
The EGM conversion to CAPI was completed

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INTRODUCTION

During the EMRO Conference held in Locarno in 2001, we had the opportunity to present the approach we wanted to use in our planned EGM conversion to CAPI. The EGM is a multimedia survey covering TV, radio, print, internet, cinema and other non-media information on products consumption, lifestyles and household equipment on the basis of an annual sample size of 43.000 face-to-face interviews.

Let us remember some of the main elements of our CAPI approach:

- *Several questions within the same screen in order to minimise the number of different screens.*
- *Reduction of post-coding to a minimum.*
- *On-line interviewers manual always easily accessible.*
- *The interviewer should be able to enter remarks at any point.*
- *Automated time stamp for every question.*
- *Easy backward navigation throughout the questionnaire.*
- *Configurable visual appearance (fonts, size, colours, background, etc.).*
- *Different languages. The selected language can be changed at any point of the interview.*
- *Integration of a supervision module.*
- *Wide range of rotation possibilities for sections, questions, titles, etc. The used sequence should be registered.*

After some initial steps which included some attempts to build up a CAPI questionnaire with both Bellview CAPI and Quancept CAPI, two important decisions were taken:

- *To develop our own CAPI application software suitable to our specific needs.*
- *To use Tablet PC's (with touch screen and no physical keyboard). We selected Fujitsu devices, specifically the Tablet LT P-600 with a screen size of 8.4 inches.*

We also wanted to switch from a single field contractor approach to a three companies scheme. And we wanted to do it at the same time that the conversion to CAPI. Through a simplified tender procedure, the fieldwork was finally assigned to TNS, AC Nielsen and Ipsos. Each institute is responsible for one third of the total sample size, each individual third being equally representative of the Spanish population.

Our main goals were:

- To improve the fieldwork quality.
- To improve the speed of data delivery
- To reduce the interview duration.
- To achieve some operational savings in the medium term.
- To implement the optional selection of different languages.

The net effect on the running field costs was an increase of around 12% due mainly to the impact of the hardware costs. A total of around 120 Tablet PC devices are presently devoted to the EGM fieldwork.

The project started in 1999, the decision to develop our own CAPI software was taken in September 2000 and the first version of our CAPI application was ready by June 2001. In September/October 2001, we run a pilot test with 2.800 CAPI interviews in parallel with the fieldwork of one wave of our regular EGM survey. In December 2001, the AIMC Board gave the go-ahead to the project and the AIMC General Assembly officially approved it in February 2002.

CAPI QUESTIONNAIRE

It is important to mention that, on top of the CAPI questionnaire itself, the application also handles the procedure to select the households through the random route and the control of non-contacts, refusals, second visits, etc. through a special “route administration module”.

Edición de rutas

Opciones: Importar Anulaciones Ayuda

Datos de la ruta

Año	Día	Código	Provincia	Municipio	Distrito	Sección	Estado	Día
2001	2	2011	MADRID	Madrid del Norte	01	007	Activo	3

Entradas en la ruta

Opciones de visualización: Ver todas las entradas

Párrafo: PASEO PINO CENTINELA (DE) de 9 a 9. URBANIZACIONES NOROCCIDENTE

Callejero Ruta

Ent. Objetivo	Descripción	Calle	Nº	Ent. Pl.	Planta	Vir. Se	Fecha	Hora
Entrevista 2	Salto de Planta	AVDA VALDEPASTORES (DE)	da 1	3	0	0	12/05/2001	19:02
Entrevista 2	Salto de Planta	AVDA VALDEPASTORES (DE)	da 2	2	0	0	12/05/2001	19:02
Entrevista 2	Salto de Planta	AVDA VALDEPASTORES (DE)	da 9	2	0	0	12/05/2001	19:02
Entrevista 2	1ª Visita - Contacto	AVDA VALDEPASTORES (DE)	da 11	5	2	3	12/05/2001	19:03
Entrevista 2	Edificio no dedicado a viviendas	AVDA VALDEPASTORES (DE)	da 11	5	0	0	12/05/2001	19:03
Entrevista 2	Salto de Planta	AVDA VALDEPASTORES (DE)	da 12	2	0	0	12/05/2001	19:04
Entrevista 2	1ª Visita - Contacto	AVDA VALDEPASTORES (DE)	da 15	7	5	4	12/05/2001	19:04
Entrevista 3	Aplazamiento	AVDA VALDEPASTORES (DE)	da 15	7	5	4	12/05/2001	19:04
Entrevista 2	Entrevista Finalizada	AVDA VALDEPASTORES (DE)	da 11	5	2	3	13/05/2001	08:13
Entrevista 4	Salto de Planta	CALLE JACOBIN (DE)	da 1 a 3	0	0	0	13/05/2001	08:14
Entrevista 4	Edificio no dedicado a viviendas	CALLE JACOBIN (DE)	da 1 a 3	0	0	0	13/05/2001	08:14
Entrevista 4	1ª Visita - Contacto	CALLE JACOBIN (DE)	da 1 a 3	0	0	0	13/05/2001	08:14
Entrevista 1	Aplazamiento	PASEO PINO CENTINELA (DE)	da 10	4	3	2	13/05/2001	08:51

Datos a Completar

Cuenta Habitantes: 873 Cuenta Mujeres: 373

Franja Horaria

Tipo de Franja: MAÑANA Entrevistas por completar: 5

Legenda

Entrevista: Aplazado/S.P. Finalizado Pendiente Borrado

Consultar Añadir 2ª Visita Eliminar Deshacer Reanudar Consultar

The CAPI questionnaire basically kept the content of the paper version but a number of adjustments were made in order to take advantage of the capabilities of new system e.g. rotation scheme, interview routing, etc. and it is specially important to mention the significant changes implemented in the radio and television sections (see figures below).

egm EGM

Introduction | Language | Selection | Individual | Newspapers | Supplements | Magazines | Cinema | Radio | Television

Monthly magazines | Magazines | Cinema | Cinema | Cinema | Cinema | Cinema | Radio | Radio frequency | Listened to the radio | Where do you listen to the radio

Please, try to remember the moments when you listened to the radio yesterday, or simply did it at home, at work or in the car or anywhere else, even for a few minutes during the day.
(Interviewer: must mention, little by little, the hour intervals and mark those where he/she listened to the radio)
Yesterday morning, between.../Midday, between.../In the afternoon.../In the evening, between...

Up to 8 am | Morning 8-2 | Afternoon 2-4 | Evening 4-8 | Night 8-12 | Night after 12 pm

Could you specify the type of wave, announcer, network, station, and content being listened to?

Freq FM Dial: 88.9 Net: ONDA CERD RADIO Show El peluco

Freq FM Cont: Noticias Net: CADENA FLAK

Freq FM Ann: Carlos Moreno Net: ONDA CERD RADIO Show Le + 40

Freq FM Cont: Music Ann: Rigo Martin Net: MQ-9MA FM

egm EGM

Language | Selection | Individual | Newspapers | Supplements | Magazines | Cinema | Radio | Television | Home equip

CadEasic | CadCanal+ | CadCinema | CadMusic | CadDisney | CadOptions | Tune | Signal source | Watched past 30 days | Watched yesterday

Which TV channels have you watched yesterday, at any time, regardless of the fact that you have watched them at home, at a bar, at some friends' home or anywhere else? At what times of the day?

E. morning from 4-8h | Morning de 8 a 1 | Afternoon from 1-17h | Ev. from 17-20 | Night from 20-24h

ANTENA3

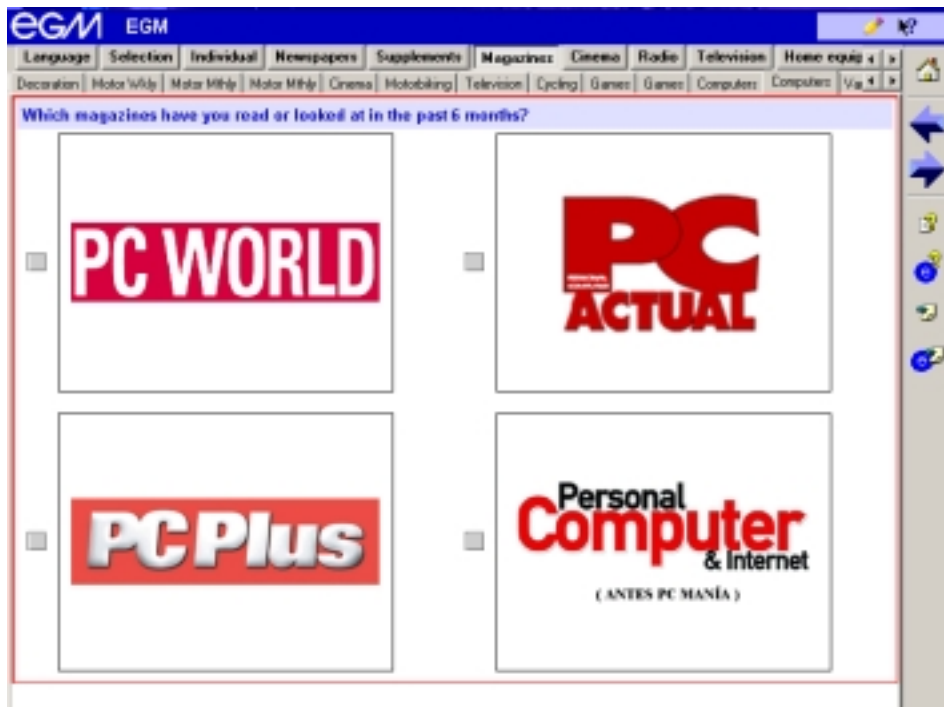
CANAL PLUS

TELEONCO

TVE1

TVE2

Mastheads of publications are presented in groups of four (minimum three) titles per screen as shown above. See Appendix A for a discussion on the comparative size of the different mastheads.



IMPLEMENTATION APPROACH

We decided to adopt a gradual strategy to implement the new system. The paper and pencil work was to be replaced by CAPI with a gradual switch approach in order to smooth the audience changes due to the new methodology, thus accepting the disadvantage of creating a somewhat “fictitious wrong trend” due only to this gradual implementation. The plan finally accepted and achieved was:

- *Second wave 2002 (April / May): Two thirds of the fieldwork made by Ipsos with the regular paper and pencil system and one third made by TNS using the new CAPI technique.*
- *Third wave 2002 (October/November): One third made by Ipsos using paper questionnaires, a second third made by TNS with CAPI and the last third made by Nielsen also using CAPI.*
- *First wave 2003 (February/March): All the work done with CAPI by TNS, Nielsen and Ipsos (one third each).*

SOME OPERATIONAL RESULTS

From the operational point of view, the implementation run quite successfully. The initial reaction of the interviewers was somewhat negative, specially in connection with the strict “route control” forced by the application. But those feelings disappeared after the first weeks of experience. In general, the number of problems we had to face and correct was within the expected range. And the interviewers reported that the CAPI interview was much more pleasant and interesting for the interviewees.

The impact on the duration of the average interview was remarkable:

	1 st wave 2002 (only paper)	2 nd wave 2002 (paper and CAPI)	3 rd wave 2002 (paper and CAPI)	1 st wave 2003 (only CAPI)
Only CAPI interviews	-	33,0 minutes	30,4 minutes	29,2 minutes
Total interviews	41,7 minutes	39,2 minutes	34,3 minutes	29,2 minutes

The average duration is very consistent among the three CAPI fieldwork suppliers. The comparison above shows quite equivalent figures. Ipsos is expected to decrease their time in their second wave.

Supplier	2 nd wave 2002 (paper and CAPI)	3 rd wave 2002 (paper and CAPI)	1 st wave 2003 (only CAPI)
TNS	33,0 minutes	28,8 minutes	28,5 minutes
Nielsen		32,0 minutes	28,6 minutes
Ipsos			30,6 minutes

It is interesting to look at the statistics collected in relation to some of the interview circumstances (first wave 2003).

Place of interview

Inside the household	41,9%
At the door of the household	52,9%
Outside the household	5,1%

The interviewee and the screen

Looking to the screen all the time	36,7%
Looking to the screen only when needed	62,6%

Position of interviewee and interviewer

	Interviewee	Interviewer
Standing	71,2%	69,8%
Seated	28,2%	29,7%

Tablet PC support

On the interviewer's arm	77,3%
On a table	11,7%
On the arm / On a table	10,5%

Once again, we find reasons to believe that the work of the interviewer is far from being comfortable. A typical interview is made at the door of the household by a standing interviewer with the PC Tablet resting on his arm.

There are four language versions of the questionnaire: Spanish (Castilian), Galician, Basque and English. The integrated Application Manual and Field Manual are only available in Spanish.

The switch to CAPI did not have a significant effect on the achieved response rates where we keep a 30%-31% level.

IMPACT ON AUDIENCE LEVELS

General

All the comparisons presented here are made on the basis of the results of the two waves where both interview types (CAPI and Paper and Pencil) were used: 2nd and 3rd wave of 2002. The number of interviews involved in the two waves were 29.236 (14.529 made on CAPI and 14.707 on paper questionnaires). The average of the two periods is compared for each system.

Sample profile

The demographical profiles of both samples are fairly equivalent.

	CAPI	PAPI
	%	%
SEX		
Male	49,7	49,9
Female	50,3	50,1
FAMILY ROLE		
Housewife	49,4	49,2
Main income earner	51,6	51,9
Others	18,1	19,1
SOCIO-ECONOMIC CLASS		
High	5,1	6,4
Medium high	14,6	13,8
Medium	40,8	41,0
Medium low	28,7	27,3
Low	10,8	11,5
AGE		
14 to 19	6,2	7,2
20 to 24	7,4	7,4
25 to 34	17,5	15,8
35 to 44	16,6	15,1
45 to 54	12,4	11,3
55 to 64	12,6	12,8
65 +	27,3	30,4

EDUCATIONAL LEVEL		
Not able to read	2,6	2,8
No education	10,7	10,4
Primary school	16,7	15,9
Secondary school	30,4	35,9
High school.	25,6	22,7
University degree (3 years)	6,2	5,6
University degree (5+ years)	7,8	6,6

Print media

I have followed the lines of analysis used by Michael Brown in his paper “Changing horses” presented in the 2002 EMRO Conference.

Let us call “total readership” to the readership level obtained during the period determined by the used time-related filter question. In our case, this period is one month for the Daily Newspapers and six months for the Sunday Supplements and Magazines.

GROSS TOTAL READERSHIP

Totalled across publications, the proportions of respondents claiming “total” readership are as follows:

	CAP	Paper	Index (Paper=100)
Daily Newspapers	174,1	156,7	111,1
General info	137,4	120,9	113,7
Sport info	34,4	34,0	101,3
Sunday Supplements	57,0	65,1	87,6
Weekly Magazines	120,0	151,0	79,5
Monthly Magazines	124,5	144,6	86,1

While the Newspapers are favoured by the methodology change, the Magazines get lower figures.

NET TOTAL READERSHIP

When we look at the proportions of respondents claiming to read one or more titles, the sense of the differences is kept but to a lesser degree

	CAPI	Paper	Index (Paper=100)
Daily Newspapers	75,8	72,4	104,7
General info	71,9	67,7	106,2
Sport info	26,5	26,5	99,8
Sunday Supplements	36,4	39,5	92,3
Weekly Magazines	49,6	57,4	86,5
Monthly Magazines	42,3	49,1	86,3

GROSS/NET TOTAL READERSHIP

The estimates of the number of titles claimed to be read for each publication type show slight increases and decreases for Newspapers and Magazines respectively.

	CAPI	Paper	Index (Paper=100)
Daily Newspapers	2,3	2,2	106,1
General info	1,9	1,8	107,0
Sport info	1,3	1,3	101,2
Sunday Supplements	1,6	1,6	95,0
Weekly Magazines	2,4	2,6	92,0
Monthly Magazines	2,9	2,9	99,9

PROFILE OF GROSS TOTAL READERSHIP BY CLAIMED FREQUENCY OF READING (%)

The wording of our frequency question is: “How many issues do you usually read or looked at of the (seven/four/six) that come out during (a week/a month/six months) ?”. We use a pure numerical scale where 1-stands for “less than one”.

	CAPI									Paper								
	1-	1	2	3	4	5	6	7	1-	1	2	3	4	5	6	7		
Daily Newspapers	3,9	24,0	19,6	12,7	6,4	9,1	2,8	21,4	11,7	26,9	19,0	8,8	4,3	8,6	2,8	17,9		
General info	3,7	23,7	19,7	12,5	6,3	9,5	2,7	22,0	11,1	26,5	18,2	8,9	4,4	9,5	3,0	18,4		
Sport info	4,1	24,5	19,5	13,9	7,1	7,4	3,3	20,3	12,3	27,8	21,7	8,7	4,1	5,6	2,4	17,3		
Sunday Supplements	1,6	13,0	14,8	5,2	65,3				7,3	11,6	16,5	4,2	60,4					
Weekly Magazines	8,2	36,1	23,1	6,5	26,2				20,3	32,1	22,8	3,3	21,5					
Monthly Magazines	2,7	21,2	20,3	15,0	6,2	3,3	31,4		2,3	24,9	25,1	11,3	4,6	1,9	30,0			

GROSS AVERAGE ISSUE READERSHIP

The table shows the number of readership claims within the last publication period totalled across all the titles. The increase for Newspapers is substantially higher for Magazines. All publication types show an increase which is specially important for Newspapers and also for Monthly Magazines.

	CAPI	Paper	Index (Paper=100)
Daily Newspapers	62,0	47,9	129,4
General info	48,4	37,1	130,2
Sport info	13,4	10,6	126,2
Sunday Supplements	45,8	43,0	106,5
Weekly Magazines	51,1	49,3	103,5
Monthly Magazines	87,4	77,1	113,3

NET AVERAGE ISSUE READERSHIP

When we turn to net AIR, the increase for Newspapers is kept but for Magazines the impact becomes negative.

	CAPI	Paper	Index (Paper=100)
Daily Newspapers	42,0	34,4	121,9
General info	37,9	30,5	124,5
Sport info	11,0	9,2	119,5
Sunday Supplements	30,0	28,2	106,6
Weekly Magazines	28,2	29,2	96,4
Monthly Magazines	35,1	37,0	94,8

GROSS/NET AVERAGE ISSUE READERSHIP

There is a specially important increase in the average number of titles read by a Monthly Magazines reader.

	CAPI	Paper	Index (Paper=100)
Daily Newspapers	1,5	1,4	106,0
General info	1,3	1,2	105,0
Sport info	1,2	1,2	105,7
Sunday Supplements	1,5	1,5	100,1
Weekly Magazines	1,8	1,7	107,3
Monthly Magazines	2,5	2,1	119,5

PROFILE OF GROSS AVERAGE ISSUE READERSHIP BY CLAIMED FREQUENCY OF READING

	CAPI								Paper							
	1-	1	2	3	4	5	6	7	1-	1	2	3	4	5	6	7
<i>Daily Newspapers</i>	0,5	6,6	9,3	8,9	6,6	13,7	5,0	49,3	1,0	6,8	8,7	6,9	5,1	14,6	5,3	51,7
<i>General info</i>	0,4	6,3	9,3	8,4	6,6	14,4	4,6	49,8	1,1	6,6	8,2	6,4	5,0	15,5	5,5	51,9
<i>Sport info</i>	0,9	7,6	9,5	10,9	6,7	10,6	6,3	47,5	1,1	7,2	10,7	8,4	5,5	10,7	4,6	51,8
<i>Sunday Supplements</i>	0,5	5,2	5,9	2,9	85,6				0,8	3,3	3,9	1,6	90,3			
<i>Weekly Magazines</i>	2,3	17,7	19,0	8,7	52,2				2,8	11,4	16,9	6,3	62,6			
<i>Monthly Magazines</i>	1,0	13,3	18,2	14,8	7,0	3,8	41,9		0,7	9,2	15,2	11,5	6,3	2,6	54,4	

RATIO OF GROSS AVERAGE ISSUE READERSHIP TO GROSS TOTAL READERSHIP

The proportion of readers who qualify as issue period readers among those claiming to ever read the publication is systematically higher in CAPI.

	CAPI	Paper	Index (Paper=100)
<i>Daily Newspapers</i>	0,36	0,31	116,5
<i>General info</i>	0,35	0,31	114,8
<i>Sport info</i>	0,39	0,31	124,9
<i>Sunday Supplements</i>	0,80	0,66	121,6
<i>Weekly Magazines</i>	0,43	0,33	130,4
<i>Monthly Magazines</i>	0,70	0,53	131,7

RATIO OF NET AVERAGE ISSUE READERSHIP TO NET TOTAL READERSHIP

	CAPI	Paper	Index (Paper=100)
<i>Daily Newspapers</i>	0,55	0,48	116,6
<i>General info</i>	0,53	0,45	117,0
<i>Sport info</i>	0,42	0,35	119,6
<i>Sunday Supplements</i>	0,82	0,71	115,4
<i>Weekly Magazines</i>	0,57	0,51	111,8
<i>Monthly Magazines</i>	0,83	0,75	110,1

At individual title level, we find relatively strong differences per title as shown in the following table.

	<i>CAPL</i>	<i>Paper</i>	<i>Index (Paper=100)</i>
Newspapers			
<i>El País</i>	5,6	3,7	151,0
<i>El Mundo</i>	3,8	2,6	150,1
<i>ABC</i>	2,9	2,0	142,9
<i>El Periódico</i>	2,5	2,1	117,6
<i>La Vanguardia</i>	2,0	1,7	112,3
<i>La Voz de Galicia</i>	2,0	1,5	132,2
Sport Newspapers			
<i>Marca</i>	7,6	6,1	125,0
<i>As</i>	2,7	1,8	149,7
Weekly Magazines			
<i>Pronto</i>	10,0	10,1	98,7
<i>Hola</i>	7,0	6,9	100,9
<i>Lecturas</i>	4,2	3,9	108,1
<i>Semana</i>	3,9	4,0	96,2
<i>Qué me dices</i>	4,2	3,4	120,7
<i>Diez Minutos</i>	3,6	2,9	125,4
Monthly Magazines			
<i>Muy Interesante</i>	5,3	5,1	103,8
<i>Quo</i>	3,8	3,1	123,6
<i>El Mueble</i>	2,9	2,9	89,9
<i>National Geography</i>	2,8	2,0	101,4

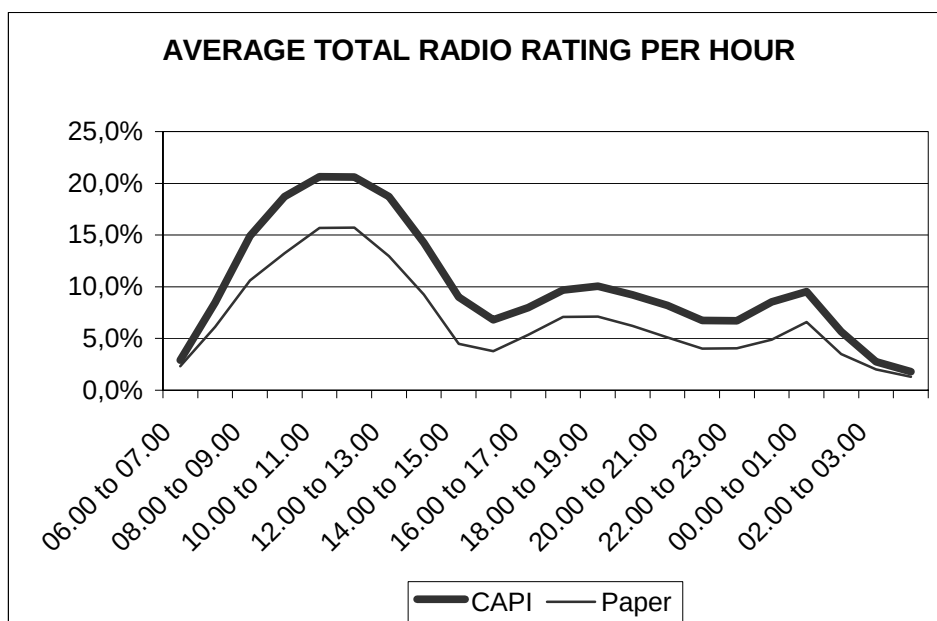
Radio

The average listening time per person increased a 46,2 % (from 92,0 to 134,5 minutes). This can be decomposed in two effects: an increase of 18,6 % in the number of listeners and a 23,2 % growth in the average listening time per listener.

Daily reach	CAPI	Paper	Index (Paper=100)
Total Radio	60,3	50,8	118,6
Generalist Radio (News)	31,7	27,1	116,9
Specialised Radio (Music)	27,8	25,0	111,1
Individual Networks			
Ser	12,2	11,0	111,5
Onda Cero	5,5	5,0	110,1
RNE	5,2	4,5	115,7
Cope	5,1	3,9	131,1
Cadena 40	8,1	6,8	119,7
Cadena Dial	5,3	4,2	125,0

AVERAGE TOTAL RADIO RATING PER HOUR

	CAPI	Paper	Index (Paper=100)
06.00 to 07.00	2,9%	2,3%	125,6
07.00 to 08.00	8,5%	6,1%	138,5
08.00 to 09.00	14,9%	10,6%	140,7
09.00 to 10.00	18,7%	13,2%	141,4
10.00 to 11.00	20,6%	15,7%	131,6
11.00 to 12.00	20,6%	15,7%	131,0
12.00 to 13.00	18,7%	13,0%	144,5
13.00 to 14.00	14,3%	9,2%	154,4
14.00 to 15.00	9,0%	4,5%	201,1
15.00 to 16.00	6,8%	3,8%	181,1
16.00 to 17.00	8,0%	5,4%	149,0
17.00 to 18.00	9,7%	7,1%	136,4
18.00 to 19.00	10,0%	7,1%	141,3
19.00 to 20.00	9,2%	6,2%	148,4
20.00 to 21.00	8,2%	5,1%	161,1
21.00 to 22.00	6,7%	4,0%	167,3
22.00 to 23.00	6,7%	4,1%	165,6
23.00 to 00.00	8,5%	4,9%	175,0
00.00 to 01.00	9,5%	6,6%	145,0
01.00 to 02.00	5,7%	3,5%	161,6
02.00 to 03.00	2,8%	2,0%	137,4
03.00 to 04.00	1,8%	1,3%	138,0



Share	CAPI	Paper
<i>Total Radio</i>	100,0%	100,0%
<i>Generalist Radio (News)</i>	49,7%	50,6%
<i>Specialised Radio (Music)</i>	44,2%	44,8%
<i>Individual Networks</i>		
<i>Ser</i>	17,1%	17,3%
<i>Onda Cero</i>	9,5%	9,1%
<i>RNE</i>	7,2%	6,9%
<i>Cope</i>	7,6%	6,5%
<i>Cadena 40</i>	11,5%	9,3%
<i>Cadena Dial</i>	8,7%	7,7%
<i>Others</i>	38,4%	43,2%

Television

For Television, there was no impact at all. The daily reach as well as the average viewing time remained stable.

Cinema

	CAPI	Paper	Index (Paper=100)
Last week	10,3	9,9	104,4
Last month	28,8	27,4	105,1

Internet

	CAPI	Paper	Index (Paper=100)
Last month	21,7	23,1	94,0

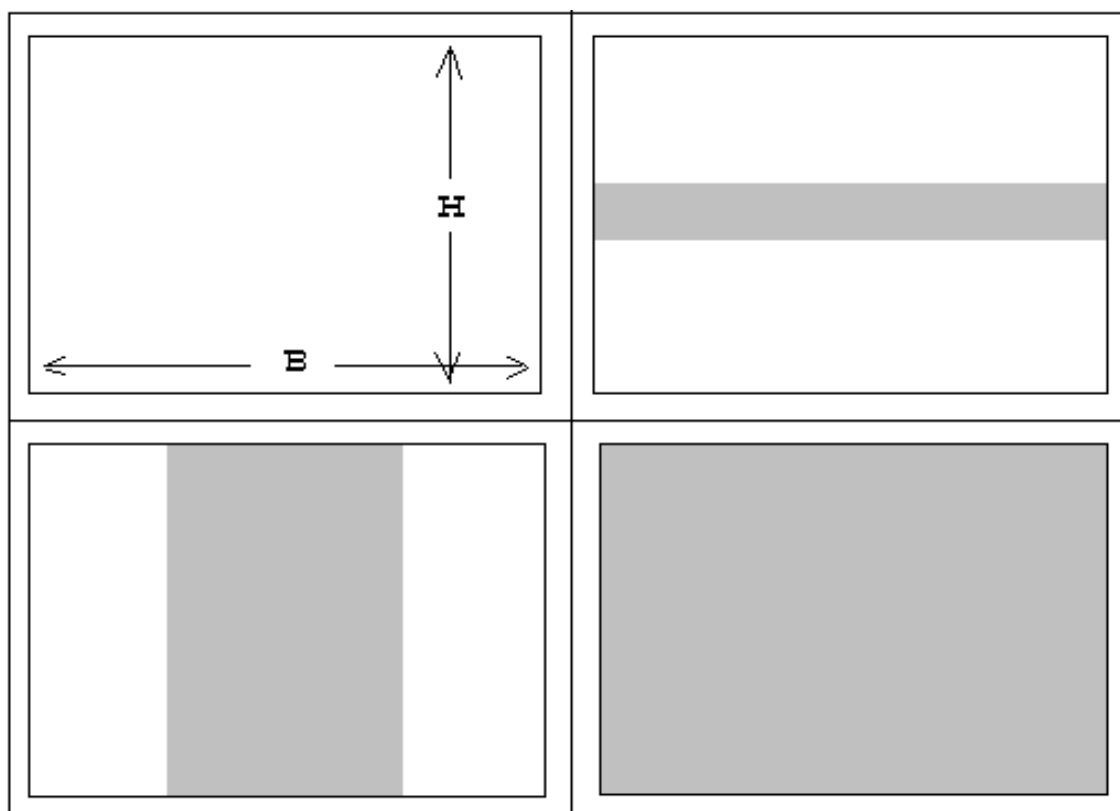
Summary of changes

Media Type	Measure	CAPI/Paper Index
Newspapers	Gross AIR	129,4
Weekly Magazines	Gross AIR	103,5
Monthly Magazines	Gross AIR	113,3
Radio	Daily reach	118,6
	Listening time per listener	123,2
	Listening time per head	146,2
Television	Viewing time per head	102,4
Cinema	Last week goers	104,4
Internet	Last month users	94,0

It is not easy to find clues that could explain the reasons behind those changes. A methodological change implies a "currency" change. And the most important thing to implement a new currency is the market consensus. In this particular case, it was not difficult to get the acceptance of the market because the new methodology, among other "minor" benefits, was able to provide the market with "a more accurate picture of reality", meaning, as everybody knows, higher audience levels.

APPENDIX A: SIZE OF MASTHEADS

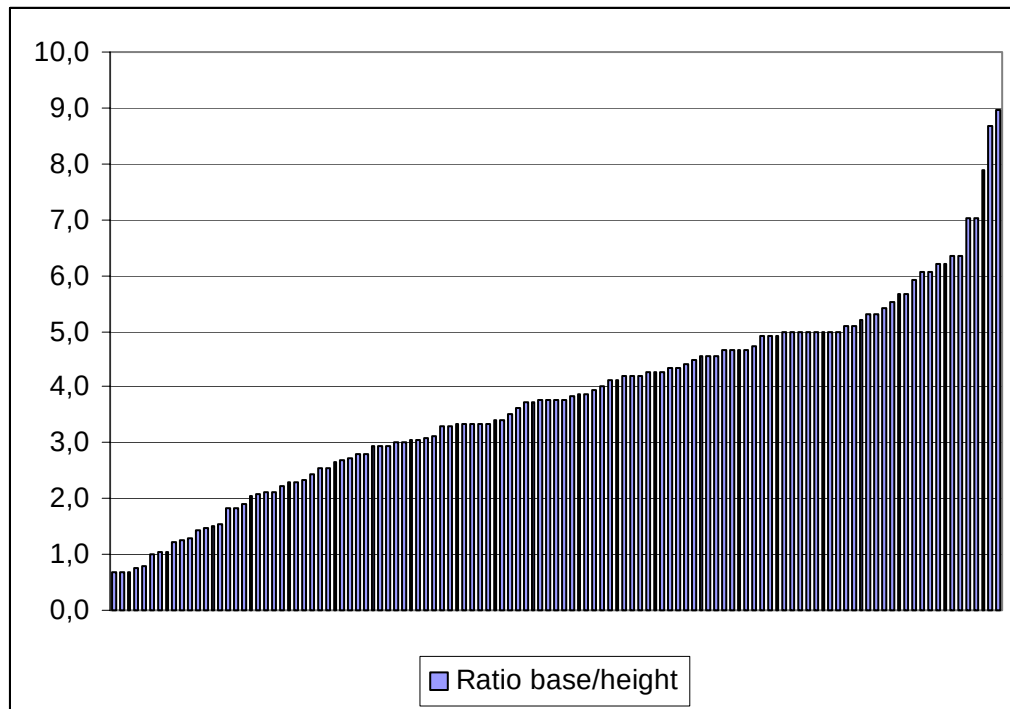
We wanted to present 4 mastheads per screen as shown below. The mastheads should be inscribed in a rectangle with base B and height H . The ratio B/H (denoted by R) is 1,3. If you try to inscribe each masthead so that it occupies the maximum surface (within the limitations of the base rectangle) you take the risk that the actual masthead area could significantly differ from title to title, as you have to keep the ratio “ r ” base/height for each individual masthead.



The variation of the ratio “ r ” base/height for the mastheads of the Spanish publications is rather high.

Variation of ratio base/height “ r ”	
Minimum Value	0,66
Maximum Value	8,97
Mean Value	3,77
Coefficient of variation	45%

Histogram of “r” values



We can call title efficiency to the degree of occupation of the maximum area (B.H) of the masthead area of an specific title. If the dimensions of the specific masthead are “b” and “h”, we are talking of the ratio

$$\frac{\text{Area_of_title_masthead}}{\text{Maximum_area}} = \frac{h * b}{H * B}$$

If we denote

$$r = \frac{b}{h} \quad R = \frac{B}{H}$$

we can calculate the efficiency as R/r when $r > R$ and as r/R when $r < R$.

We tried to combine two conflicting goals:

- Minimise the inequality of the masthead areas across the different titles.
- Use a reasonable proportion of the base rectangle area as measured by the mean efficiency.

We work towards the first goal by introducing a “maximum efficiency value”(α), and by experimenting with different values of maximum efficiency, we obtain:

Maximum efficiency (α)	Inequality/ Coefficient of variation of mastheads areas	Ratio Maximum to Minimum efficiency	Mean efficiency
0,1	0,0%	1,0	0,10
0,2	3,6%	1,4	0,20
0,3	12,1%	2,0	0,28
0,4	21,6%	2,7	0,33
0,5	29,3%	3,4	0,35
0,6	35,1%	4,1	0,38
0,7	39,5%	4,7	0,39
0,8	43,0%	5,4	0,40
0,9	45,6%	6,1	0,41
1,0	46,3%	6,5	0,41

After this analysis, the compromise solution favoured the value of 0,5 for the maximum efficiency.

Determination of individual masthead dimensions

Being (b^* , h^*) the dimensions we are looking for, we need to maximise the product $b^* \cdot h^*$ under the following constraints:

1. $h^* \leq H$
2. $b^* \leq B$
3. $\frac{b^*}{h^*} = r$
4. $b^* \cdot h^* \leq \alpha \cdot B \cdot H$

On those bases, we have to determine b^* and h^* as follows

1. If $r \geq R$

$$\begin{aligned}
 1.1 \quad \text{If } \frac{R}{r} \leq \alpha & \quad \begin{cases} b^* = B \\ h^* = \frac{B}{r} \end{cases} \\
 1.2 \quad \text{If } \frac{R}{r} > \alpha & \quad \begin{cases} b^* = \sqrt{\alpha r B H} \\ h^* = \sqrt{\frac{\alpha}{r} B H} \end{cases}
 \end{aligned}$$

2. If $r < R$

$$\begin{aligned}
 2.1 \quad & \text{If } \frac{r}{R} \leq \alpha \quad \begin{cases} h^* = H \\ b^* = H.r \end{cases} \\
 2.2 \quad & \text{If } \frac{r}{R} > \alpha \quad \begin{cases} h^* = \sqrt{\frac{\alpha}{r}} BH \\ b^* = \sqrt{\alpha r} BH \end{cases}
 \end{aligned}$$