

## **How much information? Chapters from the history of the accounting of information flows and knowledge stocks**

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"How much information?" A question, which has been raised by electric engineers, mathematicians and the researchers studying the "information revolution" and "information society". In the present paper I outline the history of information accounting and provide an assessment of strengths and weaknesses of various approaches.

### **1. Chapters from the history of information accounting**

#### **Chapter 1. Pioneers' epoch**

It was Ithiel de Sola Pool and Inose, who were pioneering in the attempts to account information flows and knowledge stocks in a country, particularly in the U.S. and Japan [Pool 1984]. They introduced "production" and "consumption" of information and determined the value of these variables. As a unit of their measurements "word" was introduced. Empirical - and arbitrary - rules to express the the volume of various carriers in a common unit have been defined. While they accounted various carriers and carriers altogether, their tables can not be viewed as accounts as defined in book-keeping. Marc Uri Porat in his unical treatise on U.S. information economy has first provided a comprehensive economic view of all information activities of a country.

#### **Chapter 2 System of National Information Accounts - an effort in Budapest**

Lakoff's epochal works on metaphors [Lakoff] have revealed that language reflects "folk-psychology" of phenomena and processes: the world itself, as it is represented in our mind and brain. In English, Hungarian and in a number of other languages, information is a fluid; it has volume, it flows, can be produced, outputted, inputted or consumed, and it can be stored. Commodities and value, in an economic sense, also obey the rules governing the behavior of "fluids", this is why micro-, and macroeconomic accounts can be defined and applied worldwide both in book-keeping and economy.

To explain, forecast and understand the behavior of fluids in a particular situation, the generic theory, the equations of heat and mass transfer should be adopted and applied. The theories concerning economic behavior of "information" that predict or declare that information can be consumed unless its volume in the process would change, contradict to the intuitive contents of the concept itself, which reflects in the word usage, and the traditional official statistics of information goods.

An exact theory should be based upon solid concepts, operational measurement procedures in harmony with theory of transport processes. A standard system of standard accounts is needed to compare information-related phenomena in the countries of the world. In any particular measurement the conditions of the situation should be exactly determined and extrinsic quantities should be measured and introduced.

It was the Japanese Planning Agency, which first has published bit-based figures for the "production" of information in Japan. Figures for Hungary, which have been compiled by the Pool's method have been published by the present author: [Dienes92]. At the same time, in 1990 and 1991 the figures and methodology of information accounting have been reviewed and reconsidered. As a result, a new methodology, called SNIA, System of National Information Accounts, was developed, which is directly related to SNA's approach and concepts. Then, information balances of Hungary for the period 1945-1990 have been compiled [Dienes92]. The political, practical and statistical considerations behind SNIA, as well as figures for Hungary, can be viewed at <http://free.x3.hu/infostat>.

#### **2.1 Subjects and objects of the accounting in the SNIA**

Due to the new approach, any account of information should be in accordance with national accounts, both concerning concepts and figures. SNIA has been based upon the same fundamental general concepts as [SNA93]. These include actor, institutional unit, sector, good, service, commodity, economic transaction, economic stock, economic flow, account, balance. SNIA covers those subjects, objects, relations, acts, actions and activities which are subject to legal definition, require comprehensive treatment and can be subject to operationalization.

The vary same concepts, however, have sometimes been interpreted in a wider environment to include events and objects that are beyond the present scopes of SNA, but seem to be important, and new concepts also were introduced. New integrated sectors; the main groups of social actors of information transactions, which are relevant to policy making, should also be added to those of SNA, to reflect real situation, phenomena and processes. SNIA classifies transactions by commodity.

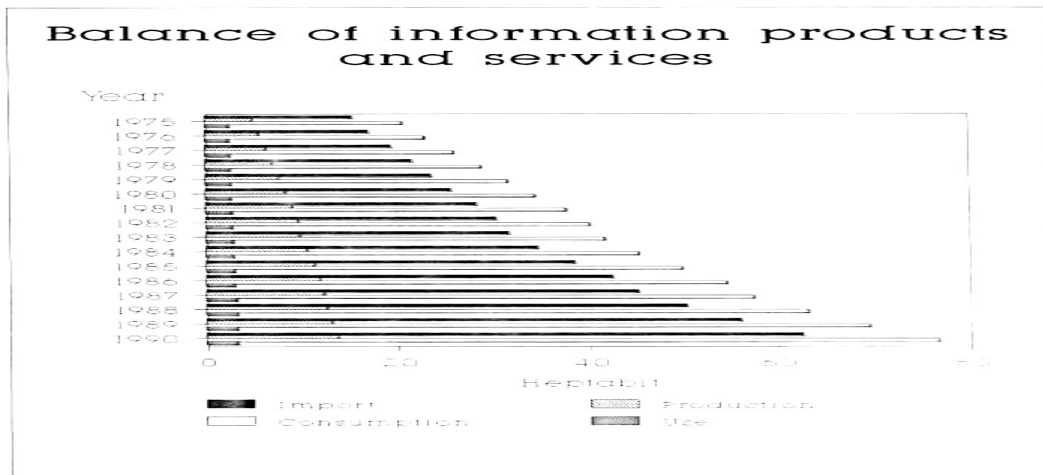
Information is understood here as something which forms or formed within (the brain of) either human or machine actors, or is represented in/on the goods/services outputted. Volume/amount of information carried by physically existing goods and services - in a standardized communication situation as defined here - is an attribute of goods and services which is very similar to extrinsic physical parameters. This interpretation seems to be in harmony with exact theories of information, such as Shannon's.

The fundamental question of SNA is "Who does What by What means for What purpose with Whom in exchange for What with What changes in Stocks?"

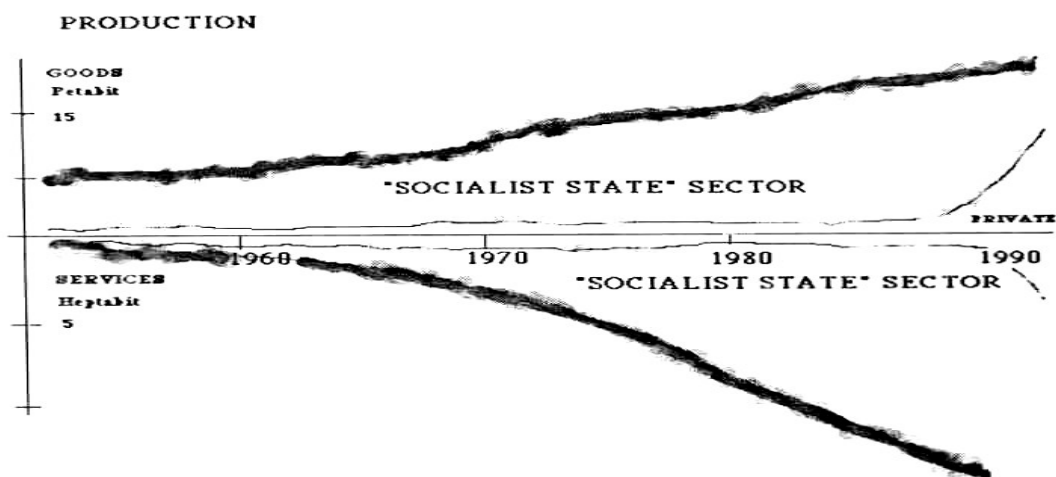
In accordance with this, an action is called an information flow if it leads to the change of information assets of participants. A transaction can be called an information transaction, if it implies the flow of information. There is a class of goods and services whose main function is just to convey/carry information, these are called information goods and services. Information goods do not include machines like computers, office and telecommunications devices; rather they include books, diskettes, records and a number of other durable media.

The non-exhaustive list of main categories, in terms of which SNIA describes information phenomena, includes information-input, -output, -production (gross and information added), -consumption, -use, -asset, -accumulation, -capital, -stock, productive -consumption, -capital consumption, -export, -import and externalities. Unlike SNA, SNIA makes difference between use and consumption: while consumption assumes the annihilation of the good or service, its use does not. Almost the whole arsenal of macroeconomics is expected to be transformable to SNIA.

The most outstanding difference between SNA and SNIA is in the way they value flows and stocks. While valuation of transactions in SNA has practically been based upon general substitutability for money, opportunity of exchange for money, SNIA provides the opportunity of valuation based upon general substitutability of information-commodities for a digital record, opportunity of recording, exchange for a digital record. Accordingly, it is not information in SNIA, which is considered as resource or product, but goods (including non-durable signals) which carry/convey information. This is in agreement with SNA, where it is not "value" which is considered as a resource or product, but goods which have or carry value. Information interpreted in such manner, can be treated similarly to energy. Various versions of SNIA accounts involve the information that goods and services carry at "sensory" or at "perception" level.



As an illustration of the several tables and figures, the Figure 1. shows output, consumption, of information commodities in Hungary in the period 1975-1990.



So far, basic SNIA tables have been compiled in bit units. Most tables, particularly those concerning all information goods and services altogether, may be, and some actually were compiled in value units, either. These tables -- called twin tables -- show "information economy" in a commodity approach. These tables do not belong to the standard set of tables of SNA, for they contain figures for such a group of goods and services whose elements are scattered in a number of industries, group of kinds and group of services of standard SNA. This set of twin tables, however, may create a bridge, a direct linkage to SNA. Different interpretation of production, different asset and national boundaries make the correction of national SNA aggregates necessary.

While SNIA has been designed for macro level analyses, its concepts and structure make it capable to treat other communication issues and situations either; as regional communication or communications among various communities and groups. These accounts do not organically belong to the SNIA as suggested.

### Chapter 3. A Standard System of National Information Accounts - Budapest in Berkeley

In the frames of a Fulbright scholarship at UC Berkeley, the present author has developed the Version 1.0 of SSNIA, a standard system of national information accounts, whose inputs are standard tables of international official statistics or statistics of international organisations. The objective of the system is

to provide a comprehensive, multipurpose intellectual framework and vehicle (accounts, balance sheets, tables, based on a set of internationally agreed concepts, definitions, conventions, classifications and accounting rules) which is compatible with SNA. Hundreds of standard indicators are available in the system for the purposes of description and analysis. The framework should allow the governments, business groups and citizens to analyze and display the important and relevant individual features of the countries and to provide information for the government to conduct a comprehensive -- non-industry and non-department level -- national and international information policy. In addition, it should be useful for conducting scientific research. The first two introductory chapters of SSNIA can be read at the website referred above.

#### Chapter 4 USSNIA - The estimation of the main SSNIA Indicators for the U.S.

- The objectives of this study - conducted in Berkeley by the present author - were to
- outline the "information household", the process of social reproduction of information in the United States in the extended framework of SNIA to
  - position the system of social reproduction of information in a space defined by the antinomies of
    - social reproduction: market--non-market,
    - corporations--governments--households,
    - production--consumption,
    - domestic--foreign,
  - determine orders of magnitude of indicators,
  - determine the main relations among them,
  - identify the main processes and trends in the U.S. in the period between 1970-1990.

Furthermore I wanted to

- gather experience with SSNIA trying to understand the way of operation of the system and
- make statements on the feasibility of the system.

The first comparisons with De Sola Pool's figures justified that his method – based upon words - underestimated volumes of information carried by spectacular carriers like TV or culture and entertainment.

The phenomenon "Electronic mass media" is really an output/consumption chain: Authors produce original music, film, entertainers play, recorders record, producers multiply records, program providers replay, transmitters transmit, broadcasters broadcast, set owners display or present, viewers when viewing reproduce information. Each player productively consumes the output of the former. While this sequence has been analysed and followed, [Pool] never tried to follow the media processes in details. This explains the differences in quantities of machine consumable information.

*Table 1. Comparison of distribution of Output in USSNIA and "supply" in [Pool] and intermediate consumption in USNIA and "consumption" in [Pool] by commodities*

Products	Output 1990 % exabit	Output 1980 % exabit	"Supply" 1980, De Sola Pool % words	Intermediate consumption, 1990 % exabit	Intermediate consumption 1980, %exabit	"Consumption" 1980 De Sola Pool, % words
Services	99,99	99,99	97,69	100,00	100,00	82,90
Human consumable	30,33	38,86	0,07	92,33	94,25	11,07
Education	7,38	9,45	0,03	43,91	45,49	6,36
Personal oral communications	11,11	14,23		11,12	10,11	
TV shows	4,60	5,89		5,45	5,65	
Supplying radio programs	0,01	0,01		0,01	0,01	
Culture and entertainment	2,14	2,74	0,02	1,35	1,40	0,44
Writing	0,00	0,00		0,00	0,00	
Reading	5,10	6,54		30,49	31,59	
Phone	0,00	0,00	0,02	0,00	0,00	4,27
Machine	69,66	61,14	97,62	7,67	5,75	71,83

consumable							
TV							
broadcasting	20,29	18,27	25,30	3,33	4,58		51,70
Radio							
broadcasting	4,24	4,60	71,80	0,03	0,03		18,80
Cable TV	45,13	38,26	0,52	4,31	1,14		0,76
TV							
programming	0,00	0,00		0,00	0,00		
Radio							
programming	0,00	0,00		0,00	0,00		
Phone and data							
services	0,00	0,00	0,00	0,00	0,00		0,57
Goods	0,01	0,01	2,76	0,00	0,00		16,18
Human							
consumable	0,01	0,01	2,24	0,00	0,00		16,10
Paper-based	0,01	0,01	2,24	0,00	0,00		16,10
Other	0,00	0,00		0,00	0,00		
Machine							
consumable	0,01	0,00	0,52	0,00	0,00		0,08
Videocassette	0,01	0,00		0,00	0,00		
Audiocassettes	0,00	0,00		0,00	0,00		
Magnetic tapes	0,00	0,00		0,00	0,00		
Magnetic							
diskettes	0,00	0,00		0,00	0,00		
Hard disks	0,00	0,00		0,00	0,00		
Film	0,00	0,00		0,00	0,00		
Other	0,00	0,00		0,00	0,00		
Altogether	100,00	100,00	100,45	100,00	100,00		99,08
of this							
SNA accounted	77,04	70,59		52,93	52,64		
Non-SNA							
accounted	22,96	29,41		47,07	47,36		
Human							
knowledge	0,00			0,00			

However, the one-semester, which the one-semester opportunity in the frames of the Fulbright scholarship, was obviously too short for such a huge a work. The main conclusions were summarized in the Spring of 1994 in the course of a number of presentations held in the U.S., including Berkeley, UCLA, UCSD and the University of Hawaii. Phragments from these presentation can be read at <http://free.x3.hu/infostat>. The summary also has been read at, and published in the proceedings of, the Delhi conference of IARIW.

Having returned from Berkeley I have to reorganize Hungarian official telecommunications statistics. In a three year period I desigend 14 new surveys while nthe number of TC services providers went up from one to thousands. I also had to compile a book on Hungarian information economy in the period 1992-96, and simply had no time to complete the study of the U.S. Whereas the tables remained phragmentary, I have never published them, and the book on the work is still in manuscript. Below I present some of these tables.

Table 2 is the extended information goods and services account of the United States for the year 1990. This account shows the change of the net volume of information at the beginning of the year in the five main sectors by main groups of commodities, as a consequence of output, export and negative externalities, import and positive externalities, and consumption. The corporations sector dominates information households. Information services, like services usually, can not be reserved or maintained, hence their volume (stock) is zero. The volume of information carried by information goods is much less, then that carried by information services. More machine consumable information was outputted, than human consumable.

*Table 2. Extended information goods and services account, of the United States, 1990 (Phragment, Part I)*

Products	Net volume of informatioas of	Output by (exabit)
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Jan 1 <sup>st</sup> . (exabit)										
Sectors →	Corp	Govt	Hholds	NPI-s	Total	Corp	Govt	Hholds	NPI-s	Total
<i>Services</i>	0	0	0	0	0	1 313 519	221 280	290 924	100	#####
<i>Human consumable</i>	0	0	0	0	0	134 727	91 580	290 924	100	517 231
Education	0	0	0	0	0	53 297	83 086	25 183	0	161 566
Personal oral communications	0	0	0	0	0	31 725	3 525	173 402	100	208 652
TV presentations	0	0	0	0	0	11	1	10 928	0	10 940
Supplying radio programs	0	0	0	0	0	0	0	94	0	94
Culture and entertainment	0	0	0	0	0	4985	0	35152	0	40136
Writing	0	0	0	0	0	0	0			
Reading	0	0	0	0	0	44 706	4 967	46 165	0	95 839
Phone	0	0	0	0	0	4	0	0	0	4
<i>Machine consumable</i>	0	0	0	0	0	1 178 792	129 701	0	0	1 308 492
TV broadcasting	0	0	0	0	0	260 043	121 082	0	0	381 125
Radio broadcasting	0	0	0	0	0	70 994	8 618	0	0	79 612
Cable TV	0	0	0	0	0	847 754	0	0	0	847 754
TV programming	0	0	0	0	0	0	0	0	0	0
Radio programming	0	0	0	0	0	0	0	0	0	0
Phone and data services	0	0	0	0	0	-	-	-	-	-
<i>Goods</i>	0	3	0	0	0	1	0	0	0	100
<i>Human consumable</i>	0	0	0	0	0	0	0	0	0	99
Paper-based	-	0	-	-	-	-	-	-	-	99
Other	-	-	-	-	-	-	-	-	-	0
<i>Machine consumable</i>	0	3	0	0	0	1	0	0	0	1
Videocassette	-	0	-	-	-	0	0	0	0	0
Audiocassettes	-	0	-	-	-	0	0	0	0	1
Magnetic tapes	-	-	-	-	-	-	-	-	-	-
Magnetic diskettes	-	-	-	-	-	-	-	-	-	-
Hard disks	-	-	-	-	-	-	-	-	-	-
Film	-	3	-	-	-	-	0	-	-	-
Other	-	-	-	-	-	0	-	-	-	-
<i>Altogether</i>	0,00	2,62	0,00	0,00	0,00	1 313 520	221 280	290 925	100	#####
of this										
<i>SNA accounted</i>	0	0	0	0	0	906 040	83 086	60 334	0	1 049 460
<i>Non-SNA accounted</i>	0	3	0	0	0	407 480	138 194	230 591	100	776 363
<i>Human knowledge</i>	-	-	-	-	-	185 023	20 557	832 185	200	#####

Table 3. Extended information goods and services account, of the United States, 1990 (Phragment, Part II.)

Products	Export and externalities evoked by (exabit)					Import and externalities at (exabit)				
	Corp	Govt	Hholds	NPI-s	Total	Corp	Govt	Hholds	NPI-s	Total
Services	4 943	1 611	1 666	0 8 220			0	0	14 338	0 14 152

Human consumable	146	427	1 666	0 2 238	0	0	4 086	0 3 900
Education	73	427	0	0 499	0	0	1 068	0 1 068
Personal oral communications	-	-	1 641	0 1 641	-	-	1 615	0 1 615
TV shows	0	0	25	0 25	0	0	186	0 0
Supplying radio programs	0	0	0	0 0	-	-	-	- -
Culture and entertainment	73	0	0	0 73	0	0	438	0 438
Writing	0	0	0	0 0				
Reading	-	-	-	- -	-	-	780	0 780
Phone	0	0	0	0 0	0	0	0	0 0
Machine consumable	4 798	1 184	0	0 5 982	0	0	10 252	0 10 252
TV broadcasting	4 088	454	0	0 4 542	0	0	9 456	0 9 456
Radio broadcasting	710	730	0	0 1 440	0	0	796	0 796
Cable TV	0	0	0	0 0	0	0	0	0 0
TV programming	0	0	0	0 0	-	-	0	0 -
Radio programming	0	0	0	0 0	-	-	-	- -
Phone and data services	-	-	-	- -	-	-	-	- -
Goods	2	0	0	0 2	0	0	0	0 0
Human consumable	0	0	0	0 0	0	0	0	0 0
Paper-based	-	-	-	- -	-	-	-	- -
Other	-	-	-	- -	-	-	-	- -
Machine consumable	2	0	0	0 2	0	0	0	0 0
Videocassette	2	0	0	0 2	0	0	0	0 0
Audiocassettes	-	-	-	- -	-	-	-	- -
Magnetic tapes	-	-	-	- -	-	-	-	- -
Magnetic diskettes	-	-	-	- -	-	-	-	- -
Hard disks	-	-	-	- -	-	-	-	- -
Film	-	-	-	- -	-	-	-	- -
Other	-	-	-	- -	-	-	-	- -
Altogether	4 945	1 611	1 666	0 8 222	0	0	14 338	0 14 152
of this								
SNA accounted	146	427	0	0 572	0	0	11 320	0 1 505
Non-SNA accounted	4 799	1 184	1 666	0 7 650	0	0	3 018	0 12 647
Human knowledge	-	-	-	- -	-	-	-	- -

Table 4. Extended information goods and services account, of the United States, 1990 (Phragment, Part III.)

Products	Consumption by (exabit)(					Net volume of information at the end of the year					
	Sectors →	Corp	Govt	Hholds	NPI-s	Total	Corp	Govt	Hholds	NPI-s	Total
Services		92 512	10 279	1 728 865	100	#####	0	0	0	0	0
Human consumable		92 511	10 279	416 103	100	518 893	0	0	0	0	0
Education		16 077	1 786	144 271	0	162 134	0	0	0	0	0
Personal oral communications		31 725	3 525	173 376	100	208 626	0	0	0	0	0
TV shows		0	0	10 916	0	10 916	0	0	0	0	0
Supplying radio programs		0	0	94	0	94	0	0	0	0	0

Culture and entertainment	0	0	40 501	0	40 501	0	0	0	0	0
Writing	0	0	0	0	0	0	0	0	0	0
Reading	44 706	4 967	46 946	0	96 619	0	0	0	0	0
Phone	4	0	0	0	4	0	0	0	0	0
Machine consumable	0	0	1 312 762	0	1 312 763	0	0	0	0	0
TV broadcasting	0	0	386 040	0	386 040	0	0	0	0	0
Radio broadcasting	0	0	78 968	0	78 968	0	0	0	0	0
Cable TV	0	0	847 754	0	847 754	0	0	0	0	0
TV programming	0	0	0	0	0	0	0	0	0	0
Radio programming	0	0	0	0	0	0	0	0	0	0
Phone and data services	0	0	0	0	0	0	0	0	0	0
Goods	0	0	0	0	0	0	0	0	0	0
Human consumable	0	0	0	0	0	0	0	0	0	0
Paper-based	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Machine consumable	0	0	0	0	0	0	0	0	0	0
Videocassette	-	-	-	-	-	-	-	-	-	-
Audiocassettes	-	-	-	-	-	-	-	-	-	-
Magnetic tapes	-	-	-	-	-	-	-	-	-	-
Magnetic diskettes	-	-	-	-	-	-	-	-	-	-
Hard disks	-	-	-	-	-	-	-	-	-	-
Film	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Altogether	92 512	10 279	1 728 865	100	#####	0	0	0	0	0
of this										
SNA accounted	16 077	1 786	1 457 033	0	1 050 393	0	0	0	0	0
Non-SNA accounted	76 435	8 492	271 832	100	781 263	0	0	0	0	0
Human knowledge	-	-	-	-	-	-	-	-	-	-

The volume of information commodities that has been outputted in the U.S., totalled 1 878 heptabit in 1990. SNA-accounted commodities made three quarters out of the volume of output. The output has been dominated by broadcasting. The ten-year growth rate from 1980 to 1990 was 38%. Stocks have been dominated by human knowledge: both print and digital media remain subordinate when comparing estimated volumes of knowledge stocks of human individuals. Originals are far subordinate to copies. The reader is kindly invited to study the figures deposited at the site above.

Table 5. Output and growth rate of information by groups of services and goods

Products	Output, 1980 (exabit)	Output, 1990 (exabit)	Ten year growth rate (exabit/exabit*100)
<i>Services altogether</i>	<b>1 319 708</b>	<b>1 825 724</b>	<b>138</b>
<i>Human consumable</i>	435 902	517 231	119
Education	121 815	161 566	133
Personal oral communications	169 076	208 652	123
TV presentation	10 017	10 940	109
Supplying radio programs	94		
Culture and entertainment	40 136		



Writing	0	0	
Reading	94 760	95 839	101
Phone	4	4	100
<i>Machine consumable</i>	883 807	1 308 492	148
TV broadcasting	267 946	381 125	142
Radio broadcasting	54 820	79 612	145
Cable TV	561 040	847 754	151
TV programming	0	0	-
Radio programming	0	0	-
Phone and data services	0	0	-
<b><i>Goods altogether</i></b>	<b>99</b>	-	-
<i>Human consumable</i>	99	-	-
Paper-based	99	-	-
Other	0	-	-
<i>Machine consumable</i>	-	-	-

Commoditization of products is a persistent phenomenon of the history of economy.

Information transfers are uncompensated information flows. In the twenty-year period between 1970 and 1990 the share of education decreased from 26% to 14%, while the share of broadcasting increased from 46% to 61%. Socially irresponsible – mainly private - broadcasting obviously replaces socially responsible education, with all consequences: violence, aggressivity, corruption of traditional values.

Table 6. Information transfers by main groups of commodities

Year	Education (exabit)	Broadcasting (exabit)	Others (exabit)	Altogether (exabit)	Altogether (Output=100)	Altogether per capita (petabit)
1990	108 269	460 738	184 425	753 431	41	3,01
Transfers=100	14,37	61,15	24,48			
1980	106 067	322 766	143 925	572 759	43	2,52
Transfers=100	18,52	56,35	25,13			
1970	108 487	190 843	115 328	414 658	50	2,02
Transfers=100	26,16	46,02	27,81			

Significant volumes of information are accompanied to economic transactions as “ordering of a commodity”, “billing”, “money transfer”, etc. Beyond SNA-like indicators the volume of these information transactions has been estimated. These figures are shown in table 1.

Table 7. Intersectoral flow of information output (Exabit, phragment)

From	To					Altogether sources
	Corporations	Governments	Households	NPI-s	Rest of the world	
Corporations			1 237 073	0	4 943	1 313 519
Governments			212 787	0	1 611	221 280
Households			290 824	100	1 666	305 252
NPI-s	0	0	100	0	0	100
Rest of the world	0	0	14 327	0		14 142
Altogether uses	0	0	1 755 111	100	8 220	1 854 293
						1 763 432

Table 8. Obligatory supply of information closely connected to transactions

Classes of examples	Source of obligation	Estimated magnitude of order of volume of information 10 to k, k=	Source of raw data	Estimated volume of information (Exabit)
A. Information for soliciting business services				
A.1 Services, goods non-specified	Interestedness			
Order				

A.2 Postal and telecomm services	Interestedness			
Mail address		14<	Stat.Abs.U.S.91	1,16E-04
Phone dialling		10<	FCC Stat.Com.Carr.	5,49E-08
A.3 Financial services	Interestedness, law			
ATM transactions		11<	Func.cost. anal.199	3,62E-07
Applications for loans		12<	Natl.avg.rept, 1990	
Checking account transactions		12<	Natl.avg.rept, 1990	2,30E-07
Savings account transactions		12<	Natl.avg.rept, 1990	
A.4 Medical services	Interestedness, law			
B. Copies of contracts and agreements	Interestedness			
C. Information on delivery of goods and services	Law			
Retail bills, receipts		13<	Stat.abs.U.S.91	2,49E-05
D. Information provided to consumers				
Notice of usage	Law			
Contents information on food products	Law	14<	Stat.abs.U.S.91	3,70E-04
E. Payment information	Interestedness, law			
F. Information on soliciting job	Interestedness, law		Stat.abs.U.S.91	
G. Information provided for courts				
By ensuer in civil lawsuits	Interestedness, law	20<		
By subpoenaed witness	Law	20<		2,74E-02
H. Information provided to authorities	Law			
For a driver's license	Law			
For recording birth	Law	8<	Stat.abs.U.S.91	2,90E-10
For getting permission to conduct profession	Law			
Produce drugs	Law			
Distribute films	Law			

## **Chapter 5. New research in Berkeley**

The new research object - transplanted from Hungary to Berkeley - has been soon adopted and got several followers, after the two-semester Fulbright term of the present author had ended. Once School of Library and Information Sciences has got a new mission which is reflected in the new name: School of Information and Management. Professor Varian a world-wide known information-economist - has been appointed to the Dean of the school. For the time being, five persons conduct a world-wide survey at UC Berkeley, also publishing data for the U.S. The Berkeley group focused its attention to some of the SSNIA indicators. They redefined several media and estimate yearly „information production”, „information consumption”, „accumulated stocks of information”, rates of growth and „other valuables of interest”. "Produced", i.e. outputted, commodities sometimes are called "flow" as a contrary to "stocks".

Senior researchers Peter Lyman and Hal Varian [Varian00] have published the results of the study entitled „How much information?” [www.berkeley.edu]

Any measurement which aspires to the rank of being qualified as „technical” or „scientific”, should have a well founded and well defined methodology. Information – the fundamental concept of classical theory of communications – assumes a transmitter and a receiver and a noisy telecommunication channel. There is no such amount there, as an immanent, absolute quantity of information „in a book” and as a thing as “production or consumption of information” in classic theory. [Braman] in her classical study collected several definitions to „information”, none of which is suitable for measuring „information” in an economic context. Furthermore, production, output, flow, consumption are internationally standardised concepts and quantities which are measured in the frames of theory and methodology of national accounting [SNA].

In their recent study, Lyman and Varian *do not provide a new generic definition* of their own, concerning their variables-indicators. Unless one created a new definition, he should decide whether he - as an economist - is interested in the macroeconomy of production/consumption/accumulation of goods and services or, as an electric engineer is interested in transmission of signals in noisy channels. The elements of the two theories must not be mixed in some arbitrary ways. The authors mistakenly adopted the information paradigm from the theory of communications and tried to merge it into macroeconomics.

The authors adopt a specialized "store model". As the authors write: "Soon it will be technologically possible for an average person to access virtually all recorded information. The natural question then becomes: How much information is there to store?"

This approach is straightforward for a company, like the storage media company which financed the study, or someone, who has a vision of a future information society with monopolistic content distributor. However, for a citizen/netizen or policy maker, this is not an issue. A store model like this, has nothing in common with political economy of information commodities. A policy maker should be interested in economic issues. The „production” and „consumption” figures of the authors can not be directly matched with "value" figures. Major policy issues in economy are related to rarity, uneven distribution, local lack of commodities. Millions of people just can not access the Net or can download only insignificant volumes from the surface and never have production tools which make them to be able to profit from those remarkable terabytes. In a country, like Hungary, telecommunications companies may provide services on prices which are higher than those in the developed countries. Millions never can transgress "media information", the kind of the newest ambushes in Palestine, computer games, pop stars – the old content in a new digital form.

The study do not deals with us, *human individuals*, whose information storage and processing capability, with some  $10^{12-14}$  neural cells, and  $10^3$  links each, is still much more than anything mentioned in Varian's study. Humans should stand in the centre of any serious worldwide quantitative descriptive economic model and theory of information society.

One of the conclusions of the study that while "information production" is growing exponentially, "information consumption" actually does not change. This is not surprising, given Lyman and Varian are neglecting "machine information consumption", i.e. consumption of information commodities by owners of machines. This is consumption of commodities - like floppies, on-line signals, etc. - they input into their machines. Machines actually receive more and more information, which is the far most important process of information economy and policy. The more computers are installed, the more Winchesters, CD-s and floppies are not only produced, and consumed, but equally importantly whose contents are consumed. Ignoring consumption of floppies and Winchesters when accounting their production is just misleading. Statistics regularly account "consumption by one's machines" as one's consumption. Examples can be "fuel consumption by cars", "electric energy consumption by household equipment, or factory equipment".

Theoretical and methodological sloppiness, dull conceptual background is most outstanding in the chapter on broadcast media. Broadcast media are "par excellence" *mass* media. Surprisingly enough the figures of production of mass communication are based upon broadcast time only, and the authors do not take into account the billions of hours millions of viewers/listeners with watching/listening. A mass medium without its audience, daily reach, would not be a mass medium at all. Actually, since communication of stations with their daily reach is accounted as if it were one channel with one viewer, it is not surprising, that phone conversations were found to be more productive than mass media. Furthermore, the authors are not sure whether radio broadcasting and print media should be measured in compressed or uncompressed bytes. For a statistician it is clear that statistics should reflect facts. It is a matter of fact that broadcasting stations transmit programs, and never compressed programs.

Methodological inadequacy and sloppiness have lead the authors to the assumption of „democratisation of „data”". In fact nothing like democratization can be concluded from Varian's data. "Data" can not be "democratic" or "more democratic". It is a society, which can be - more or less - democratic. While a vast amount of unique information is actually created and stored by individuals, this does not necessarily imply, that they can play a more significant role in political decision making. The right for a professional to sit behind a screen, and gaze at EXCEL tables for eight hours daily, is probably much more blue-collarization of white-collars than democratization of society. Most data on personal

computers can never serve as capital, having neither commercial value nor the capability of providing capital income to the owner, even if millions have acquire fortunes by building their busines by PC-s and on the Internet.

### **Chapter 6. A European Initiative - ESIA**

In the frames of a co-operation of Dutch, Austrian, Hungarian, Italian and Spanish researchers an effort has been made to define ESIA - an European Standard System of Information Accounts.

### **Chapter 7. SSNIA Version 1.2**

The rapid development of technology has allowed that new statistical procedures would be defined at the human/machine and machine/machine interfaces. Since 1994 a number of standard indicators have been introduced to measure information flow on electronic networks. Significant development of cognitive psychology, statistical psychology and neurolingusitics have allowed to refine models of human brain and statistical procedures to measure quantitative changes.

### **2. Strength and weaknesses of various efforts**

Natural-unit terms and value-unit terms reflect different aspects of transactions. SSNIA's solution to a dual account of phenomena and processes promises more than the one-sided approaches. [Pool] and [Varian00]'s "unitary costs" reflect only a particular moment of value flows escorting the flows of information commodities.

*Table 9. Units of measurements in the accounts*

No	Unit of measurement	de Sola Pool	SSNIA 1.0	Included in [Varian]
1	word	yes	no	no
2	bit	no	yes	yes
3	monetary unit	no	yes	no

The sophisticated system of SNA indicators have been developed for following the production, distribution and redistribution of commodities. Production, reproduction, distribution and redistribution of information commodities can not be followed unless the whole system of SNA indicators were applied. For instance, the output of books and their consumption shows a dynamic growth in value terms in Hungary in the 1990-2000 period. However, in natural unit terms, both output and consumption show a stagnation or a decrease in the same period. When the accumulation of human knowledge - from books - are studied, it is obvious, that the growth of consumption in value terms is due to the increasing of profit margins, production and material cost. No more, but less information - from books - has been accumulated by human individuals - something, which is hidden by the figures in value terms. More color pictures, better quality, however, favors to easier reading.

*Table 10. Important indicators in various studies*

No	Indicator	de Sola Pool	SSNIA	[Varian]
1	production	yes	In accordance with SNA, production is not an indicator, but a process	yes
2	output	no	yes	no
3	consumption	yes	yes	mostly no
4	stock	no	yes	yes
5	accumulation	no	yes	no
6	exports	no	yes	no
7	imports	no	yes	no
8	externalities	no	yes	no
9	input	no	yes	no
10	use	no	yes	no
11	information added	no	yes	no
12	transfer	no	yes	no
13	asset	no	yes	no
14	valuable	no	yes	no
15	capital	no	yes	no
16	depreciation	no	yes	no

Any serious account should have a grasp, big enough to cover a reasonable majority of actors, transactions, commodities.

If several small actors are defined, the output of services will be significantly greater, than in the case, when big units are defined as actors. If no more than one actor is defined, the amount of output should be zero, since any output assumes a consumer, to whom the output is outputted. Without defining classes of actors no serious accounts can be prepared.

*Table 11. Classes of commodities in various studies*

No	Commodity class	de Sola Pool	SSNIA 1.0	[Varian]
1	Radio	Programming and broadcasting	S/M/L and stereo; programming, broadcasting and presentation are accounted	Programming only
2	TV	B/w, colour programming and broadcasting	Programming, broadcasting and presentation are accounted	Programming only
3	Cable TV	Programming and broadcasting	Programming, broadcasting and presentation are accounted	Programming only
4	Record, magnetic tape	Yes	LP, MC records, 4,5 mm tapes, recorded and unrecorded cassettes	Yes
5	Movies	Yes	Feature films, documentaries, 8 and 16mm films	No
6	Education	Yes	primary, secondary and tertiary education	No
7	Newspaper	Yes	Yes	Yes
8	Magazine	Yes	Yes	Ye
9	Book	Ye	Ye	Yes
10	Telephone directory	Yes	Included in books	No
11	Direct mail	Yes	Included in mails	No
12	Mail	Yes	Yes	Yes
13	Phone	Yes	Local, domestic and international	Yes
14	Telex	Yes	Yes	No
15	Telegraph	Yes	Voice and paper delivery	No
16	Mailgram	No	No	No
17	Fax	Yes	Yes	No
18	Data	Yes	Yes	No
19	Office documents	No	Yes	Yes
20	www	No	No	Yes
21	e-mail, mailing list	No	Yes	Yes
22	Usenet	No	No	Yes
23	FTP	No	No	Yes
24	IRC, messaging services, Telnet	No	No	Yes
25	Hard disk drives	No	Yes	Yes
26	Floppy disks	No	Yes	Yes
27	Removable magnetic disk drives	No	Yes, included in hard disk drives	Yes
28	Digital data creation	No	Yes: "keypunching"	Yes
29	Optical disks (CD, CD-ROM)	No	Ye	Yes
30	Photofilms	No	Yes	Yes, paper-based photoes included
31	Motion pictures	No	Ye	Yes
32	X-ray films	No	Yes	Yes
33	Recorded ROM, RAM, chip-memories	No	Yes	No
34	Personal communications	No	Yes	No
35	Human knowledge	Bo	Yes	No
36	TV show and upplying radio program	No	Yes	No
37	R+D, spectator sports institutions, theatres, musei, culture and entertainment	No	Yes	No

Similarly to SSNIA, [Varian00]'s interest extends both to the "originals" and "copies". The definition of "originals" sometimes is not trivial, or even if the definition would be clear, no statistics can be collected. For instance, majority of radio programmes is nothing else then broadcasting of canned

music, replay of records, accounted as such there. For several countries, no detailed statistics are available on the volume of canned and alive programmes. On the other hand, total broadcast time can not be considered - like Varian does - the volume of information produced by program-makers and broadcasters. Broadcast time characterizes the volume of programming, and the sum of all receiver-hours of all listeners characterizes the performance of broadcasters.

There are several transactions related to the web technology, of which Varian's account extends to the accumulation of contents only. He does not even consider the output and consumption of *web services*, when copies are reproduced for the user to be displayed on his screen, even though several figures are available for their volume (sessions, visits, page-impressions, click-ons or downloads of the pages).

Table 12. *Classes of actors*

No	Actor class	de Sola Pool	SSNIA 1.0	[Varian]
1	governments	no	yes	no
2	individuals	no	yes	no
3	enterprises	no	yes	no
4	non-profits	no	yes	no
5	nations	yes	yes	yes
6	ethnic and language communities	no	yes	no
7	regions	no	yes	no

Table 13. *Classes of classifications*

No	Classification	de Sola Pool	SSNIA 1.0	[Varian]
1	Actors	no	yes	no
2	Transactions	no	yes	no
3	Commodities	yes	yes	yes
4	Sectors	no	yes	no
5	Industries	no	yes	yes
6	Stocks	no	yes	no

There are some commodities, whose definitions in the different studies are similar enough to compare their bit-equivalents.

The differences in the values of the bit-equivalents may reflect differences in the definitions in various systems. A hypothetic scanning as a tool to define the volume of information provides significantly higher figures, than character-wise re-keypunching. [SNIA92] makes *distinction between sensory (scanning) and substantial amount/volume of information* carried by a non-digital information commodity.

Compression is another important factor. Each and any file is either compressed or non-compressed. Statistics is a science about measuring, observing reality, „as is“. Though the bit-volume of all files recorded intentionally compressed or not on a digital carrier is a factual number, which is known for users, [Varian00] adopts an additional *compressed volume*.

The differences may reflect real differences or different assumptions concerning the nature of the commodity. While definition of "print sheets in a book" is an international definition, the average number of figures and pictures, particularly colored pictures, in books may be different in various countries in various years. The issues of newspapers are much more voluminous in the U.S., than in Hungary, due to excess ad-attachments and thematic enclosures, their bit-equivalents must be different.

The great differences in Table 5. can be explained by the differences of definitions and assumptions that various authors introduced. USSNIA assumed hypothetic „scanning“, [Varian00] hypothetic scanning and re-keypunching to determine volume of information in print media. [Varian00] assumed figures, which differ from figures for standard channels assumed in USSNIA. This shows how necessary the international standardization of information accounting is.

Due to technical progress, the values of equivalents prepared for different years, are obviously different. The average size of a Winchester in circulation in 1990 assumably did not exceed 100 Mbyte, while it is well over 20 Gbyte in 2002. Technical progress penetrates rich countries first: the average size of Winchesters in the rich and technically more developed U.S. is greater than it is in poor countries in the same year.

Table 14. Bit-equivalents of some comparable commodities in USSNIA and [Varian00]

No	Commodity class	USSNIA 1994	Varian 1999
1	Radio broadcasting: hour	0,63 Gb/hour	0,05 Gb/hour
2	TV broadcasting: hour	46,6 Gb/hour	1,3 Gb/hour
3	Audiocassette	0,95 Gb/tape	1 Gb/tape (Blank audio tape)
4	Videotapes	184/Gb/tape	4 Gb/tape (Blank video tape)
5	Newspaper	283 Gb/year/title	115 Mb/year/title
6	Magazine	9,6 Gb/year/title	225-650 Mb/year/title
7	Book	4,36 Gb/book	41 Mb/book
8	Mail	120 Kb/mail	75 Kb/mail
9	Phone	1,32 Mb/DAM	0,96 Mb/perc
10	Floppy disks	1,44Mb/disk	1,44 Mb/disk

### **3. Future: The floor is now open**

Ten years ago, when SNIA and SSNIA were invented, the situation was premature to launch a concerted international effort to define and introduce a SNIA into the system of standard official statistics.

Meanwhile vast majority of population in the developed countries have become regular users, several times the slaves, of digital information technology. For millions, the fact that all kinds of human and non-human information are convertible, now is obvious. Professionals of nations need and demand real figures which reflect information activity of their own, governments, enterprises, various big brothers, real economic flows and knowledge stocks, standard figures by official statistical institutions. Traditional macroeconomic tables do not cover basic processes and phenomena in information societies. Primitive eclectic "rankings" of nations can not replace statistics, which show undergoing deep macroeconomic processes, "the essence" of information societies. While the EU, and the OECD urge an "information society", information commodities have either not been defined. Copyright and intellectual property are key issues, but their treatment in accounts of the official statistics is not yet well solved. The efforts of OECD and EUROSTAT to define ICT sectors of the economy, and ICT commodities regularly neglect human information and non-digital world - the majority.

The recent discovery of correlation between nation's GDP and population's average IQ [Lynn02], underscores the importance of serious information statistics. Time is ripe for an international scientific cooperation of researchers in statistical offices and educational organisations, devoted to seeking of truth and welfare of nations, and also independent enough from various power groups, can lead to really useful information statistics, to the implementation of a system of standard information accounts, as contoured in SSNIA 1.0 and 2.0.

Its time scientific community and community of official statisticians joined and defined information age accounts for information societies. This might prevent laymen and digital prophets to blow their trumpets and allows citizens to take part in the very creation of new societies. This will be the real "democratisation of data". A common language concerning the core macroeconomic issues in information societies is a core issue in international understanding. The Fulbright Program with his special tools might promote the process.

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# **How much information? Accounting the information flows and knowledge stocks**

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*Table 1. Units of measurements in the accounts*

No	Unit of measurement	de Sola Pool	SSNIA 1.0	Included in [Varian]
1	word	yes	no	no
2	bit	no	yes	yes
3	monetary unit	no	yes	no

*Table 2. Important indicators in various studies*

No	Indicator	de Sola Pool	SSNIA	[Varian]
1	production	yes	In accordance with SNA, production is not an indicator, but a process	yes
2	output	no	yes	no
3	consumption	yes	yes	mostly no
4	stock	no	yes	yes
5	accumulation	no	yes	no
6	exports	no	yes	no
7	imports	no	yes	no
8	externalities	no	yes	no
9	input	no	yes	no
10	use	no	yes	no
11	information added	no	yes	no
12	transfer	no	yes	no
13	asset	no	yes	no
14	valuable	no	yes	no
15	capital	no	yes	no
16	depreciation	no	yes	no

Table 3. Classes of commodities in various studies

No	Commodity class	de Sola Pool	SSNIA 1.0	[Varian]
1	Radio	Programming and broadcasting	S/M/L and stereo; programming, broadcasting and presentation are accounted	Programming only
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6	Education	Yes	primary, secondary and tertiary education	No
7	Newspaper	Yes	Yes	Yes
8	Magazine	Yes	Yes	Yes
9	Book	Yes	Yes	Yes
10	Telephone directory	Yes	Included in books	No
11	Direct mail	Yes	Included in mails	No
12	Mail	Yes	Yes	Yes
13	Phone	Yes	Local, domestic and international	Yes
14	Telex	Yes	Yes	No
15	Telegraph	Yes	Voice and paper delivery	No
16	Mailgram	No	No	No
17	Fax	Yes	Yes	No
18	Data	Yes	Yes	No
19	Office documents	No	Yes	Yes
20	www	No	No	Yes
21	e-mail, mailing list	No	Yes	Yes
22	Usenet	No	No	Yes
23	FTP	No	No	Yes
24	IRC, messaging services, Telnet	No	No	Yes
25	Hard disk drives	No	Yes	Yes
26	Floppy disks	No	Yes	Yes
27	Removable magnetic disk drives	No	Yes, included in hard disk drives	Yes
28	Digital data creation	No	Yes: "keypunching"	Yes
29	Optical disks (CD, CD-ROM)	No	Yes	Yes
30	Photofilms	No	Yes	Yes, paper-based photoes included
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34	Personal communications	No	Yes	No
35	Human knowledge	No	Yes	No
36	TV show and applying radio program	No	Yes	No
37	R+D, spectator sports institutions, theatres, musei, culture and entertainment	No	Yes	No

*Table 4. Classes of actors*

No	Actor class	de Sola Pool	SSNIA 1.0	[Varian]
1	governments	no	yes	no
2	individuals	no	yes	no
3	enterprises	no	yes	no
4	non-profits	no	yes	no
5	nations	yes	yes	yes
6	ethnic and language communities	no	yes	no
7	regions	no	yes	no

*Table 5. Classes of classifications*

No	Classification	de Sola Pool	SSNIA 1.0	[Varian]
1	Actors	no	yes	no
2	Transactions	no	yes	no
3	Commodities	yes	yes	yes
4	Sectors	no	yes	no
5	Industries	no	yes	yes
6	Stocks	no	yes	no

*Table 6. Bit-equivalents of some comparable commodities in USSNIA and [Varian00]*

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6	Magazine	9,6 Gb/year/title	225-650 Mb/year/title
7	Book	4,36 Gb/book	41 Mb/book
8	Mail	120 Kb/mail	75 Kb/mail
9	Phone	1,32 Mb/DAM	0,96 Mb/perc
10	Floppy disks	1,44Mb/disk	1,44 Mb/disk