downwind! Was that a warning? The CCIR vote on 1125/60 as a world-wide production standard was terrible, maybe 1,000 to 3! Perhaps I exaggerate. It sure didn't seem so at the time, though.[43]

In May 1986, the CCIR XVI Plenary Assembly unanimously agreed to postpone taking a decision on a worldwide HDTV studio standard until the next Plenary Assembly in 1990. In 1987, the 1125/60 proposal submitted to the CCIR was adopted as the national studio standard by Japanese authorities (Okai 1987). With the start of 8 h regular broadcast of the Hi-Vision system 25 November 1991, "Japan became the first nation to bring HDTV to prime time" and hoped "to show the world the length of its lead in high-definition technology."[44] There was still no other HDTV system being used in daily broadcasts and commercially available.

During the 1980s, the 1125/60 parameters had also emerged as the SMPTE 240M standard for HDTV production equipment in the US. Two other important policy groups had given their endorsement to this HDTV production standard: the ATSC and the ANSI. But by 1989, the ATSC had formally left their previous support for the 1125/60 production standard, favoring instead a "common image" production standard based on 1,920 pixels per active line and 1,080 active scanning lines per picture (Jurgen 1989:30; Schaefer and Atkin 1991:413).

[41] Following the then Executive Director of ATSC, it was the SMPTE that in 1985 proposed the 16:9 ratio because they wanted "to permit a shoot and protect scheme to cover any released aspect ratio between 4:3 and 2.35:1" (in the existing library of films, the narrowest pictures were generally 4:3 and the widest pictures were generally 2.35.1; Robert Hopkins, "Advanced Television Systems," speech at Consumer Electronics Show, Washington, DC, January 1986; Hopkins, "Comments on HDTV," speech at ITS Lunch Meeting, May 8, 1996).

[42] "Proposal for a new Recommendation: Parameter values for signal generation in HDTV studios and for international exchange of HDTV programs," Annex II to Report 801–2, The Present State of High-Definition Television (1974–1978–1982–1986; CCIR Document 11/499 (Rev. 1))

[43] Robert Hopkins, "A Look Back, A Look Forward," luncheon speech, IEEE 45th Annual Broadcast Symposium, Washington, D.C., September 22, 1995.

[44] http://www.nytimes.com/1991/11/26/business/few-see-japan-make-tv-history.html?pagewanted=1.

The HDTV demonstrations in the US in 1981 were *some* of the sources that spurred an increasing number of participants to get involved in a range of R & D programs set up in the USA to (re)create, test, and observe the development of various improved NTSC, enhanced 525-line and HDTV systems to replace NTSC as the new national advanced television (ATV) transmission standard. The evolution of these new alternative R & D programs was corresponded by attempts channeled through the FCC, the regulator, to (re)shape and fix the institutional conditions for tomorrow's (HD)TV system. After completing a series of tests to evaluate competing systems, the FCC was expected to take the decision about an American standard in 1993. The CBS, among others, lobbied hard for an HDTV solution that would guarantee the survival of the existing 1,420 independent local TV broadcasting stations, using terrestrial transmission networks and cable TV systems (Flaherty 1991).

Although satellites were still expected to play a role, during 1990 and the following year, it was becoming apparent that the USA was going in the direction of over-the-air terrestrial transmissions of HDTV, and in particular the development of "all-digital" transmission systems that would fit in the standard bandwidth allocated for existing terrestrial TV services in the USA (6 MHz). The heightening of interest in digital transmission systems for (HD)TV was also coupled with significant advances in digital modulations and channel-coding techniques.

Shortly after the 1986 CCIR Plenary Assembly, a particular alternative (European) experimental program made its first public appearance: the *Eureka EU95 HDTV Project*. This project promoted an HDTV studio standard and a transmission system related to the MAC emission standards that were under development for future satellite broadcasts in Europe, involving 1,250 lines, 50 Hz, progressive 1:1 scanning, and a 16:9 aspect ratio. It appeared as the Japanese 1125/60 system's most vigorous opponent in what by then increasingly was reported upon as a "war" or "battle" over which technical standards should ultimately carry HDTV and its market(s). At the time battle slogans and costumes became attached to HDTV, visions and experimental work had also begun to include other applications than broadcasting, such as, for instance, theater, exhibitions, education, medicine, and computer graphics.

After over 20 years of studies and discussions aiming at reconciling the 50 and 60 Hz worlds, it was not, however, until 1998 that was approved a draft version of a recommendation for production and international program exchange of HDTV that were applicable to both 50 and 60 Hz field rates (as well as to the 24 Hz original frame rate for film), supporting both interlaced ("2:1") and progressively ("1:1") processed TV signals.[45] Largely framed by the development of digital technology and progress in electronic technology, the work that led to *Recommendation ITU-R BT. 709-3* was carried out over several years by many individuals, organizations, and administrations at a number of places throughout the world and many were the discussions, tests, demonstrations, reports, and recommendations that contributed to its evolution.

[45] The CCIR and the ITU-R (which superceded the CCIR in 1992) obviously had to face the reality of progressively scanned TV pictures as an alternative method to the about 70-year-old trick of *interlace* (*i*) *scanning* ("2:1"). *Progressive* (*p*) *scanning* ("1:1"), that is, a complete picture (frame) is displayed, for instance, 50 times per second.

The current version of *Recommendation ITU-R BT.709* says "that for HDTV program production and international exchange, one of the systems described in Parts 1 or 2 of this Recommendation, should be used" and "that for new HDTV program production and international exchange, systems described in Part 2 are preferred."[46] Part 1 is based upon the old "battle" between the 1125/60/2:1 system and the 1250/50/1:1 system. Eventually, an alternative was added (Part 2), based on the Common Image Format formally agreed upon in 1998, encouraging a 1,080× 1,920 format as the preferred image system for new HDTV implementations. Today's (HD)TV arrangements are made up of a mix of alternative systems and technologies, carrying circumstances and battles of the past as well as standards linked to new combinations of words such as flat screen TV, HD-ready and Full-HDTV.[47]

9 The HDTV Demonstrations in the Rear-View Mirror

Thus, there still is no single worldwide studio standard for HDTV. Nevertheless, in stories about the early development of HDTV, the NHK demonstration at the SMPTE conference in 1981 often appears as a privileged event or turning point, marking a boundary between the past, the present, and the future in relation to various individuals' and groups' actions and even non-action. For example, in 1990, Andrew F. Inglis, who had worked as a broadcast industry professional for 45 years in the USA, portrayed the 1981 demonstration as the peak of pioneering research in HDTV systems made by the Japanese NHK. He continues:

> The results were variously described as awesome, extraordinary, and breathtaking. Its spectrum bandwidth, 30 MHz, was excessive for broadcasting, but it was the ancestor of the various MUSE systems […] introduced later. (Inglis 1990:475)

Following Inglis, both the SMPTE demonstrations and a demonstration of the NHK experimental system held a few weeks later in Washington were important for widening the dance of experimental reconstructions and standardization of HDTV:

> The NHK demonstration was the catalyst for the widespread participation by the television industry. The SMPTE showing was seen primarily by professional engineers, but CBS hosted a semipublic demonstration in Washington a month later for the press, government officials, and other broadcasters. This aroused wider interest, and at least a dozen companies joined NHK and Sony (which had developed much of NHK's equipment) in

[46] Recommendation ITU-R BT.709-5. Parameter values for the HDTV standards for production and international program exchange (Question ITU-R 27/11) (1990–1994–1995–1998–2000–2002).

[47] According to Erik Stare (telephone calls 2008-10-21; 2009-01-07), a research engineer who has been highly involved in (HD)TV standardization in recent decades, today the production standard of 1,920× 1,080/2:1 ("1080i") has become dominant and it seems like the old alternatives are becoming extinct. Also 1,280×720/1:1 ("720p"—"HD-Ready") is increasingly used in 50/60/24 Hz while the standard of 1,920× 1,080/1:1 ("1080p"—"Full HD") for 50 and 60 Hz is not yet so common because of the huge bandwidth requirement in studio and in transmissions between studios (1080p is, however, used for film, 24 Hz).

> the quest for a system that would be accepted as the standard by regulatory authorities and the marketplace. (Inglis 1990:476).

Without discussing the immediate effect of any of these demonstrations, in 1987 the then SMPTE Engineering Vice-President pointed out that 2 weeks after "the first North American demonstration of the NHK HDTV system" at the 1981 SMPTE conference, a demonstration was conducted in Washington, D.C., for the FCC and other government bodies (Streeter 1987). In a lecture held in 1988, his successor made the following claim:

> At the 1981 SMPTE Television Conference in San Francisco, NHK demonstrated their HDTV system for the first time outside of their laboratories in Japan. Interest in HDTV in the United States was gaining strength as a result of the NHK demonstration, and the active support of CBS as well as many Japanese manufacturers. (Kennedy 1989:68)

And when Steven Barlow in the early twenty-first century gave his account of the early years of HDTV, he wrote: "The first demonstration of HDTV in the United States took place in 1981 and generated a great deal of interest."[48] A similar account of this event can be found on the NHK Labs' website:

> The first demonstration of an HDTV system was presented in the United States in 1981, making a strong impression with its breathtaking images. Standardization of the HDTV system, because of the potential profits involved, had become a significant global issue involving competition between corporations and diplomacy between countries.[49]

> In response to a fervent request from the Society of Motion Picture and Television Engineers (SMPTE) in the United States, NHK's high-definition TV system was presented at the society's Winter Conference in San Francisco./…/ It caused a big sensation.[50]

For a different view, we can look at another claim, as publicized recently by a scholar based in the USA (according to the NHK's website, the Japanese experimental system was, however, not labeled Hi-Vision until 1985[51]):

> NHK showed prototypes of Hi-Vision equipment at the 1981 meeting of the Society for Motion Picture and Television Engineers (SMPTE). Since these prototypes were pre-MUSE, they were not taken seriously. Nobody in the United States was interested in broadcasting a signal that required 30 megahertz of bandwidth. (Hart 2004:95).

Nevertheless, the HDTV demonstrations at the SMPTE conference in February 1981 seem to have survived as a privileged point in stories spread across terrains

[48] http://www.audioholics.com/education/display-formats-technology/hdtv-past-present-and-future-part-i-history, last modified July, 2009.

[49] http://www.nhk.or.jp/strl/aboutstrl/evolution-of-tv-en/p17/index.html, access 080924.

[50] http://www.nhk.or.jp/strl/aboutstrl/evolution-of-tv-en/p16/column/index2.html, access 080924, Copyright 2002 NHK.

[51] www.nhk.or.jp/strl/aboutstrl/evolution-of-tv-en/p16/index.html, access 24/9 080924.

associated with a particular European-based association: the EBU.[52] For instance, if we follow the public tale of David Wood, Head of New Technology, EBU, this particular NHK demonstration in 1981 was a "milestone for us." He continues:

> The demonstration was organized by Joseph Flaherty of CBS, one of the great champions of HDTV. The EBU's senior technical body was its 'Bureau of the Technical Committee' and they were, at that time, involved in a close dialog with the SMPTE about the parameter values for a conventional-quality digital production standard ('4:2:2'). The SMPTE invited the Bureau to come to San Francisco at this same time, so there could be joint discussions about this '4:2:2' format. Being in San Francisco, it was inevitable that the Bureau would see the NHK demonstration of HDTV–and be impressed by it. Bells began to ring in European heads that HDTV was moving closer to operational practice. To illustrate European ways, Henri Mertens usually recounted that '*when the United States launches a satellite, Europe launches a committee'*. This was time for another committee too. (Wood 2007:2/6; italics in the orig.)

Following Wood, this meant that Sub-group V1 of Working Party V of the EBU in 1981 decided to set up a Specialist Group to investigate HDTV. Wood became the secretary of this group, V1/HDTV. As told by him, shortly after this group had started, "we learned that George Waters, then Vice President of the EBU and Director General of RTE in Ireland, had invited NHK to bring their demonstration of HDTV to the next EBU General Assembly" which was scheduled to take place in June 1982 in Killarney, Ireland (Wood 2007:2/6). As Wood remembers, this became yet another milestone for the EBU in relation to HDTV:

> This first demonstration of HDTV in Europe looked like being (and was) a jewel in the crown for that meeting. Needless to say, V1/HDTV held a meeting at the same time in Ireland, and eagerly saw the demonstration (in the author's case, many times).
>
> The demonstration in Ireland was more comprehensive than the one that the SMPTE had seen. NHK and CBS brought material which showed a range of natural history and sport in HDTV, and a nature documentary about Japanese culture. Delegates (or at least the author) could not believe their eyes. The outstanding beauty of a flock of pink flamingos in HDTV tore into the senses. We seemed to be looking through a window. At the end of the program it seemed incredible to have minute credit lines which could still be read on the screen. The reality of HDTV and its potential for broadcasting was coming home to us. (Wood 2007:3/6)

Here, I would like to pay attention also to another milestone as defined by Wood in and from the point of view of his position in the EBU. In the late 1970s, a

[52] Founded in 1950, the EBU has an identity as a representative and defender of a large collective of broadcasters' interest at European and international levels. The EBU has traditionally been highly involved in R & D of radio and TV systems, including partnership and cooperation for the development and introduction of new standards, systems and products. By the late 1980s, the EBU had about 35 member broadcaster organizations, who provided broadcasting services which were national in character, throughout Europe and around the Mediterranean.

delegation from the EBU should have visited the NHK Labs "to see it for themselves": the development of HDTV in Japan. One of the delegates, Henri Mertens, Chief Engineers of the EBU in Brussels at that time, later told Wood that they were impressed, but convinced its use in Europe was "a long way off."[53] In Wood's tale, the actions of the SMPTE in relation to the early development of HDTV were important for shaping the EBU's initial (low) interest in HDTV:

> EBU members watched the SMPTE (the Society of/…/) set up a committee to examine HDTV and its applications in the late 1970. Their report concluded that HDTV would have a place principally in the cinema. EBU respected the SMPTE very much. If anyone would know where HDTV could be important, it should be the SMPTE, so the matter was put on one side for broadcasting in Europe for the moment. The IBA Long range Studies Report on HDTV is an example of the EBU Members' sentiment at the time.[54]

Wood's account was published in July 2007, at a time when HDTV had begun to appear as real-world pieces of consumer equipment in an increasing number of private homes. At that moment we also see certain cases of demonstrations becoming the central act of the historical presentation of the rise of HDTV and honoured HDTV men (women are generally conspicuous by their absence) in the rituals and official documents of organizations such as the SMPTE and the EBU. The demonstrations of a new experimental Japanese HDTV system in the USA in 1981 and in Ireland the following year are frequently used as reference points that mark the birth of HDTV (or the upheaval of traditional TV that marks a new beginning). Go to the publications of the ITU, for instance, where we are told that "2006 and 2007 marked the 25th anniversaries of the first demonstrations of HDTV, respectively in North America and in Europe."[55]

Ceremonial events and official representations of the early HDTV history bring to light different dimensions of the institutionalization of a new movement of innovation. In particular, they point to the two-way constitutive relationship between the identity of certain meaning-making individuals and larger collective phenomena such as a company, a nation, or a pattern of interactions and routines. Take, for example, the role of Takashi Fujio in relation to a new global movement of recombination called HDTV. With the exception of the SMPTE Report published in April 1981, Fujio himself is generally and notoriously absent in (anglophone) HDTV stories constructed before the twenty-first century. Yet, we must not be ignorant of the status Fujio has gained recently in the relatively closed networks of like-minded peers outside Japan at a time when HDTV seems to become more and more "normal" and stabilized by many. Read the *EBU Technical Review* published in July 2007, for instance,[56] where we, in the

[53] Mertens, quoted in Wood 2007, 1/6.

[54] Wood 2007:2/6, with references to "A Study of High Definition Television Systems." Report of the HDTV Study Group to the SMPTE Committee on New Technology, July 1979, and Walter Anderson: "IBA Long range Study Report 3: High Definition Television," Independent Broadcasting Authority, UK, January 1980.

[55] "HDTV 25th Anniversary of the Introduction of HDTV in Europe," Recommendation ITU-R BT.709 1982–2007, www.itu.int/ITU-R/go/.

[56] For other examples, visit the IEEE's website (http://www.ieee.org/portal/pages/about/awards/bios/2002ibukaTF.html, accessed 1/9 2008) and the SMPTE website (http://www.smpte.org/about/awards_program/sarnoff, accessed 1/2 2009).

same paper, first are told that Junji Kamada from NHK "was a founding father of HDTV in Japan" (Wood 2007:5) but then (p. 6) can read:

> Finally, if the author had to say who he thinks invented HDTV, he would probably suggest that most laurels go to Dr Fujio from the NHK Research laboratory in Japan. It was the work of a genius, and of a charming man, and Dr Fujio's legacy will live for many decades to come.

At the fortieth edition of the Broadcasting Convention (IBC), which was held September 6–11 2007 in Amsterdam, Dr. Fujio was awarded an honorary lifetime membership of the EBU Technical Assembly "in recognition of his inspired research which led to the development of High Definition Television" (Radio 2007). The presentation ceremony took place at a special Session on the history of HDTV on Sunday 9 September from 10.30 to 11.30, arranged to celebrate a particular anniversary: "25 years since HDTV was first demonstrated at an EBU general assembly in Killarney, Ireland." The press release (28th August 2007) that advertised the event tells a simple tale:

> High Definition Television (HDTV) will become the most powerful medium yet devised by man. HDTV would not have been possible without the pioneering work of Dr Takashi Fujio. His work in the 1970s at the NHK Research Laboratory in Tokyo Japan, into the psycho-physics of television viewing laid the foundation stones on which HDTV would be built. His achievements included understanding the relationship between perception, picture size, detail, and aspect ratio (the ratio of picture width to picture height). The technical elements of the HDTV systems we see today are based on his findings. Dr Fujio himself participated in many discussions at the EBU about HDTV in the 1980s, bringing the benefit of his work and knowledge to Europeans. (EBU 2007, Latest update 10.09.2007)

Similarly, in a newsletter produced by the NHK Labs, we can read that Dr. Fujio, their ex Director-General, was awarded an honorary lifetime membership of the EBU Technical Assembly at the IBC 2007 in relation to 'HDTV25', an event arranged "to celebrate the 25th anniversary of the first exhibit of the HDTV system in Europe at the EBU General Assembly in June 1982." But this newsletter directs our attention not so much to marking off certain individuals from others, but to the frequent use of the words "we" and "our" in relation to the development of TV systems. It also directs our attention to "the global influence" of the SMPTE and, in particular, the "significant role" this US-based "commercial standardization organization" has played in HDTV standardization.[57]

The details of the cases at hand illustrate once more that the articulation of what has in fact been "demonstrated" or "shown" and what is claimed as its implications and meanings are all open to interpretation and negotiation even in the case of one single demonstration (Collins 1988; Shapin 1988:402). To be sure, the HDTV demonstrations at the SMPTE Winter Television Conference in 1981 and at the EBU

[57] "IBC2007 held" and "Super Hi-Vision (SHV): Approved as SMPTE Standard," in *Broadcast Technology* no.33, Winter 2008, p. 17, NHK Labs (http://www.nhk.or.jp/strl/publica/bt/en/to0033.pdf—131.0 KB accessed 081007).

General Assembly in 1982 still produce meanings and value and are the object of unstable and contested narrations, revisions, and imaginations. It seems that it was less important what the demonstrators "actually" did with the prototype HDTV equipment displayed than how those activities and new objects were framed and interpreted in discrepant ways by different contending parties, each connecting the claims and practices of the Japanese experimental program to other places, times, routines, and agendas.

10 The Co-production of Standards, Heroes, and Key Moments

So what does my HDTV story say about the links between demonstrations and the (re)creation of technical standards? Firstly, it indicates that neither technical standards nor staged demonstrations can be disentangled from the carrying out of new combinations as a whole. Secondly, it confirms that the carrying out of new combinations corresponding to what Law (1987) calls "heterogeneous engineering" is arduous work, tightroping between the past, the present, and the future. Technical standards and other social rules play a crucial role in providing firmer footing in this tightroping, closing the gap between the old and the new "ordering of things." They are (re)created in attempts to impose regularized patterns of interaction to deal with the uncertainties associated with that gap.

My HDTV story also confirms that it is not always preferable to be the first mover in innovation. Whether referring to the first supplier, the first firm to sell, the first firm to use, or the first band of enthusiasts among consumers to use a new product/system, the first mover usually takes unprecedented risks. Linked to such risk-taking, the HDTV story shows that the carrying out of new combinations involves seeing, observing, and reporting that something new, strange, or distant really works, that it fits with existing rules and routines, interests, and local contingencies. Like many others, (HD)TV engineers carry, transform, and extend a set of deeply rooted norms and conventions that capture the critical role of visibility in the processing of information and decision-making, invoking the value of first-hand observation, credible testimony, multiple witnessing, and so on. For instance, they are taught to represent and observe phenomena generated through carefully orchestrated experiments; they are also aware of the manipulative capacity of these arrangements and their use as weapons of persuasion.

The objective of organizing and reporting upon such carefully organized experiments, sometimes called demonstrations, is often that of inviting new "voices" of persons, assemblages, interests, know-how, technologies, and traditions to participate in the joint shaping of some future reality through a dialog with the past and the present. Consequently, such an extended dialog must involve compromises—compromises between the diversity of "voices" involved, also the "voices" of traditions, technologies, and situations that are not necessarily physically present. This is also why staged demonstrations may favor the hybridization, confrontation, and transmutation of ideas, interests, and concerns as a way to induce durable interactions and relations as much as the development of alternative or competing experimental standards and projects. As an institutionalized device for persuasion, negotiation, and the assertion of power, demonstrations are important

resources in making visible, defining and enacting what can be connected to what and what cannot in the future.

My sources do not establish the exact links between the HDTV demonstrations in the USA in 1981 and the particular methods/parameter values that were negotiated and modified in fixing common technical standards for HDTV. They do not tell me, for instance, about other less public tests, demonstrations, reports, and discussions that also contributed to the work that led to *Recommendation ITU-R BT. 709*. But my sources do indicate that the fabrication, framing, and dissemination of these specific demonstrations in 1981 had significance for *how* and *why* specific kinds of interaction, alternative standards, and routines evolved in this experimental (HD)TV movement of innovation. I wish to argue that these demonstrations (1) helped innovative projects to grow and for some to enlarge their grip on reality more than others; (2) helped transform HDTV from what appeared to be one project, concept, system, and set of standards into a range of competing projects, systems, and packages of standards, each evolving in terms of its own framings and particular arrangements; and (3) provide us with some key insights into both the convergent and divergent paths that the development of (HD)TV has taken in recent decades.

Alongside the efforts of NHK and others to win wider interest in—and public support for—the extension and standardization of a new experimental TV program, an important aspect of this process was to achieve broader visibility through performing new possible combinations before relevant individuals and groups. This visibility was largely mediated through common procedures, techniques, places, and centers of organizations that had become institutionalized in previous attempts at mobilizing broader support for new movements of experimentation and recombination. Outside Japan, NHK and their allies were able to woo a number of organizations in the official machinery of government institutionalized to manage and change technical standards for TV and other electronic communications systems. By gaining presence or recognition in the public media, spaces, and routines of organizations such as the SMPTE, the ITU, and the EBU, something called HDTV had, indeed, began to move across territorial and other boundaries by the early 1980s.

The demonstrations at the SMPTE conference in 1981 were *some* of the means through which a new (or renewed) social movement of experimentation—HDTV—expanded and evolved as a transnational public policy issue. These demonstrations and those in the setting of an EBU General Assembly the following year have survived as collectively witnessed events that dramatically mark the initial stage of HDTV as an expanding global movement of experimentation and the opening of a publicized "battle" over future international HDTV standards.

We are here touching upon a returning theme in the history of science and technology. This is that there are many accounts portraying demonstrations as privileged events that project past discoveries, inventions, experimental phenomena as well as certain persons into the future as part of the legitimate and successful promotion of innovative experimental programs. A related theme is the portrayal of demonstrations as a property of an individual who also tends to play the causal (human) role of putting in motion a process of "revolutionary" or "miraculous" transformation. Consider the machines/systems and related staged experiments and tests associated with, for instance, Alexander Graham Bell, Thomas Edison,

Guglielmo Marconi, and John Logie Baird. Yet, each of these historical cases provides us with the grounds for portraying entrepreneurship and heterogenous engineering as essentially collective action; many people working in different countries and settings contributed to the assembling and modification of a range of different "things." The history of technology also provides us with several cases of "battles" over which technical systems and standards should ultimately carry the new market(s) under construction. For instance, in the case of the television system developed and promoted by Baird and his allies in the mid 1920s, we now know that a later 240 lines version of their electromechanical system was eventually (1937) dropped in England, ousted by the all-electronic 405 line system put forward by Marconi EMI.[58] We also know that eventually the world became split into several TV systems. Yet, Baird still holds a place of distinction in the history of television, frequently portrayed as the first person to achieve and demonstrate the world's first "real" or "true" television system.

Some 50 years after Baird's experimental TV transmissions, Takashi Fujio, a research leader at the NHK Labs in Japan, was involved in the collective work of attempting to generate wider interest in the extension and standardization of a new experimental (HD)TV program. This work included the careful management of arguments through the publication of reports and the planning and organization of performances of experimental work at various settings in Japan and beyond. It also included the appropriation of the old Anglo-Saxon term "high definition television." Appearing as the first visible spokesperson of an experimental program named HDTV abroad, performing in key public "theaters," Fujio was able to woo others capable of attempting to (re)create rules and redirect resources from old combinations to new ones (Schumpeter 1934/2007:68). The performances were part of a skillfully managed publicity to enroll the SMPTE and the EBU as platforms for extending and institutionalizing the experimental work Fujio and his colleagues were carrying out. In 1991, two American communications scholars (Schaefer and Atkin 1991:413) wrote: "It was in 1981 that NHK unveiled its first, true high-definition television system." We now know that the experimental HDTV system displayed and demonstrated by Fujio in 1981 never became accepted as a wordwide standard and that the world has remained split into several (HD)TV systems.

It is still too early to tell whether Fujio—like Baird and the likes—eventually will gain a position as the founder or hero of a particular movement of innovation also in some broader transnational institutionalized public memory. Just like others before him, Fujio had reached a position that impelled him to act as the first visible "promoter" to stand up and make both himself and particular experimental objects publicly present as signposts pointing towards a common future path of recombination, cooperation, and routines (standards). Such signposting of the future came to a head in theatrical demonstrations designed to serve as privileged events highlighting the great divide between existing routines and the new future ones in processes of mobilizing broader support.

Just like, for instance, the BBC in relation to Baird's experimental TV system in the 1920s, in more contemporary times the members, sites, technologies, and rituals

[58] http://www.bbc.co.uk/history/historic_figures/baird_logie.shtml, http://www.answers.com/topic/john-logie-baird (access 090928).

of institutionalized bodies such as the SMPTE and the EBU seem to have a prominent role in the production, translation, and preservation of entrepreneurial stories, interpreting past action and projecting it into the future. Here, too—in interpretations and narrations about entrepreneurial action relating to (HD)TV—various arguments and claims become persuasive by being situated in the legitimating context and "rules" of witnessing, in particular witnessing as a collective experience bounded in time and place ("a live event," a "now"). Here too, stories about the early, present, or future development of a "whole"—(HD)TV—are backed up by the creation and use of a point, an event, that invokes imaginations of "liveliness," public experience, and reality.

My access to anglophone sources authored by Fujio and reporters associated with hegemonic groups such as the EBU and the SMPTE have made me omit many other important followers (and critics) of an emerging experimental HDTV movement, much of the "materials and forces" in conflict and alliance and the multiple transformations which have surrounded HDTV. This omission is also an invitation to consider the role of demonstrations and other types of displays in relation to the ways in which once innovative movements are presented and protected. For instance, it is hard to find historical narratives contradicting the image of innovation as something capable of being traced back to an individual who became the first person to give publicly visible signs and stipulations of a new movement of experimentation and recombination in the context of an association capable of (re)creating rules and redirecting resources from relevant old combinations to new ones. It tends to be the executives who are "seen" by some public in the creation and protection of entrepreneurial action: in written accounts, visual representations and witnessed events. I sadly have to admit that this is mirrored also in this paper. By circulating this paper, I run the risk of being accused of repeating others' images and accounts of HDTV, aligning myself with those portraying Fujio (and Flaherty) as a great man and certain HDTV demonstrations orchestrated in the early 1980s as "big moments." Yet, there is no doubt that these demonstrations made a difference and that today's TV systems—whether called "high-def," digital TV, or something else—owe something to these two men.

It may be so that certain individuals are "extraordinary" with particular faculty of combination and powers of intuition, skill, authority, and persuasion. Nevertheless, like the work invested in the creation of technical standards, the creation of big moments and images of heroic individuals through collectively witnessed events—demonstrations, rituals of commemorations, and honorary awarding—is the result of joint action which allows the entrepreneurial function to travel and become protected along prescribed paths across time and space. The creation of important events and personage in stories about entrepreneurial action can be seen as the result of the (re)creation, translation, and extension of dominant interests, objects, and standards of particular groups in the very process of carrying out and protecting new combinations. The portrayal of any "thing"—persons, experimental work, and standards included—always reflects the narrator's aims and interests; it is the narrator that creates the narrative context in which this "thing" is interpreted and linked to the past, the present, and is projected into the future. And this is, among other reasons, why demonstrations and other types of display are good points of

departure for analyzing how new movements of recombinations, their repertoire of legitimate stories, promoters, and standards, evolve. To be sure, attending to the practicalities and particularities of demonstrations opens up the possibility of reconsidering the type of uncertainties and reservations, which is an important part of the carrying out of new combinations, reminding us again that it might have been otherwise.

My paper takes the readers back to a moment when the destiny of (HD)TV was highly uncertain and its properties, meanings, content, and boundaries were remarkably open and flexible. Hopefully, I have given (HD)TV a complex present too, where its identities, key moments, heroes, and standards are still fragile and may differ between contexts. Yet, without doubt, the demonstrations studied here have become fixed historical points used to impute meanings to and legitimize actions as well as non-actions in narratives that support people's attempt to understand, rule, and govern the development of HDTV. In HDTV narratives, these particular demonstrations have gained a position as what Gieryn (2002:114) would call "truth-spots"; that is, places "where claims are born, or said to be."[59] But my analysis of HDTV suggests that not only geographical location (spots on the globe) but also *events* and *actions* bounded in place *and* time ("a now") through an act of witnessing should be added to the list of modulators from which claims take on special authority and gain credibility. After all, although the experimental system demonstrated was never accepted as the basis for global HDTV standards, these particular demonstrations have become privileged events bounded in place and time that are still used—both by historians and others—to lend credibility and direction to claims about the early development of HDTV all over the world, including cases of neglect and the building of competing experimental programs.

To be sure, my (HD)TV study is a reminder of the "kinds of dangers that stem from the uncontrollable nature of mediated visibility" (Thompson 2005:41). Or, as Latour (1987) would put it, the fate of what the NHK Labs and their allies said and made "is in later users' hands." He would, therefore, be unsurprised by finding that the HDTV demonstrations considered here have gained a position not only as "truth-spots" but also as full-blooded mediators, transforming, translating, distorting, and modifying the meaning or the elements they are supposed to carry (Latour 2005:39). In this view, the HDTV demonstrations in the US in 1981, and in Europe the following year, proved nothing for certain but demonstrated the boundaries of persuasion, the vanishing point of hesitation at which certainty stops and doubt or credence begins. Disbelief is, in general, the mortal enemy of entrepreneurship and innovation.

[59] Gieryn has brought in the concept of "truth-spot" in his discussion of how *places* (not actions and events) lend credibility to beliefs and claims in science, religion, art, law, politics, and other culture-producing practices. In the words of Gieryn (2006, p. 29, note 3), "A 'truth-spot' (Gieryn 2002) is a delimited geographical location that lends credibility to claims. Truth-spots are 'places' in that they are not just a point in the universe, but also and irreducibly: (1) the material stuff agglomerated there, both natural and human-built; and (2) cultural interpretations and narrations (more or less explicit) that give meaning to the spot."

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