April 10, 1986

To: Bruce Hoban - Republic Radio
Re: Arbitron Radio Weighting Presentation

Enclosed is a copy of the Arbitron presentation on Radio Weighting that was done at the March Radio Advisory Council meeting.

Please call if you have any questions about the presentation.

Sincerely,

[Signature]

MHS:eo
Enc.
RADIO WEIGHTING

RADIO ADVISORY COUNCIL
MARCH 1986
CLAIRE KUMMER

ARBITRON RATINGS
RADIO
WHY WEIGHT THE IN-TAB SAMPLE?

- RETURNED SAMPLE NOT IN PERFECT PROPORTION TO THE UNIVERSE

AND

- DIFFERENT BEHAVIOR PATTERNS AMONG DIFFERENT SEGMENTS OF THE UNIVERSE
RETURNED SAMPLE NOT IN PROPORTION TO UNIVERSE...

- SAMPLE FRAME

- DIFFERENTIAL USABILITY, CONSENT. RETURN THAT CAN'T BE PERFECTLY FORECASTED AND/OR CONTROLLED UP FRONT

- DISPROPORTIONAL SAMPLING
DIFFERENT BEHAVIOR PATTERNS AMONG DIFFERENT UNIVERSE SEGMENTS:

- GEOGRAPHY
- AGE
- SEX
- ETHNICITY
WHAT IS SAMPLE BALANCING?

- A means of weighting survey data to a set of controls which yields the least extreme in weights for application to each interview.

- Weighting is performed "on the margin," rather than to each individual cell.
WHY IS IT IMPORTANT TO KEEP THE WEIGHTING TO THE LOWEST LEVEL POSSIBLE?

BECAUSE WEIGHTING LOWERS THE EFFECTIVE SAMPLE BASE -- THERE IS A TRADE-OFF BETWEEN REMOVAL OF BIAS AND MAINTENANCE OF ESB. WEIGHTING CONTROLS THAT ARE "TOO TIGHT" MAY PRODUCE SUCH EXTREME WEIGHTS THAT THEY PUSH TOO MUCH "BOUNCE" INTO THE RESULTS -- THE BIAS REMOVAL FUNCTION THEY PERFORM CAN BECOME ACADEMIC.
SOME SAMPLE BALANCING TERMS

MODEL - ONE COMPLETE SET OF DATA UPON WHICH SAMPLE BALANCING IS PERFORMED

EXAMPLE:

MODEL 1
METRO
SURVEY AREA

MODEL 2
NON-METRO TOTAL SURVEY AREA
TERMS

MARGINAL - A CHARACTERISTIC CHOSEN FOR USE IN WEIGHTING A MODEL; EACH WEIGHTING CHARACTERISTIC WITHIN A MODEL IS A DIMENSION

EXAMPLE:

ONE MARGINAL

SEX/AGE

TWO MARGINALS

SEX/AGE

COUNTY

THREE MARGINALS

SEX/AGE

COUNTY

RACE
TERMS

CLASS - A SPECIFIC, DEFINED SUBSET OF A GIVEN MARGINAL

EXAMPLE:
TERMS

**CELL** - The combination of classes from two or more marginals

**EXAMPLE:**

```
COUNTY

SEX/AGE

COUNTY

RACE

SEX/AGE
```

**CELL**
HOW DOES SAMPLE BALANCING WORK?

- ASSUME A MODEL MADE UP OF TWO MARGINALS WITH TWO CLASSES EACH

![Diagram](A 2x2 table with rows labeled 'A' and 'B', and columns labeled 'Men' and 'Women'. The cells are labeled 'A', 'B', 'Men', and 'Women'.)
**MARGINAL DATA**

<table>
<thead>
<tr>
<th>MARGINAL</th>
<th>CLASS</th>
<th>IN-TAB</th>
<th>POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEX</td>
<td>MEN</td>
<td>25</td>
<td>50,000</td>
</tr>
<tr>
<td></td>
<td>WOMEN</td>
<td>75</td>
<td>50,000</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>100</td>
<td>100,000</td>
</tr>
<tr>
<td>COUNTY</td>
<td>B</td>
<td>60</td>
<td>90,000</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>40</td>
<td>10,000</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>100</td>
<td>100,000</td>
</tr>
</tbody>
</table>

**CELL DATA**

<table>
<thead>
<tr>
<th>COUNTY→</th>
<th>POPULATION</th>
<th>SEX</th>
<th>IN-TAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>49</td>
<td>41</td>
<td>90</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COUNTY←</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>45</td>
</tr>
</tbody>
</table>

**ARBITRON RATINGS**

RAC/MARCH 86
C. KUMMER
1. Adjust first marginal to control figure by calculating a weight for each class

Class weight = \[
\frac{\text{Control}}{\text{In-TAB}}
\]

<table>
<thead>
<tr>
<th>SEX</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>A</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>IN-TAB</th>
<th>CONTROL</th>
<th>CLASS WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>50</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>50</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Arbitron Ratings
Radio

RAC/March 86
C. Kummer
2. NOW MULTIPLY THE IN-TAB IN EACH CELL BY ITS CLASS WEIGHT

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>SEX</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>SEX</td>
<td>15 x 2.0</td>
<td>45 x .67</td>
</tr>
<tr>
<td>A</td>
<td>SEX</td>
<td>10 x 2.0</td>
<td>30 x .67</td>
</tr>
<tr>
<td></td>
<td>SUM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\text{COUNTY} & & \text{MEN} & & \text{WOMEN} \\
B & & 15 \times 2.0 & & 45 \times 0.67 \\
A & & 10 \times 2.0 & & 30 \times 0.67
\end{align*}
\]

\[
\begin{align*}
\text{COUNTY} & & \text{SEX} \\
B & & \text{MEN} = 30 & & \text{WOMEN} = 30 \\
A & & \text{MEN} = 20 & & \text{WOMEN} = 20
\end{align*}
\]

IN-TAB 50 50
CONTROL 50 50

Percentages

**ARBITRON RATINGS**

**RADIO**

RAC/MARCH 86
C. KUMMER
3. **ADJUST SECOND MARGINAL TO CONTROL FIGURE BY CALCULATING A WEIGHT FOR EACH CLASS**

<table>
<thead>
<tr>
<th>SEX</th>
<th>MEN</th>
<th>WOMEN</th>
<th>IN-TAB</th>
<th>CONTROL</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUNTY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>30</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>1.5</td>
</tr>
<tr>
<td>A</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>10</td>
<td>.25</td>
</tr>
<tr>
<td>IN-TAB</td>
<td>50</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL</td>
<td>50</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Now repeat step 2: multiply the "IN-TAB" in each cell by its class weight.

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>SEX</th>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>30 x 1.5</td>
<td>30 x 1.5</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>20 x 0.25</td>
<td>20 x 0.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>SEX</th>
<th>MEN</th>
<th>WOMEN</th>
<th>IN-TAB CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>45</td>
<td>45</td>
<td>90 90</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>5</td>
<td>5</td>
<td>10 10</td>
</tr>
</tbody>
</table>

IN-TAB 50 50
CONTROL 50 50
5. THE FIRST "PASS" IS COMPLETE. TEST FOR "CONVERGENCE"
BY COMPARING ADJUSTED IN-TAB AND CONTROL MARGINAL
VALUES FOR AGREEMENT.

IN THIS SIMPLE EXAMPLE, AGREEMENT WAS REACHED IN ONE
PASS. THIS IS USUALLY NOT THE CASE.
RESULTS

MARGINAL (RIM) WEIGHTS:

MEN 2.0
WOMEN .67
B 1.5
A .25

CELL WEIGHTS ARE CALCULATED BY MULTIPLYING THE RIM WEIGHTS ASSOCIATED WITH EACH CELL:

\[ 2.0 \times 1.5 = 3.0 \]

SAMPLE BALANCING IS COMPLETE.
TO CALCULATE THE PPDV FOR EACH CELL:

1. CALCULATE THE AVERAGE PPDV:

\[
\frac{\text{TOTAL POPULATION}}{\text{TOTAL IN-TAB}} = \text{AVERAGE PPDV}
\]

\[
\frac{100,000}{100} = 1,000
\]

2. CALCULATE CELL PPDV:

\[
\text{AVERAGE PPDV} \times \text{CELL WEIGHT} = \text{CELL PPDV}
\]

Each usable diary takes on the calculated PPDV for its cell.
COMPARISON OF CELLS FOR THE POPULATION AND THE WEIGHTED IN-TAB:

### POPULATION

<table>
<thead>
<tr>
<th></th>
<th>MEN</th>
<th>WOMEN</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>COUNTY</td>
<td>49,000</td>
<td>41,000</td>
<td>90,000</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>9,000</td>
<td>10,000</td>
</tr>
<tr>
<td></td>
<td>50,000</td>
<td>50,000</td>
<td></td>
</tr>
</tbody>
</table>

### WEIGHTED IN-TAB

<table>
<thead>
<tr>
<th></th>
<th>MEN</th>
<th>WOMEN</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>COUNTY</td>
<td>45,000</td>
<td>45,000</td>
<td>90,000</td>
</tr>
<tr>
<td></td>
<td>5,000</td>
<td>5,000</td>
<td>10,000</td>
</tr>
<tr>
<td></td>
<td>50,000</td>
<td>50,000</td>
<td></td>
</tr>
</tbody>
</table>

MARGINALS AGREE... CELLS DO NOT BECAUSE WE DID NOT WEIGHT ON THEM.
HOW DOES ARBITRON APPLY SAMPLE BALANCING?

1. GEOGRAPHIC WEIGHTING UNIT:
   USUALLY INDIVIDUAL COUNTIES

2. SEX AND AGE IN 16 GROUPS:

<table>
<thead>
<tr>
<th>MEN</th>
<th>WOMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-17</td>
<td>12-17</td>
</tr>
<tr>
<td>18-24</td>
<td>18-24</td>
</tr>
<tr>
<td>25-34</td>
<td>25-34</td>
</tr>
<tr>
<td>35-44</td>
<td>35-44</td>
</tr>
<tr>
<td>45-49</td>
<td>45-49</td>
</tr>
<tr>
<td>50-54</td>
<td>50-54</td>
</tr>
<tr>
<td>55-64</td>
<td>55-64</td>
</tr>
<tr>
<td>65+</td>
<td>65+</td>
</tr>
</tbody>
</table>

3. RACE/NATIONALITY:
   BLACK/OTHER
   HISPANIC/OTHER
   BLACK/HISPANIC/OTHER
HOW DOES ARBITRON APPLY SAMPLE BALANCING?

- MODELS ARE USUALLY MAJOR GEOGRAPHIC REPORTING AREAS:
  - METRO
  - NON-METRO/NON-TSA ADI
  - NON-METRO/NON-ADI TSA

- OTHER USES OF MODELS:
  - RACE/NATIONALITY (WHERE SAMPLE SIZE IS LARGE ENOUGH)
  - "EMBEDDED" METROS
CALENDAR WEIGHTING -- CONTROLLING FOR DIFFERENTIAL RETURNS BY MONTH

- EACH 4-WEEK PERIOD OF A 12-WEEK SURVEY PERIOD WILL BE CONTROLLED TO REPRESENT ITS FAIR ONE-THIRD SHARE OF THE TOTAL

- CALENDAR WEIGHTING WILL BE ANOTHER MARGINAL AND WILL ADD ANOTHER DIMENSION TO EACH MODEL:

  **TWO DIMENSIONS**

  **THREE DIMENSIONS**
WEIGHTING LOWERS ESB...HOW MUCH WILL THIS ADDED WEIGHTING FOR CALENDAR TIME LOWER ESB?

A VERY SMALL AMOUNT -- WE ESTIMATE LESS THAN 5% FOR MOST REPORTING AREAS.
WHAT IMPACT WILL THIS HAVE ON REPORTED ESTIMATES?

MINIMAL...

- SAMPLES FAIRLY WELL-DISTRIBUTED MOST OF THE TIME, SO LITTLE WEIGHTING TO BE DONE

- ON PERSONS 12+, WE EXPECT NO DIFFERENCE IN AQH RATING 95% OF THE TIME, ± .1 RATING POINT 5% OF THE TIME

- ANY IMPACT WILL HAVE NO SYSTEMATIC EFFECT BY STATION TYPE OR FORMAT, BECAUSE SAMPLE IMBALANCE BY MONTH IS NOT SYSTEMATIC

...NO DISRUPTIVE EFFECT ON TRENDS
WHAT ABOUT ARBITRENDS?

- THE INTRODUCTION OF CALENDAR TIME WEIGHTING ON THE MARGIN ALLOWS US TO ALIGN THE METHODOLOGY FOR PRODUCING ARBITRENDS ROLLING AVERAGES WITH THAT OF THE QUARTERLY REPORTS.

CURRENTLY:

\[
\begin{array}{ccc}
\text{MONTH 2} & \text{MONTH 3} & \text{MONTH 1} \\
& & 3 \\
\end{array}
\]

AFTER THE CHANGE:

\[
\begin{array}{ccc}
\text{MONTH 2} & \text{MONTH 3} & \text{MONTH 1} \\
\end{array}
\]
WHY CAN'T ARBITRON PROCESS ARBITRENDS ROLLING AVERAGES "LIKE THE QUARTERLY" NOW?

- BECAUSE SAMPLE SIZES CAN AND DO CHANGE BY DESIGN ACROSS SURVEY PERIODS:
  - MARKET DEFINITION CHANGES
  - EMBEDDED METROS WITH DIFFERENT REPORTING FREQUENCY THAN PARENT

- SOME FORM OF MONTHLY CONTROL NEEDED TO ADJUST

- SAMPLE SIZE CHANGES ACROSS MONTHS WITHIN SURVEY PERIODS OCCUR BY CHANCE, NOT BY DESIGN AND ARE RARELY EXTREME
WHAT IMPACT WILL THIS HAVE ON THE ARBITRENDS ROLLING AVERAGES ESTIMATES?

MINIMAL...

- DIFFERENCE BETWEEN CURRENT MARKET REPORT (NO WEIGHTING ON CALENDAR MONTH) AND CURRENT ARBITRENDS (RIGOROUS MODEL CONTROL ON MONTH) PRODUCES NO DIFFERENCE 80% OF THE TIME AND ± .1 20% OF THE TIME

- THIS WILL ADD SOME WEIGHTING TO THE MARKET REPORT AND REDUCE SOME OF THE WEIGHTING ON THE ARBITRENDS ROLLING AVERAGE ESTIMATES SO THAT BOTH ARE TREATED CONSISTENTLY

- THERE WILL BE LITTLE IMPACT ON EITHER