From High Hopes to High Deficit and Back:
A Historic Overview of Europe's HDTV Policy and Reflections Towards the Future of HDTV

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ABSTRACT
This paper describes the standardisation process and introduction timeline of high definition television. The development of the standard is a process that goes back over forty years, but HDTV is only today slowly finding its place in the home entertainment market. This paper explores why the European standard for HDTV was not widely adopted, what Europe's relation to HDTV means today, and proposes some general lessons that can be learned for the benefit of the development of HDTV's successor, Ultra HDTV aka Super Hi-Vision.

ACM Classification
A.m Miscellaneous

General Terms
Economics, Standardisation.

Keywords
HDTV, High Definition, European policy, standardisation processes, Super Hi-Vision, Ultra High Definition Television.

1. INTRODUCING "THE TELEVISION OF THE FUTURE"
After several years of discussion and a long standardisation effort, HDTV is gradually being introduced to market. The television standard which introduces a drastic increase of image quality and surround sound has been a long time in the making, and its standardisation has followed very different trajectories in Japan – its birthplace -, the US and Europe. Although there are some conflicting reports, it is estimated that around 35 percent [9] [9] of US households own an HD-Ready television and of that share somewhere between 20 and 40 percent receive actual HD programming. Numbers for Europe are even less clear, but it is generally accepted that they are lower than those for the North American market. In March 2008 a report was published stating that only 5 percent of HDTV owners in Europe watches HD content [10] and another one claiming that around 20 percent of Western European households owns an HD capable television [9].
So as "the future of television" is finding its way to market, one might forget the long and strenuous standardisation process that lies at its basis. When Europe found its consumer electronics sector on a downhill slope, experiencing strong competition from the Japanese industry, and it became apparent HDTV would be "the next big thing" for the industry, the European institutions wanted to intervene and positively inspire the sector by developing a European standard for high definition television. HDTV meant an enormous opportunity for national governments, international institutions, but mostly the audiovisual industry and its successful standardisation would become a top priority in Europe. Today however, the development of the European hardware policy for HDTV is often looked back on as one of the biggest failures in standardisation history. One might – somewhat controversially - say HDTV found its way to market *despite* Europe's hardware policy decisions.
This paper will examine the process of Europe's HDTV standardisation effort, taking a look at past decisions and their consequences. This historical analysis will lead to some lessons for ongoing and future standardisation processes, as HDTV's successor is already starting to emerge.

2. GLOBAL HDTV STANDARDISATION: A LONG AND TUMULTUOUS HISTORY[1]
This section will contextualise the debate by giving an overview of the state of the European consumer electronics industry at the time HDTV introduction was put on the agenda of the industry and policy makers. In section 2.2 a brief history of the HDTV standardisation effort is presented, which resulted in the abbreviation mockingly coming to stand for High Deficit Television.

[1] Section adapted from author 2 (1995) and author 1 (2007).

2.1 Overview

The development of hardware and infrastructure required for the production, transmission and reception of audiovisual programmes is at least as important as the programmes themselves. Large infrastructural projects are an important stimulant for the productivity and competitiveness of national industries [13]. The production of audiovisual hardware, which drives the consumer electronics industry and possible spin-offs in other industrial sectors, has many times led to intense competition, both on the internal national level, or externally on the international and even global level. This competitiveness has specifically come forward in several standard wars throughout the history of the audiovisual sector. The interests of hardware manufacturers are only sufficiently protected when the technology they develop is standardised in a nationally or preferably internationally protected norm, and, without established standards, the distribution of software is hindered. To facilitate these standardisation processes, different bodies have been created in Europe, e.g. the International Standardisation Organisation (ISO) and the International Telecommunication Union (ITU), which is divided into several well-known subdivisions; ITU-R for radio communications, ITU-T for telecommunications standardisation and ITU-D for the development sector. This process makes the standard a trade instrument that can ensure distribution to other markets, or on the contrary, protect the internal market from import. Examples of such standard wars are the battle between VHS and Betamax for videocassettes, and the difficult standardisation process for the resolution of television screens [13].

This last struggle has been a constant in the history of television. When black and white TV was standardised, North America used a system with 525 lines of pixels, while Europe proposed a system of 625 lines in 1948 [14]. The Japanese followed the American standard. The European and American systems were incompatible and still exist today.

During the introduction of colour television a similar war raged, again with incompatibility as a consequence. In 1953 the Federal Communications Commission (FCC) established NTSC as the standard for colour television in the US, a norm later also adopted by Japan. Europe felt the quality of NTSC left much to be desired and started developing different norms throughout the continent. France developed SECAM, which was later adopted in Eastern Europe and Greece, while Germany created PAL, establishing a norm for Western Europe, Brazil and Southern Asia [6]. These examples show that the best standard from a technological point of view does not necessarily becomes widely accepted. VHS was inferior to Betamax, and NTSC came to stand for Never The Same Color [5], which illustrates that not only industrial but also economical, political and even cultural aspects may influence a standardisation process.

As technological advances were made in the nineteen eighties and while economical interests became important across borders, the European Community started developing an audiovisual and telecommunications policy and the institutions gradually became more involved in matters of standardisation. During the same period, they became the driving force of a cross border industrial policy. As far as the audiovisual sector is concerned, two initiatives were seminal and closely linked to each other. The first was the development of the television equipment of the future, with the main focus being on high definition television at the time. With the introduction of HDTV the standardisation battle between the US/Japan/Europe triad was reignited. A second European initiative was the creation of a pan European fibre-optic broadband network of which HDTV would be one of the most important applications.

The development of hardware and infrastructure needs to go hand in hand with the negotiations for their standardisation if they want to succeed in the market place. At first this was true for the European initiatives: the development of HDTV and the creation of an integrated broadband network were logical consequences of the harmonisation, standardisation and liberalisation initiatives on the continent. Both served the same goal of creating an integrated economical market, thus creating benefits of scale and putting forward the European cultural identity. However, these initiatives did not have a chance to come to full fruition. On the contrary, the development of the technology and the competition initiated by the institutions lead to divergence and disintegration, both on the community's HDTV policy as in the field of creating a fibre-optic broadband network [13]. The following section will look specifically at the standardisation process for HDTV and contextualise the failure of Europe's proposal for a high definition norm.

2.2 From High Hopes to High Deficit

In the 1980s, Europe's consumer electronics industry found itself on a downhill slope. The market was flooded with devices from Japan that were cheaper and more popular, bringing European companies like Philips and Thomson in serious trouble. The television market was saturated and the impact the introduction of the VCR had had on it, was gradually fading way. The industry was in need of a new impulse, something the introduction of HDTV could very well provide. HDTV went far beyond refreshing the consumer market, as the standard promised more than simply offering new devices to end users; it meant a complete overhaul of the production chain, from recording, over editing to broadcasting. HDTV could mean the salvation of an entire industry. The interests were so great, an international standardisation war broke out, trying to find the best performing and commercially most interesting standard [16].

The first concrete initiatives were taken by Japan, with the first research into HDTV dating back to the sixties. It was calculated that by 1989 the Japanese public broadcaster NHK (Nippon Hoso Kyoka) had already spent around 148 million dollar on the development of HDTV [13][7]. By 1986, NHK had created a standard for HDTV called HiVision and proposed it would become the new global norm for high definition television. This system came with a substantial disadvantage however: it was not at all compatible with TV sets on the market at that time, which meant every TV in the world would have to be replaced in order to function with the new standard. Europe responded to this development by requesting a delay of HiVision's standardisation with the CCIR (Comité Consultatif International de Radiocommunications which would later become ITU-R) and promised to develop a standard that would be at least as capable as the Japanese one and compatible with existing systems, within four years of time. To achieve this goal, Philips, together with Thomson, Bosch and Thorn EMI, initiated the EU95 project within the framework of Eureka, a pan-European industrial-technological cooperative network. Eureka differed from the European framework R&D programmes in that it focused more on commercial research of technologies that were closer to market. Member states felt that the EU should maintain a neutral position when it comes to technological R&D, which is why the framework programmes focus more on fundamental, bottom-

down, pre-standardisation and pre-competitive research and constitutes the reason why Eureka was brought into life. This initiative by the French facilitated more commercially aimed research and functioned as a network of 23 members (a number of European countries and the Commission). It offered a framework for international cooperation in technological research that is close to market and commercialisation, as opposed to the work done in the four-year framework programmes. The EU95 project had the main objective of developing a standard that could compete with the Japanese one and consisted of around forty industrial partners from the consumer electronics industry and related sectors in nine countries.

The final European norm would later be known as Vision 1250, an analogue standard that was named after the number of vertical lines the new screens could display. The standard for transmission was called MAC. To counteract the Japanese, Europe suggested a transitional transmission system to ensure compatibility with existing systems called D2MAC. This standard was compatible with PAL and SECAM but already offered a better picture and audio quality. Later the HDMAC standard would be introduced that was not compatible with SECAM and PAL, but did work with D2MAC. Like the Japanese system, the European signal would be broadcast via satellite and would be available over the air and on cable if these networks were upgraded. Europe estimated it would be ready to roll out products to market by 1996-1997. It was easy convincing manufacturers of the need for such a standard as it represented a significant amelioration of image quality, which could reinvigorate the struggling television industry [13].

During the development of Vision 1250 however, several crucial elements were not assessed with the appropriate thoroughness. There was no broad consultation of the actors involved in the field as the standardisation effort was a panic reaction sparked by a self-preservation reflex of the industry. Negotiations were held only with the struggling consumer electronics companies, who were unable to make founded strategic decisions at that time. Not the European institutions, nor consumer organisations, public broadcasters or foreign companies were consulted during the development of this new standard, which resulted in a few critical errors.

There was a structural problem that meant an a priori disadvantage for the European standard: programming could only be broadcast via cable and satellite links, due to difficulties with the compression techniques of the time. But most European countries had a strong tradition of broadcasting over the air, a distribution channel that would not be able to support Vision 1250. Moreover, the quality of the satellite signal was not on par with the relatively high standards the European audience was accustomed to. The developed television sets were not appealing to end users as they were large, clumsy and very expensive, plus consumers also had to purchase a satellite receiver, which suffered from the same defects. The most fundamental barrier for the adoption of this standard however seems to have been a lack of coherence in policy decisions. As much as the hardware industry was supported in its efforts, as little attention was paid to the software market, in casu the content providers. Because hardware manufacturers were hitting delays in developing equipment, problems arose for broadcasters who wanted to invest in the technology. The material was either unavailable or far too expensive. This posed a particular problem for broadcasters and content producers, who were being faced with a changing television production environment. Most of them simply wanted to protect their position in the market and could not be motivated to make large and risky investments in new hardware. As a result, there was no compelling high definition content delivered to the end user, heralding the quick demise of Vision 1250.

The MAC standard for transmission did not have a very long life either. Because broadcasters felt bypassed by the European MAC initiative, they started developing their own transmission standards based on the existing technology. Mainly public broadcasters started these developments as they were put under increasing pressure by the liberalisation plans of the EU, and were in many cases supported by national governments who also were sceptical of the opening of the European market. The public broadcasters developed an improved version of PAL, named PALPlus that would have to compete with HDMAC [6]. Combined with the problematic standardisation of MAC, PALPlus would become the default standard for satellite broadcasts, effectively rendering MAC useless.

Why did the introduction and standardisation of HDTV fail in Europe, compared to the North American case? Part of the answer can be found in the way the different parties involved were consulted and how the standardisation effort was organized. The situation in the US was benefited by the involvement of the FCC (Federal Communications Commission), a very influential government monitoring authority, for which there is no comparable institution in Europe. The FCC prepared a broad consultation with manufacturers, major networks and other involved organisations to launch an HDTV standard in a more structured and efficient manner. Distribution issues were also handled by investing in compression technology research and making possible the broadcast of HDTV signals over the air via digital, rather than analogue standards, something that was grossly underestimated in Europe. The FCC created ACATS (Advisory Committee on Advanced Television Service) to assist in the development of the new potential HDTV standards. The development was also financially supported by the US government: as early as 1988 a North American government technology research programme called DARPA (Defense Advanced Research Projects Agency) announced a $30 million grant for the development of both HDTV displays and display processor technology. International organisations would be able to apply for this grant, which was not the case in the European and Japanese case, and some firms, among which NHK, made project proposals. By the summer of 1989 thirteen grants were acknowledged towards the development of HDTV technology. After the FCC emphasised that the newly developed standard had to be compatible with the NTSC system to allow for an easy transition from the old to the new signal, seven proposals for systems remained by 1990. By the summer of 1991, five major technologies remained for testing, of which only two were completely digital. When the FCC announced it preferred the development of a digital standard, NHK dropped out of the race, and after further development four all-digital systems remained. When ACATS concluded there were still crucial problems with the remaining four technologies, the FCC proposed they be merged in order to increase the efficiency of development. On 24 May 1993, the so-called “Grand Alliance” was formed bringing together Philips North America, Thomson Consumer Electronics, Zenith, General Instruments, AT&T and the MIT. The result was an all-digital HDTV system that was compatible with the NTSC technology [13].

In Europe’s defence, the quality of the standard definition broadcast system PAL is of a much higher standard than NTSC in

North America. Colour distortions and other quality issues plague the latter and as a consequence the difference between SD and HD is more apparent for an American vs. a European consumer. But at the basis of the "failed" standardisation effort lie the more fundamental issues mentioned in the paragraph above. Europe specifically underestimated the potential of digital television in general. The MAC standard was an analogue norm, which was technically sound, but proved difficult to work with and was not ready for the convergence of communications and media that was slowly beginning to manifest itself.
European businesses followed these discussions from close by and, noticing some crucial structural mistakes were made in the European approach, jumped on the North American – and digital - bandwagon in order to cut their losses. Europe was left behind with the substantial bill of a non-existing standard and the abbreviation HDTV came to stand for High Deficit Television.
In the years that followed, new international standardisation bodies were formed, while others merged or changed names. Instead of being the result of very strict top down policy decisions, a more bottom up approach was found preferable as the norms for HDTV were finalised through cooperation between industry players. The standards that are currently used to broadcast HDTV are ATSC (North America, parts of South America and South Korea), DVB (Europe, Australia, parts of Asia and Africa) and ISDB-T (Japan, Brazil) [6]. The screen resolutions for high definition images were finally standardised in the mid-2000s by the ITU (International Telecommunications Union) and the SMPTE (Society of Motion Picture and Television Engineers). ITU-R Recommendation 709-5 defines how video luminance and colour information is digitised for HDTV. It also specifies the different possible refresh rates for high definition television. The SMPTE, which was founded in the US in 1916, gathers 200 organisations in 64 countries and has over 400 defined standards on its conto. The 720p, 1080i and 1080p standards were defined in the framework of this organisation, in 2001 for 720p - which was considered a transitional technology at the time - and in 2005 for 1080i and 1080p [2].

"SMPTE 274M-2005: *This HD standard defines the 1920x1080 spatial resolution (image sample structure) and several frame rates for this resolution. 1920 pixels define the active number of pixels per line and 1080 lines are the active number of lines per frame. Frame rates can be either interlaced or progressive. Special consideration is given to NTSC frame rate compatibility by defining 60, 30 and 24 hertz frame rates which are divided by 1.001. ...*

SMPTE 296M-2001: *This HD standard defines the 1280x720 spatial resolution at various frame rates. All frame rates are progressive only. There are 1280 active pixels per line and 720 active lines per frame. Special consideration is given to NTSC frame rate compatibility by defining 60, 30 and 24 hertz frame rates which are divided by 1.001."* [2]

The SMPTE also defined the standards created by the EU, but these were only used for testing purposes. Some further standardisation work regarding the transfer of the HD signal via coax cable were made, but are too technical to be mentioned here.
In 2005 an effort was made towards consumers to clarify the different HDTV standards. The European Industry Association for Information Systems, Communication Technologies and Consumer Electronics (EICTA) [4] created the "HD Ready" logo, which indicates some minimum requirements towards displaying high definition images on television sets.
The following section will take a step back and explore where misjudgements were made and how they influenced the standardisation process.

3. THE FAILED EUROPEAN HDTV POLICY?

After the Vision 1250 standard failed, Europe took a step back in the active R&D of HDTV. In 1989 the Commission published a document arguing that the 1250 standard should be implemented as soon as possible. At the time, the following five goals were put forward:

- *To make every effort to ensure that the European industry develops in time all the technology, components and equipment required for the launching of HDTV services.*
- *To promote the adoption of the European proposal based on the 1250 lines, 50 complete frames per second progressive scanning parameters, as the single world standard for the origination and exchange of HDTV programme material.*
- *To promote the widest use of the European HDTV system throughout the world.*
- *To promote the introduction, as soon as possible - and in accordance with a suitable timetable from 1992 - of HDTV services in Europe.*
- *To make every effort to ensure that the European film and television production industry achieves the capability, experience and dimension required to occupy a competitive position on the HDTV world market and to allow the Member States to make their own cultural contribution*. [3]

As it turns out none of these goals were met in the proposed timeframe. In 2004 a new working document was released which carefully examined the situation and made some preliminary recommendations [1]. It is mentioned in quite clear terms that there should be no policy related intervention with regard to HDTV as a "*policy approach to HDTV would be counterproductive*". It goes on to say that "*coordination between the member states is needed*" in order to successfully stimulate HDTV adoption. These are quite vague statements, which lead us to believe Europe will not be hard-pressed to take a position in the debate on HDTV. It is stated that coordination is required, but not who should organize it. There seems to be more confidence in a bottom-up approach in which the television industry itself drives innovation. An efficient audiovisual policy should include a wide consultation of the field and a striving towards consensus. This implies creating an environment that stimulates consultation and cooperation via both formal and informal channels. The approach should however try to avoid one major pitfall, namely that the consultation process and the reached consensus are dominated by the most powerful actors. When comparing the American approach to the European one, some clear differences become apparent. One of the most predominant reasons the European HDTV policy failed was the lack of coordination, consultation and consensus development between the most important and interdependent actors like producers, networks, telecom organisations, device manufacturers and political bodies. The entire community strategy was based on the suggestions and interests of the largest and most influential industrial actors. Compared to that of the US, the European policy approach

neglected the input of smaller organisations, companies, research institutes or university laboratories. Even public broadcasters, who had always played a valuable role in technological advancement, were not consulted during the HDTV standardisation process. This almost selective consultation of actors would contribute to the demise of the European standard.

The EU's methods also lacked coherence and long-term vision. By ignoring the interdependence between the involved stakeholders like producers, telecoms, political institutions etc. the typical chicken-and-egg problem became abundantly apparent in the television industry for the first time: no hardware without software, no production without distribution and vice versa. Instead of making sure such issues could not arise, the European hardware policy fuelled them. Introducing the standard with success would be dependent on the availability of adapted and appropriate content and the possibility and willingness of broadcasters to air the programmes, which was realised too late. There was also a substantial discrepancy between the budgets allocated to software development on the one hand, and hardware on the other. While the MEDIA programme (stimulating content production in Europe) was still in its experimental stages, ambitious hardware projects like Race or EU95 received over 50 times more funding [13]. Even though continuity and a long-term vision were ambitioned in theory, the practice of allowing industrial interests to be dominant is witness to a short-term perspective. It was an ad hoc solution that was devised to serve the interest of some major European concerns in a short time span. In this process, it was automatically assumed that the other actors in the field would follow the proposed strategy. But these other stakeholders were put under pressure by different audiovisual liberalisation measures enforced by Europe, leading them to either not support the community's plans for HDTV, or to downright oppose them. This is illustrated by the public broadcasters developing an SD standard to compete with HDTV, as was mentioned earlier.

If Europe had followed a comparable trajectory to the US and set up a wide public consultation and cooperation process with smaller research firms, university labs and public broadcasters, some long-term issues would have undoubtedly been identified sooner and could have been considered in the policy decisions. In Europe, there was a fundamental difference between the principles the institutions advocated versus the policies they actually implemented: while open competition principles were preached, strong industrial-technological intervention seemingly was practiced. Above all, the complexity of the technological case requires and intense international cooperation effort. The North American approach in the HDTV development was based on this international reflex, as opposed to the European and Japanese effort, which feared foreign R&D input. European and Japanese companies were thus shielded from technological advances made in other countries that could have benefited the research. In both cases a nationalist and protectionist reflex was present, a priori stifling the development of transnational agreements and standards.

Whereas the US organised a public debate on HDTV, Europe in general chose to exercise its policies behind closed doors. Dissonant views hardly reached the public opinion and institutions that were called into life to play a verifying and validating role, like the European Parliament or consumer organisations, did not have enough information to adequately perform their tasks.

A last aspect that led to the failure of the European HDTV standardisation effort were the so-called consumer interests that would be defended by the enacted policy. Both in the case of the fibre-optic network and that of HDTV a completely overestimated and maybe even non-existent consumer demand led to the demise of the projects. There was hardly any consumer demand for an improvement of the image quality in Europe, and the industrial and community bodies followed a push strategy to position the products in the market. Consumer research only gained traction in the late eighties, so although there was a lot of polemic and discussion on consumer interests, it was not founded in research but based on the interests of the industrial parties. Together with the other elements cited above, overestimated consumer demand did not give the European HDTV policy many chances for success.

However, although this policy might not have led to a unified European HDTV standard, there are positive effects and outcomes that can be attributed to it. Philips found a breath of fresh air and survived the crisis it was going through. The presence of innovative HDTV production companies like Alfacam Group in Belgium, Sky in the UK (who both started broadcasting in HD quality quite early in Europe) or other European HDTV-based industrial actors, indicate the policy decisions of the late eighties-early nineties have not been entirely in vain.

Of course the context the EU is finding itself in at the moment cannot be dismissed either. After several referenda blocked the introduction of the European constitution, Europe found itself in an existential crisis, which is only today slowly being resolved. In such a context it is hard to practice any form of policy, and even more so with regard to quickly evolving (mostly technical) dossiers.

All these external difficulties should be considered when evaluating the EU's HDTV policy, and as always, contextualisation is important in understanding its particularities.

4. LESSONS LEARNED

With the HDTV standardisation effort often referred to as a failure, there are some general lessons about hardware standardisation in the audiovisual sector that can be learned from this case's history. This section by no means has the intention of providing an exhaustive list of guarantors for successful standardisation. It does however take some key elements that went wrong in the European HDTV standardisation and generalises them to fundamental aspects that should be taken into account when thinking about the standardisation of the successor to high definition television, which will be elaborated upon later.

4.1 From the drawing board to reality

Many cases in the past have shown that technological advancement cannot easily be planned, despite the efforts of developers or lobbyists who might like to see it otherwise. More than the social construction of technologies theory, according to which users may find uses for technology unexpected by their developers, surrounding factors like politics, economics, international relations or even culture can have an impact on how, when and if new technology is adopted. The European HDTV standardisation effort is a prime example of how contextual factors and the results of hastily made decisions had more impact than the incredible impulse the EU institutions tried to give the norm. When developing new technological standards that have such a direct impact on the consumer market, more time should be spent on considering potential factors that might inhibit or alter

adoption patterns in earlier stages of development. This can be achieved by involving as many related actors as possible in a setting that allows open discussion, and is related to the choice between a top down or bottom up approach (section 4.2).
An extra element that can be taken into account in this context is the importance of control during the development process. Even though community money was involved, the HDTV standardisation was largely carried out behind closed doors and at industrial meetings with limited public access. The effort would have benefited from transparency so that independent control organisations like the European Parliament or consumer groups could have access to status updates during development, and the ability to step in when it became apparent certain important elements were overlooked. Implementing a thorough control system can ensure that unexpected shifts or emerging contextual factors can be responded to with proper action and before it is too late and the effort fails.

4.2 Top down vs. bottom up

When developing a standard of which the success or failure can have important political and economical consequences, as was the case with HDTV in Europe, there is a clear danger of pulling the protectionist card and not inviting enough relevant parties to the discussion. As was proven in the case of HDTV, a one-sided approach to such a radical technological innovation will usually have detrimental effects. It is of critical importance to organise a wide consultation of the field, before undertaking concrete action. A bottom up method and a striving for consensus on fundamental issues should be a preferable approach.
This becomes abundantly clear when comparing the European to the American case. The European sector responded to the international HDTV standardisation efforts with decisions founded in a panic reaction. Therefore no broad consultation was organised, omitting some crucial players such as the public broadcasters and the end user from the standardisation development. This hasty process would only serve the interests of dominant, established organisations, leading to the failure of the HDTV initiative. In some cases a strongly centralised effort can be successful, but generally speaking, and especially when considering the audiovisual sector where hard- and software should go hand in hand, a broad consultation of the field should be essential.

4.3 Avoiding chicken-and-egg

As was touched upon in section 4.1, an audiovisual policy should try to look beyond the technological development of a new standard, but keep in mind contextual aspects in order to avoid the chicken-and-egg problem. Unfortunately, in the case of HDTV, this problem became painfully clear. When the standard was finalised and devices were pushed to market it quickly became apparent there was not enough compelling content broadcast in high definition to attract consumers. Hence, the need for coherence in any audiovisual policy becomes clear. There was a balance between the development of the actual HDTV *hardware* and its distribution, via the Race project, which researched the possibilities of an integrated European fibre-optic broadband network. It is accepted the HDTV policy failed severely in supporting the content industries. As mentioned in earlier sections, a disproportionate amount of funding went to the development of the hardware, compared to what was spent towards the development of HD programming.
This problem still persists to some extent in the current HDTV landscape, worldwide. Although the world has settled on three standards for HD screens several years ago, only now initiatives for HD broadcasting channels are gradually becoming commonplace and even then there is disagreement on which broadcasting norm is the most efficient one. The chicken-and-egg discussion seems particularly relevant for the audiovisual industry, where development of hard- and software should go hand in hand. In the specific case of screen resolution standardisation it has been the content industry running behind the hardware manufacturers (also for example in the 4:3 vs. 16:9 transition, which still creates problems today) and this would also seem to be the case for the successor to HDTV, which will be elaborated upon in section 5.

4.4 The consumer as an excuse

The European HDTV case also illustrates how consumer welfare can be used as a justification to attain certain goals. It is accepted that the development of HDTV in Europe was inspired by the distress of the European consumer electronics industry while consumer demand was drawn on as a pretext. Tools to measure consumer interest were not put to use in time during the development process, as opposed to the North American approach involving a broad consultation of the market. In Europe, market research into HDTV potential was carried out too late and no consumer organisations were involved in the standardisation process. Over the last years it seems there has been in a shift in this field, and consumer interests have certainly gained importance. When considering the most likely candidate to succeed HDTV, Ultra High Definition Television aka Super Hi-Vision developed in Japan, it quickly becomes apparent that consumer research is now a lager part of the development strategy (cf. section 5). However, the quite gradual adoption rate HDTV is seeing across Europe can be explained by the somewhat artificial demand that is created by the consumer electronics industry. Hence, when a standard is developed, especially in the consumer electronics segment, consumer welfare should be crucial and guarded by organisations that keep their best interests at heart.

5. OUTLOOK

After the failed policy, the EU did not continue to intervene in the HDTV case. Standardisation was left to the industry, with some initiatives in a European context, like the HD-Ready logo by EICTA. The technology is now slowly gaining traction with content producers, distributors and consumers, and is likely to gradually become the new television standard in the coming years. Recent figures indicate 90% of sold television sets are HDTVs, of which around half support 1080p, the HD norm of the highest quality. Figure 1 shows this growing adoption of HD capable televisions [17].

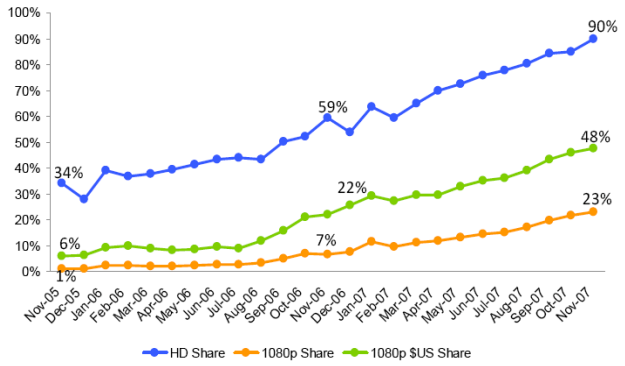

Figure 1. Share of HDTVs sold vs. classic screens

Prices for HD capable screens are also decreasing dramatically as manufacturers perfect the technology and production of parts becomes more affordable. It can be expected this trend will also positively influence HD adoption, at least with end users. Figure 2 gives a price projection for various sizes of HD capable screens, including both plasma and LCD technology [18].

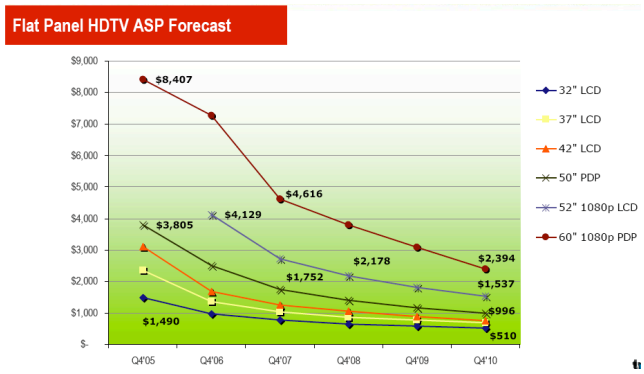

Figure 2. Price forecast for HD capable displays

Keeping its history in mind, it can be assumed that the EU will not intervene in the development of the successor to HDTV. Since the mid-nineteen nineties, Japanese public broadcaster NHK has been working on Ultra High Definition Television (UHDTV) or Super Hi-Vision (SHV), of which the latter term seems to be used more frequently, as the next step in the standardisation of TV screen resolutions [15]. This standard has a resolution of 7680x4320 pixels, sixteen times sharper than an HDTV image, and will most likely be accompanied by 22-channel audio. Because the resolution is a multiplication of current HDTV standards, the aspect ratio of the screens would remain the same, making SHV backwards compatible with HDTV. The high pixel density will quite likely lead to larger screens in the consumer electronics market, with display sizes varying between 100 and 200 inches. The transmission of this large amount of data is one of the key research challenges in the further development of SHV. Currently the SHV signal is broken up into 16 channels that are compressed after recording using existing compression techniques like MPEG-2, transmitted separately and recombined when they arrive at their destination. Any slight discrepancy in recombining the different streams can cause motion sickness in the audience, so great care must be taken in further researching compression methods [15]. A prototype of the technology was first presented at the 2005 World Expo in Aichi, Japan, and a further developed version of the norm was shown at industry events in Europe and the US throughout 2006. NHK would like to start test broadcasts for SHV via satellite in 2015 and roll out the technology on the Japanese market around 2025.

Considering the 4 general lessons to be learned from the HDTV standardisation, we can make some careful observations about how the SHV standardisation seems to be evolving.

- *Technological determinism*: as far as we can judge from current information, it would seem SHV, like HDTV, constitutes in the first place a technological standardisation process. Japanese public broadcaster NHK is developing the standard, although this time around, there seems to be more willingness from the Japanese to seek forms of international cooperation, both with the public and private sector. The BBC, EBU and the RAI are currently supporting development of SHV as the follow up standard for HDTV [11].
- *Top down vs. bottom up*: as NHK is Japan's public broadcaster, there is clear government involvement in the development of this standard. NHK is financed through a system of viewer fees [12] so SHV is not entirely developed using a bottom up approach. However, there has been an effort to attract international partners, both in the public and private sector, with success it would seem: SHV is being developed in close cooperation with the BBC, RAI, the EBU and Siemens. This interesting presence of European broadcasting and technology companies would seem to indicate a different approach will be taken, compared to the HDTV effort [11].
- *Chicken-and-egg*: the content production sector will need to be even more closely involved in the SHV effort. The HDTV standardisation teaches us lack of content was detrimental to the adoption of the standard, with consequences still abundantly clear today. The cooperation with European public broadcasters is laudable but a broad range of content producers needs to be attracted. This will be a crucial element in the successful adoption of SHV.
- *The consumer*: at the moment, SHV is not significant yet as an end user product. As the technology only becomes relevant for screens larger than 100 inches, it will not become the standard for home entertainment in the close future. However, if 100+ inch screens become more widespread, it is likely that the argument of consumer demand for more quality will be used to rationalise the move to SHV. However, even in this quite early state of development, the role of the consumer is more closely examined than during the HDTV research, because of a particular reason. Like mentioned earlier, when the SHV streams are not properly recombined, motion sickness may occur in audiences, something that is undesirable for obvious reasons. A recent article mentions how consumer testing will be a crucial aspect of the success of SHV [15].

At the time of writing, SHV appears to be the only potential successor to HDTV with no other standardisation efforts known to the public. Again it is the Japanese public broadcaster and the Japanese government that initiated the fundamental research with regard to the next generation in television hardware production and distribution. Given the European history and the path laid out by the HDTV standardisation, it is highly unlikely the institutions will take initiatives in this field. There is still a great deal of active research on the development of hardware related to the audiovisual industry in the European Framework Programmes,

although the focus seems to have shifted towards projects on future network technologies with increasing attention going to the mobile world and energy efficient technologies. Unless the Japanese experience fundamental problems in the development of SHV or there is a global disagreement on its adoption, it is doubtful Europe will undertake a standardisation effort of comparable magnitude to that of HDTV in developing its successor.

6. CONCLUSION

This paper gave an overview of the standardisation process of high definition television in Europe, in a global context. The global history of HDTV was outlined, describing the context in which the standardisation effort took place. After Europe took some hasty decisions and the standardisation process on the continent failed, the European institutions withdrew from intervening in this branch of the industry and allowed a bottom up approach. After that, some general lessons that can be learned from this tumultuous history were described. Firstly, technological innovations cannot be seen in a vacuum and are influenced by various external elements; secondly, a centrally organised, top down approach was favoured over a bottom up initiative which led to resistance from the industry and other actors; thirdly, the content industries were not sufficiently supported to make HDTV programming, resulting in a chicken-and-egg deadlock between hard- and software and fourthly, consumer demand and welfare was used as an excuse to push forward the industry's agenda. After the evaluation of these criterions for the HDTV standardisation, they were applied to SHV, the successor to HDTV. A careful first analysis seems to indicate that more effort is begin made to address the issues that were raised. There is room for improvement when it comes to avoiding a technology deterministic approach and especially towards steering clear of an impasse when it comes to hard- versus software, but it may also be too early in the standardisation process to judge these criteria. The history of HDTV does however explain why the European institutions seem reluctant to play a role in the introduction of SHV and can hopefully provide some valuable lessons towards the further development of the latter.

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