

How Much Information? 2003

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3. FILM

The amount of information produced and stored on film has increased since our last study. This increase has been mainly because of the expansion in the motion picture industry, rather than in film-based photography or in X-rays. Also, this increase may not indicate future expansion in the market for film.

At the time of the last study, digital photography was nascent; by this study it has clearly emerged as the technology that will eventually turn film-based photography into a comparatively smaller market.

The equivalent of the digital camera in moving images is the digital video camera (DV). In the area of motion pictures, the transition to digital technology is likely to be slower than has been in the case with photography. One of the reasons digital camera prints (or computer format images) can take precedence over film in the photography market is that individual users are less likely to be excessively quality-conscious -- and most photographers are amateurs who use cameras for recreation and recording of information rather than for serious photography.

Motion pictures, on the other hand, are made for mass consumption, and thus there is a quality expectation. Although new digital video cameras with capabilities of output closer to motion picture cameras are now available in the market, the quality of film and video are still significantly different, and the film format still enjoys aesthetic preference.

But with the time and material processing costs of digital video editing being exponentially lower than that of film editing, it is very likely that as soon as an equity threshold is reached in terms of visual quality between film and digital video, film will similarly lose market share in motion pictures as it has in still photography.

Digital imaging formats exist in X-ray technology, and these are gaining popularity, especially in the area of dental X-rays. However, in the case of non-dental medical X-rays, the digital format has yet to take off. In this case, the issue is less one of quality than of storage. Digital X-ray images are very storage heavy, and so the traditional film-based X-rays are still predominant. [???

This again means that the route from film to the digital medium in X-rays is related to how the storage technology

develops in the next few years -- if digital storage of visual images decreases in cost and increases in efficiency, X-rays may soon see a shift away from film. Digital storage has seen much more significant adoption in industrialized nations than in developing countries.

Table 3.1: Original Data On Film Annually Worldwide (2002)

	Units	Digital Conversion	Total PB
Photography	75,000,000,000	5 MB per photo	375
Motion Pictures	10,342	(see below)	25
X-Rays	2,000,000,000	10 MB per radiograph	20
Total:			420

Source: *How much information 2003*

Table 3.2: Worldwide production of filmed original content, if stored digitally, in terabytes circa 2002.

Type of Content	Terabytes/Yr Upper Estimate	Terabytes/Yr Lower Estimate	1999 Upper Estimate	1999 Lower Estimate	% Change Upper Estimates
Photographs	375,000	37,500	410,000	41,000	-9%
Cinema	6,078	12	4,490	9	35%
Made for TV films	2,531	2,530	N/A	N/A	N/A
TV series	14,155	14,155	N/A	N/A	N/A
Direct to video	2,490	2,490	N/A	N/A	N/A
X-rays	20,000	20,000	17,200	17,200	16%
Subtotal	420,254	74,202	431,690	58,209	-2.6%

Source: *How much information 2003*

Table 3.3: Total Stock of Film Worldwide (2001)

	Units	Digital Conversion	Total PB
Photography	900,000,000,000	5 MB per photo	4,500
Motion Pictures	368,530	(see charts below)	781
X-Rays	20,000,000,000	10 MB per radiograph	200
Total:			5,481

Source: *How much information 2003*

Table 3.4: Total Copies (Including Originals) of Film Worldwide (2001)

	Units	Digital Conversion	Total PB
Photography	76,500,000,000	5 MB per photo	383
Motion Pictures	5,660	(see above)	2,903
X-Rays	2,000,000,000	10 MB per radiograph	20
Total:			3,306

Source: *How much information 2003*

I. PHOTOGRAPHS

In our previous study, the "How Much Information" project had found that film photographs were increasingly losing market to digital format film. This trend has continued as expected: digital cameras have gained a significant market share and are expected to outsell film cameras by the end of 2003. Twenty-one percent of United States households had a digital camera as of 2002.

Photographs stored in the digital format have been accounted into our calculations of magnetic information. There is however, significant photographic data stored on digital photography devices. In 2002, there were 27.5 million digital still cameras purchased worldwide as compared to 63 million analog still cameras, according to Photo Marketing Association International (PMAI).

Also, the universe of cameras was approximately 53 million cameras. (Figures provided by the InfoTrends Research Group. The figures factor an accumulation of units over time, subtracting those that are retired every 3 years on average.) The storage space on each camera is about 16 MB, on average. Earlier on, there were cameras with smaller memory storage, but currently there are an equally large number of professional and higher-end cameras with greater storage space. The size of utilized storage on these devices is **1.2 petabytes**. (See details in [Magnetic](#).)

A. Original Information Stored on Film Rolls

1. Annual Production of Titles

Among the analog camera prints, there has been a comparative decrease in the total amount of photo output. In 2002, 75 billion prints were made of photographs taken on analog cameras, according to PMAI. The most dramatic rise in the sales of film rolls took place in the mid-1990's. The sharpest fall began in 2000, and is expected to continue in 2003.

Table 3.5: Key Photograph Statistics for 2002

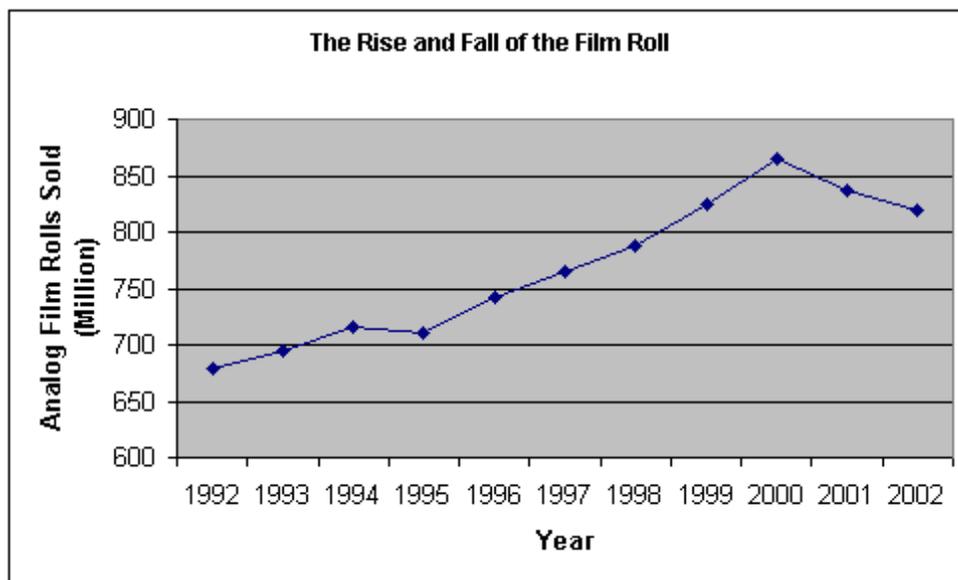
Film Prints Made (World)	75 billion
Film Rolls (World)	2.93 billion (excluding disposable cameras)
Disposable Cameras (World)	0.4 billion
Film Rolls (United States)	1.014 billion

Source: *Photo Marketing Association International*

Table 3.6: Film Rolls Sold in the United States

Year	Rolls Sold (in millions)
1992	679
1993	694
1994	716
1995	710
1996	742
1997	765
1998	787
1999	825
2000	865
2001	837
2002	820

Source: Photo Marketing Association International



Source: Photo Marketing Association International

Each roll potentially produces 30 individual exposure negatives, balancing out 24- and 36-exposure film, which are roughly produced in similar quantities (36 exposure rolls are very popular in many developing nations). This means a net capacity of about 87.9 billion exposures if all the film rolls were to be completely utilized. This figure corresponds well to the worldwide production estimate of 75 billion film prints (2002), accounting for about a 15% wastage of negatives.

Using the above figures, the total digital storage capacity of the film rolls produced in 2002 was about **440 petabytes** (87.9 billion photos at 5 MB apiece).

2. Accumulated Stock

The number of original photographs stored around the world is not a widely reported topic. It is also difficult to calculate, given the differing levels of preservation. There exist firms that stock large databases of photographs for resale; of these, the two largest are Getty Images, with 70 million images, and Corbis Images, with 65 million images.

As per our last study, approximately 750 billion photographs existed worldwide in 1999. There has been an addition of approximately 150 billion photographs in the two following years. Further, it is estimated that 2.1 billion photographs have been printed out from digital cameras. Thus, after accounting for some atrophy of photographs, the universe of photographs currently existing is close to about 900 billion. Using the same calculation of about 5 MB per photograph, this translates to a universe of 4,500 PB or 4.5 exabytes of data in still photographs.

B. Copies of Information Stored/Published on Film

There has been very little history of the large mass of photographs being copied. Kodak estimates that only about 2% of photographs are ever copied or modified in any way after they are originally developed. Of course, some photographic images are widely distributed in newspapers and magazines, but these are factored into the [Paper](#) section of this study.

Also, there are no statistics to tell what percentage of prints developed have multiple copies at the source. Thus, all original prints from negatives are counted in the first category of original pictures. Given this, the addition to the net figures of yearly photographs through copies is fairly small.

II. MOTION PICTURES

The amount of information stored on film through motion pictures is sizeable, because of the audio-visual data on every frame of motion picture reel. Traditionally, films made for popular release are duplicated with anywhere from a handful to several thousand prints, which are distributed worldwide. This makes the yearly turnover of film a large figure.

A. Original Information Stored on Motion Pictures

1. Annual Production of Titles

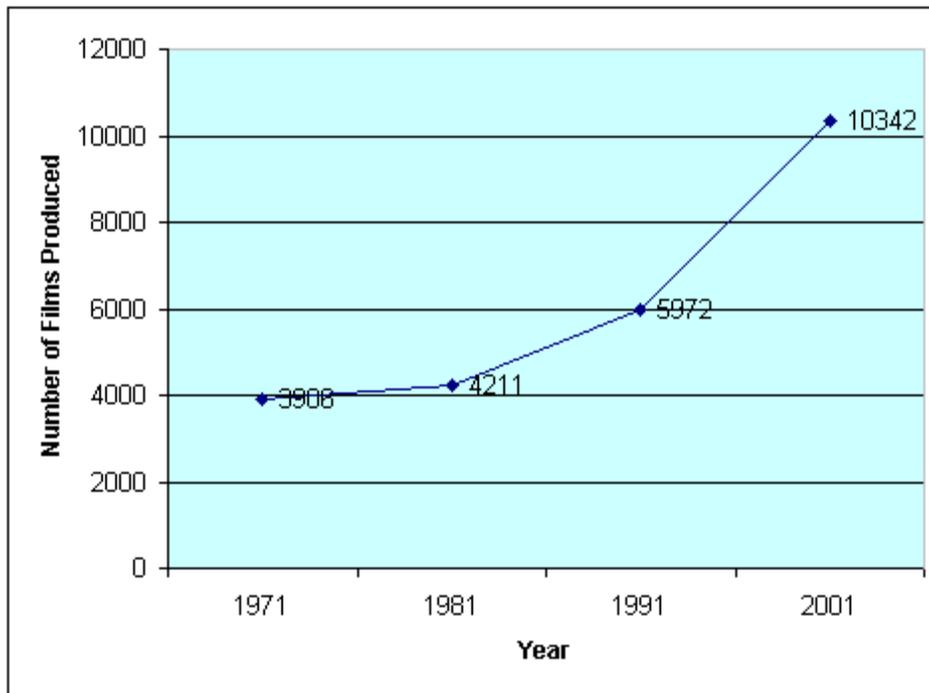
The yearly data for film production is difficult to assess, but 10,342 film titles and video were released worldwide in 2001 according to the Internet Movie Database (IMDB). This figure includes a significant number of television productions as well. Of these, a fair percentage were "short" films (approximately 20%), which is a significant change from previous years, indicating the increasing accessibility of the film medium to small filmmakers. This is evident from the significant increase in total film production during the past ten years, as compared to previous decades (see Table 3.7).

Table 3.7: Worldwide Film Production

Year	1971	1981	1991	2001
Films Produced	3,906	4,211	5,972	10,342

Source: Internet Movie Database (IMDB)

Note: This table represents **all** film production, including those films shot for television. Other parts of this section deal with only those figures of films that are specifically made for screen release. All the films included here are considered "commercial," i.e., for public release in some form. Films shot by individuals and firms, and restricted to their private consumption are not included in these figures.



This factor also points out the growth in independent filmmaking, and a phenomenal increase in digital video usage. The low cost of digital video shooting and editing equipment makes it much more data-storage-friendly than any past filming medium such as 8mm or Super 8. Also, DV tapes are inexpensive and editing equipment is now compatible with personal computers, making the home-movie a growing mode of stored audio-visual information.

It takes approximately 1 terabyte to store an hour of motion picture images in high-quality archival storage. It takes approximately 2 gigabytes to store an hour of motion picture images in digital form using the MPEG-2 compression standard. In Tables 3.8 and 3.9, we have used the larger storage measure instead of the compressed MPEG-2 standard, as this measure offers comparable numbers to archival storage space that we have estimated for photographs and X-rays.

Table 3.8: Annual title production of motion pictures

Type	Number	Multiplier*	Min. / Unit	Total Hours	Total Space (PB)
Feature Films					
Full length feature	3,851	1	90	5,776.5	6.08
Short	1,809	1	10	301.5	
Total:	5,660			6,078.0	
Made for TV	1,687	1	90	2,530.5	2.53
TV Series					
Soaps / Long-running Shows	55	250	30	6,875.0	
Sitcoms / Medium-range	80	30	30	1,200.0	

Mini Series	10	3	60	30.0	
Other TV Series	1,210	10	30	6050.0	
Total:	1,355			14,155.0	14.16
Direct to Video Movies	1,660		90	2,490.0	2.49
GRAND TOTAL	10,432			25,253.5	25.30

Source: Raw data from International Film Index 1895-1990. Chart, How much information 2003

* The Multiplier refers to the "number of units per title" – thus, we estimate that the average soap opera has about 250 shows a year, the average sitcom has 30. The remaining shows are undocumented – but around the world, it can be estimated that several of them run multiple episodes while a few are short-lived. We have therefore used 10 as the average.

2. Accumulated Stock

The number of motion pictures made around the world from 1890 to 2002 was approximately 368,530, according to *The International Film Index, 1895-1990*. The overall total is broken down into these categories of film types:

Table 3.9: Accumulated stock of motion pictures – 2003 sources

Type	Number	Multiplier*	Min. / Unit	Total Hours	Total Space (PB)
Feature Films					
Full length feature	226,771	1	90	340,156.5	
Short	57,825	1	10	9,637.5	
Total:	284,596			349,794.0	349.8
Made for TV	34,540	1	90	51,810.0	51.8
TV Series					
Soaps / Long-running Shows	419	1000	30	209,500.0	
Sitcoms / Medium-range	698	100	30	34,900.0	
Mini Series	4,197	3	60	12,591.0	
Other TV Series	22,148	10	30	110,740.0	
Total:	27,462			367,731	367.7
Direct to Video Movies	7,277	1	90	10,915.5	10.9
Live Action Video Games	553	1	60	553.0	0.5
SUBTOTAL	368,530			780,803.5	780.7

LESS (films lost to nitrate atrophy)	40,000	1	60	40,000.0	40.0
GRAND TOTAL SURVIVING ORIGINAL STOCK:	328,530			740,803.5	740.7

Source: Raw data from International Film Index, 1895 - 1990. Chart, How much information 2003

Also factored (scattered through categories) are the following:

- Animation Films and Series: 15,790
- Documentary Films: 30,475
- Silent Films: 49,417
- Black and White Films: 113,992
- Color: 254,538

UNIVERSE OF FILMS

The total production of 2001 represents 3.3 percent of the entire universe of existing original film and video production.

If the entire universe of available original film and video creations were played continuously, it would continue for 2,108 years.

It is very difficult to estimate the exact atrophy rate of nitrate film. All nitrate film eventually decays; the only way to ensure its survival is to transfer the information to another format. The conversion to acetate film in the 1950s marked a major preservation breakthrough. The rate of preservation of films since the 1950s has been excellent.

The survival of films from the Silent Era is particularly low -- only about 20 to 30% of the features made before the onset of sound still survive.

Table 3.10: Film Survival Among Silent U.S. Films

Year	Films Made	Films Surviving	Percent Surviving
1912	5	3	60.00%
1913	63	6	9.50%
1914	340	51	15.00%
1915	594	93	15.70%

1916	838	152	18.10%
1917	937	186	19.90%
1918	832	98	11.80%
1919	768	124	16.10%
1920	735	154	21.00%
1921	710	164	23.10%
1922	684	137	20.00%
1923	590	135	22.90%
1924	645	184	28.50%
1925	769	271	35.20%
1926	727	269	37.00%
1927	681	234	34.40%
1928	641	201	31.40%
1929	272	103	37.90%
1930	35	11	31.40%
TOTAL	10866	2576	23.71%

Source: Oksana Dykyj, Association of Moving Image Archivists, March 2003

If the question were how much of the film survives in the "film format" this number would be even lower as a lot of the surviving footage survives because it has been transferred into other mediums. Also, information on the archival collection of cinema in developing nations is very limited, but for this project, we have assumed more or less the same rates of survival for films outside of the United States and Europe.

However, it is known that there have been losses of major film collections, including several seminal works, both due to political activities and due to lack of attention to archiving. European and American film industries had established archives by the 1930s but most third world countries joined the bandwagon much later. The first Asian nation with film archives was Iran, in 1949. Thereafter India made its own archives in 1958 and China in 1964. Interestingly, Hong Kong and Japan, with very prolific film collections, did not have organized archives till the 1970s. The Philippines established its national film archives in 1982.

The total loss of film is hard to estimate, partly due to warfare and destruction of (or lack of access to) records in South East Asia, China and Middle East-Central Asia region. The Indian film archives, the largest non-western repository, is also among the most notorious at preservation; less than 10% of all films made before 1931 (some estimate as low as 1%) of Indian films still exist. Among the films lost is India's first talkie. Interestingly, while losses in India have been largely due to fire (most recently in 2002 due to faulty air conditioning in the film archives), there has also been significant loss through producers willfully destroying prints in the past, unmindful of the preservation value. This kind of loss is comparatively smaller in the United States and Europe due to record-keeping by agencies such as the Library of Congress.

B. Copies of Motion Pictures

The number of prints of films has changed drastically as have the sizes of audiences and the sizes of cinema hall facilities. In the 1910's, 40 prints would have been the average number of copies for a major release. By the 1920's, 160 prints would be considered a "big order," according to the Association of Moving Image Archivists (AMIA).

According to the Wolfman Report on the Photographic and Imaging Industry in the United States, the average number of prints per original motion picture was about 700 in the 1980s. In contrast, the Silver Institute reports up to 6,000 release prints may be released for feature movies. The average mass release film in the United States tends to have around 3,000 prints. This phenomenal increase in the number of copies is likely to be a result of the multiplex system of film theaters in the United States.

A number of films made, however, do not secure mass releases and are restricted to limited screenings and film festivals. Such films may have fewer than 50 prints. Indian films, a very large segment of the yearly film copy market, have an average of 300 prints in circulation per film because of the much larger size of cinema viewing halls, and the lack of "multiplexes" for shows on several screens.

A figure of 500 copies for motion pictures will be used on the assumption that many of the world's motion pictures have more limited releases than the typical Hollywood blockbuster.

A trend in motion picture information storage is likely to be the use of satellite broadcast for screening technology. This has the potential of doing away with the print copying process. At present, film release prints are largely destroyed after the major screening process is over. Firms exist that make a living by destroying release prints, reclaiming the silver, and turning some of the film into leader they can resell.

Table 3.11: Annual Production of Motion Picture Copies – Worldwide

Type	Number	Avg. Prints	Min. / Unit	Total Hours	Total Space (PB)
Feature films					
Full length feature	3,851	500	90	2,888,250	2888.2
Short	1,809	50	10	15,075	15.1
TOTAL	5,660			2,903,325	2903.3

Source: Wolfman Report on the Photographic and Imaging Industry

The "copies" of television films and series are not calculated here, because they are separately accounted for in the [Broadcast](#) section. The copies on video and DVD format are addressed in the [Magnetic](#) and [Optical](#) sections, respectively.

The prints of feature films are usually destroyed after the films have done their rounds. In earlier days, it was not uncommon for films to reach smaller towns in the United States some two years after initial release. By the time these prints were pulled out of service they were usually practically unwatchable. Then as now, as a film's distribution revenue declines, prints are pulled out of service and destroyed, partly also because the storage is very expensive.

The major studios were and still are very good at tracking and destroying prints. Release prints get junked by the thousands every year in the United States.

C. Trends in Motion Pictures

1. The Growth of Film Information Worldwide

The following chart shows the trends in growth of cinema in some of the top film-producing nations worldwide over the last four decades. The most obvious trends are the phenomenal rise in filmmaking in the United States between 1991 and 2001, contrasted with the significant fall in filmmaking in at least three other film producing nations - Italy, the Soviet Union / Russia, and Mexico. However, since our data sources only include major releases, it is likely that more films were produced in all three nations than reported.

	1971	1981	1991	2001
United States	494	506	762	1740
India	431	737	727	1013
France	165	179	247	453
UK	127	71	118	252
Germany	165	142	141	328
Italy	257	157	149	171
Japan	103	101	137	162
Soviet/ Russia	65	132	164	40
Spain	264	114	88	254
Canada	104	127	160	302
Mexico	124	98	87	43
World Total:	3,128	3,066	3,538	5,717

Source: Raw data compiled from IMDB. Chart by How much information 2003. Note: The world film data here differs from the other net figures of films because this includes only those films specifically made for film release - excluding TV films and series.

2. Comparing U.S. film production to Indian film production

A glance at the figures would indicate that the United States has overtaken India as the major producer of film in the world by a significant margin in the last decade. While this has in fact happened, it has a lot to do with the kind of film information represented in these statistics. Understanding these statistics gives us an idea of the massive growth of independent filmmaking in the United States.

This rise in American film production also has a major short-film factor that figures in the growth of American and some European film growth over the film production in India, for instance. In 2001, the United States produced 443 short films that were shot on 16-mm or 35-mm film (as factored into the statistics in Table 3.12 above), and the total number of short films released for the year in the United States alone was 541. For the same year, India had 2 listed short films.

Documentary cinema is the other area of difference. The statistics in Table 3.12 include 4 documentary films from India in the 1,013 films listed for 2001. In contrast, the figures for the United

States includes 187 documentary films, excluding video and television films. Including television and video, the U.S. documentary films released total 431, and several of these were series of documentaries. The funding for independent documentaries and short films in India is extremely low, and the technology is still very expensive for independent filmmakers to invest in. In contrast, the United States has very well-developed markets and distribution channels for independent cinema.

3. The International Spread of United States Cinema

The decline in film production in Mexico and Italy is accompanied by the massive influx of American cinema both in English language and in dubbed / subtitled versions, a market that has grown more recently. More significantly, the television production has increased very significantly in these nations - especially Mexico, offsetting the demand for indigenous film. Similarly, United States cinema has pervaded several markets where the local film industry has not been developed enough. The only major competition for United States films abroad has been Indian films, prints of which make it in dubbed versions to several Southeast Asian nations, and even Africa. However, even in many of the film-importing nations, American films are seen more favorably than Indian films; common evidence of this is that Indian films usually flood the video markets whereas United States films make it to theatrical releases.

4. Film Information Production and the Government

The most interesting statistics on the production of film information is the contrast between filmmaking in the United States and Western Europe with filmmaking in the former Eastern Bloc countries.

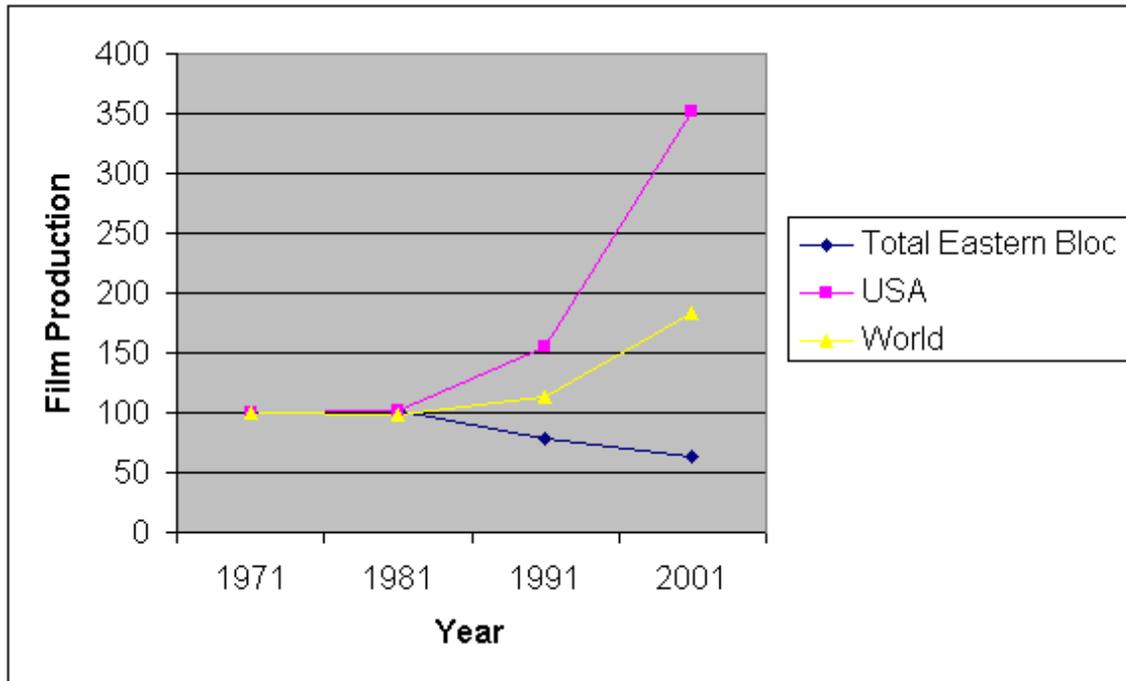
	1971	1981	1991	2001
Soviet U./Russia	66	132	164	63
Czechoslovakia	49	58	27	67
Hungary	30	24	18	48
Poland	44	39	33	29
Romania	45	29	10	10
Former Yugoslavia	153	103	69	46
Bulgaria	21	33	20	12
Albania	29	29	3	2
Total Eastern Bloc	437	447	344	277
United States	494	506	762	1,740
World Total:	3,128	3,066	3,538	5,717

Source: Raw data compiled from IMDB. Chart by How much information 2003. Note: The data excludes East Germany and does not include TV films and series.

Film was predominantly state-funded and sanctioned in most of the communist nations until about 1991. A clear trend exists showing the decline in film production with the end of government monopoly over cinema.

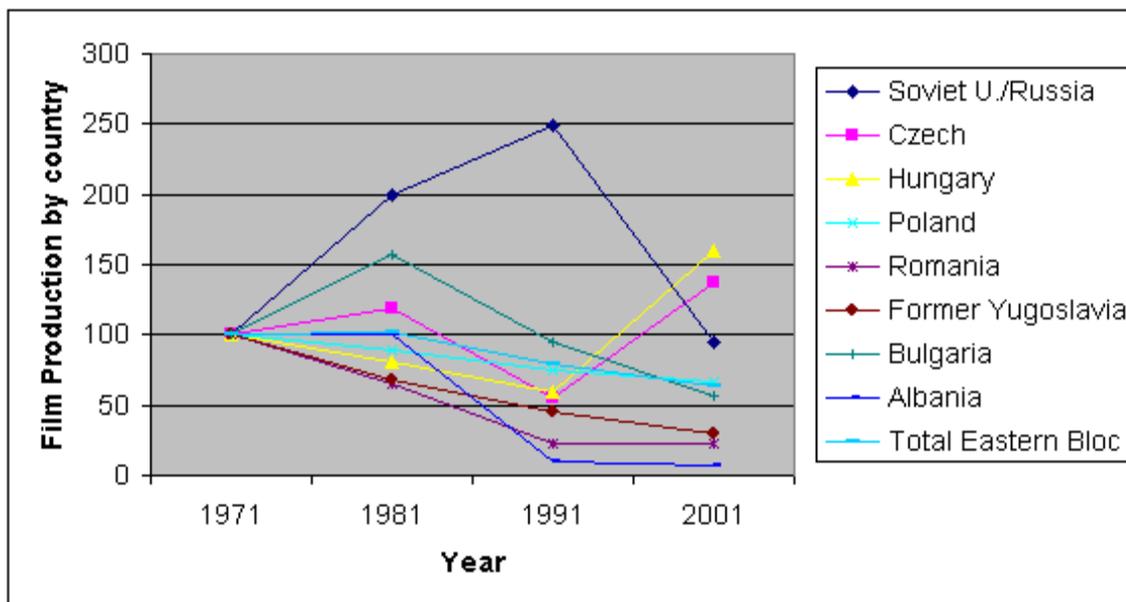
While this does indicate a lesser creation of original film information, the figures do not indicate a diminished flow in film information. On the contrary, the volume of film information in all these nations has increased - the increase mainly being credited to American and West European cinema flooding these markets where they were formerly restricted.

Film Production: Eastern Bloc vs. U.S. (Normalized to 1971 production figures)



Source: Raw data compiled from IMDB. Chart by How much information 2003.

Film in the Eastern Bloc (Normalized to 1971 production figures)



Source: Raw data compiled from IMDB. Chart by How much information 2003.

Only two countries, Hungary and the Czech Republic, were able to increase their film production from the levels attained in 1971 and 1981. Of these, the Czech film industry has traditionally been more independent of the state than in other Eastern Bloc nations. The most precipitous falls have been in Russia, which is estimated to have lost at least 50% of its production between 1991 and 2001. In

smaller countries like Albania and Romania, the film industry has become a fraction of what it was under communist governments. However, the decrease in film-making in many of these nations has been accompanied by a tremendous rise in the local production of TV programming, especially soap operas.

D. Film Trivia

Print Information Destruction

When sound came in (and after all the small-town theaters were wired for sound or closed in the early 1930's) all of the silent prints still in major studio exchanges (distributorships) were junked. Some independent exchanges kept prints of state's rights pictures or of pictures on which they could not trace ownership, but they would often sell these prints to traveling showmen or private collectors (if they could) for a couple of dollars a reel in the 1930's. With no perceived commercial value, the studios did little to maintain their silent libraries except to make periodic inspections and throw out reels that showed signs of nitrate decomposition. Fire was also a problem. The Lubin vault fire in 1914 destroyed all pre-1914 Lubin negatives as well as the negatives on a number of Bosworth and Lasky releases for which Lubin did the printing. Fox had a big fire in its East Coast vaults in 1937, destroying virtually all of the studio's pre-1935 negatives and finegrain masters. Universal destroyed virtually all of its silent negatives, finegrains and studio prints in 1948 to free up vault space. Frances Goldwyn (Goldwyn's wife) ordered all of the silent Samuel Goldwyn Productions destroyed for insurance purposes because she believed they had no value. (Source: Oksana Dykyj, Association of Moving Image Archivists)

Information Censorship!

Interestingly, of all the western nations, the countries to ban the most films are Finland, Sweden and Norway. These three nations are also among the highest producers of adult material, much of which is in turn banned in other nations. Eastern bloc, other communist nations, religious states and nations with media-restrictive policies have been excluded from this calculation. (Based on calculations on unsorted data in the Internet Movie Database.)

Information Chart-Toppers

Top languages of film production, based on calculations from unsorted data on the Internet Movie Database:

1. English
2. French
3. German
4. Spanish
5. Hindi
6. Italian
7. Japanese
8. Tamil
9. Telugu
10. Russian
11. Cantonese
12. Malayalam
13. Mandarin
14. Bengali
15. Dutch

III. X-RAY FILM

A. Original Information Stored on X-Rays

Annual Production of Originals

World. The third major use for film is the storage of X-ray images for medical, dental and industrial purposes. Approximately 2 billion radiographs are taken around the world each year, including chest X-rays, mammograms, CT scans, and so on. (Traditionally, 8% of X-ray film is used in dentistry and industrial applications.) When X-ray films are converted to digital format, it is important that there is no important clinical information lost. The American College of Radiology estimates that 10 MB of storage capacity is required for concerting a conventional radiograph to a storable digital format; to convert all radiographs to digital form would require **20 petabytes** of storage each year. Due to the heavy digital storage space requirement for X-rays, they will form a significant storage chunk in the terabyte DVD-RAM libraries market, according to a recent article in Unisys World.

United States. According to an IBM report from 2001, the 2000 American hospitals generate 7 terabytes of data each year from X-rays, mammograms, MRIs, cat-scans, endoscopies and other procedures.

Accumulated Stock

The clinical and legal uses of medical X-rays continue for an indefinite time and, therefore, prudent practice is to preserve X-rays and medical records generally for as long as possible. The same principle applies to dental X-rays. The only use of X-ray that may result in regular destruction of the resulting images is industrial testing, but even there it is likely that images are retained for a substantial period of time. Therefore, it is believed that there is little systematic destruction of the flow of new X-rays and virtually all of them are added to the stock. For the sake of calculation, it is assumed that a full ten years of X-ray images will constitute the stock. This is equivalent to approximately 20 billion images or **200 petabytes**.

B. Copies of Information Stored/Published on Film

The clinical requirements for medical X-rays demand that originals be used in almost any situation. There is no significant use of copies of X-rays at all.

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Film

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Special thanks to:

- Oksana Dykyj, Concordia University (and the Association of Moving Image Archivists) for her extremely valuable assistance on film
- Dimitrios Delis, PMAI, for his cheerful assistance with photography Information
- Michelle Slaughter, InfoTrends Research Group, for her prompt assistance with Digital Camera information

Release date: October 27, 2003. © 2003 Regents of the University of California