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What is This?

# Control-Display Relationships on the Four-Burner Range: Population Stereotypes versus Standards

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*In a follow-up of Chapanis and Lindenbaum's (1959) study of the control-display linkages on the four-burner range, 222 persons were surveyed to test the existence of population stereotypes concerning control-burner relationships. In parallel, a market survey of 49 different models of currently marketed ranges was conducted to assess the variation between existing ranges. Subjects' responses to the questionnaire revealed at least four commonly expected different linkage relationships, with no one particular stereotype emerging as predominant among them. Nonetheless, there was a very strong consensus among the respondents (98%) that the right burners should be controlled by either one of the right control knobs, while the left burners should be controlled by either one of the left control knobs. The results of the market survey yielded five different burner-control arrangements that are in current production, the most common of which was not selected by any of the subjects and violated the above expectation. The subjects' awareness of the lack of standardization was manifested in relatively low confidence associated with their choices.*

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## INTRODUCTION

In the design of control/display panels, one of the most accepted human factors principles is that the relationship between the two should be dictated by the population stereotype, if one exists. In a classic demonstration of this principle, Chapanis and Lindenbaum (1959) compared subjects' reaction time and error rate for four different range designs. In three of the designs, the burners and controls were laid out as illustrated in Figure 1, but the linkages between them dif-

fered. In the other design, the two front burners were slightly off-set to the right so that each burner was directly in front of its control knob. This design is designated as S (for Special) in Table 1 (Type I). The control display linkages for the other three designs are also represented in this table (Types II, III, and IV). The four designs were evaluated by having subjects respond to a light appearing near the center of one of the burners by pushing the appropriate control knob. Four groups of 15 subjects each were assigned to each of the models, and each subject was given 80 consecutive trials. The results, partially reproduced in Table 1, were clear-cut: Model I yielded faster reaction times and fewer er-

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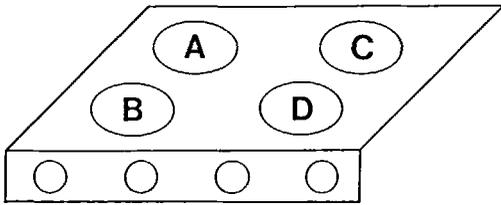


Figure 1. A schematic representation of the electric gas range burner and control designs used in the survey of population stereotypes.

rors. In a similarly designed study, with vertical control columns rather than horizontal rows. Chapanis and Mankin (1976) again demonstrated that different control-burner relationships yield differential error rates and reaction times.

In the search for a population stereotype, both of Chapanis' studies are lacking since each subject was successively exposed to 80 trials, all with the same design. To test the existence of a population stereotype directly, the subject's initial response or initial association should be assessed. To this end, subjects were presented with the drawing shown in Figure 1, and asked to indicate within each of the control knobs the burner that, to the best of their knowledge, they thought it con-

trolled. In parallel, a survey of currently marketed ranges was made in the Bloomington, Indiana area to test whether: (1) control-display design standards have at all been influenced by the human factors studies to date; and (2) whether control-display design is related to existing population stereotypes.

## METHOD

### Population Stereotypes Survey

The survey was conducted on a chance sample of 222 adults. Subjects were solicited from among university students, university employees, shoppers at a shopping center, and residents of one apartment complex.

The questionnaire was entitled "How Well Do You Know the Gas/Electric Range?" and contained a drawing similar to Figure 1 of a gas/electric range burner-control arrangement. As in Figure 1, the burners were labeled "A," "B," "C," and "C," but the controls were unlabeled. The questionnaire contained two questions prefaced by the following statement: "You are entering a *new* apartment and see a *new* range in the kitchen." The two questions were: (1) "Which knob would you turn to turn on each of the four burners? Indicate

TABLE I

Results Obtained with Different Control-Burner Linkage Designs by Chapanis and Lindenbaum (1959), and in the Present Study Through the Survey of Population Stereotypes and Market Availability

Type	Control-Burner Linkage	Errors (Chapanis & Lindenbaum, 1959)	Population Stereotypes		Models on Market
			Confidence Level 6-7	Total	
I	A B C D—S	0 (0%)	—	—	0
II	A B D C	76 (6%)	25 (11%)	55 (25%)	9 (18%)
III	A B C D	116 (10%)	25 (11%)	68 (31%)	10 (21%)
IV	B A D C	129 (11%)	29 (13%)	62 (28%)	7 (14%)
V	B A C D	—	15 (7%)	33 (15%)	6 (12%)
VI	B D A C	—	1 (<1%)	2 (1%)	0
VII	A C B D	—	0	1 (<1%)	0
VIII	A D B C	—	0	1 (<1%)	0
IX	B D C A	—	0	0	13 (27%)
X	A B C D—V	—	—	—	4 (8%)
TOTAL		—	94 (42%)	222 (100%)	49 (100%)

your answer by writing the appropriate letter inside each knob;" and (2) "How confident are you that you chose the correct knob? Indicate your confidence by a number from 1 (not confident at all) to 7 (very confident)." The introductory statement was included in order to prevent the subjects from simply filling out the form according to the arrangement existing in their own home.

#### *Market Survey of Existing Ranges*

A survey of the major appliance stores in Bloomington, Indiana, conducted during March, 1976, yielded 49 different range models made by nine different manufacturers. Although this sample is not exhaustive, it is considered to be representative of the types of ranges available on the market today. Each of the 49 models was categorized according to its control-burner relationships.

### RESULTS

The results of both surveys are summarized in Table 1 which also includes the error rates obtained in Chapanis and Lindenbaum's (1959) study. The different control-burner linkages are coded according to the sequence of the control knobs activating burners A, B, C, and D in Figure 1. Each of the different linkages is arbitrarily given a type number which will be used to reference the different linkages in the following discussion.

#### *Population Stereotypes*

In the search for a population stereotype, seven different types were indicated by the subjects, three of which (VI, VII, and VIII) were selected by only one or two subjects. Common to these three models, and differentiating them from the other four, is the fact that one of the two left burners is activated by one of the two right controls and one of the two right burners is activated by one of the two left controls. It is possible that these three types, in fact, represent coding errors by

the subjects. Thus, there is a very strong stereotype—common to 98% of the subjects—indicating that subjects expected the right burners to be controlled by either one of the right control knobs and the left burners to be controlled by either one of the left control knobs. However, the stereotype breaks down with respect to the associations within those pairings. Thus, within each pair, there does not appear to be a stereotype concerning the association between the front and rear burners and the left-right knobs arrangement. A chi-square analysis showed that Type V was chosen significantly less often than Types II, III, and IV,  $X^2(3) = 12.8$ ,  $p < 0.01$ , which did not differ significantly among themselves. Also, the subjects' confidence rating in choosing this particular type appeared to be—though was not significantly—lower than the confidence levels associated with Types II, III, and IV. The confidence ratings obtained also revealed that overall, most subjects were not very confident in their choices, only 42% indicating a confidence level of 6 or 7.

#### *Market Survey*

The survey of the existing ranges indicated that, like the people who use them, the manufacturers who make them also do not employ a single standard. In fact, control-burner linkages were found to vary, not only between manufacturers, but even within manufacturers between models.

The 49 different models available on the market today yielded six different types of control-burner linkages. The types most frequently chosen by the subjects (Types I-V) were found to be common to many of the models on the market today. However, the most frequent linkage design (Type IX), which existed on 27% of the ranges, was not selected even once by any of the subjects. Note that this type of linkage violates the one strong stereotype by having right-side burn-

ers linked to left-side controls, and left-side burners linked to right-side controls. The one "best" type, according to Chapanis and Lindenbaum (1959), was not found on any of the 49 models. Finally, to add to the confusion, a few of the models on the market today use a vertical row of controls rather than a horizontal one. Furthermore, the one vertical arrangement that was observed here (Type X—with all control knobs arranged in a single column along the right edge of the oven top, in the rear-to-front order A, B, C, D) is not one of those recommended by Chapanis and Mankin (1967) in their study of control-burner linkages with a vertical row of controls.

#### DISCUSSION

In a highly mobile society, one frequently encounters and uses new or unfamiliar gas/electric ranges. Errors in either turning these ranges on or turning them off can be costly as well as frustrating. This is most apparent with electric ranges in which the control action does not provide the user with immediate feedback. All too many people have turned on a wrong burner only to find later that while the dish they were preparing is still cold, the burner right next to it glows in beautiful red. More dangerous are possible inadvertent burns that can occur due to mistaking a hot or warm range top for a cold one. Furthermore, the increasing cost of wasted energy makes this type of error more and more expensive. To eliminate errors, good design principles call for making the control-burner linkages correspond to population stereotypes. Linkages that do not correspond to such stereotypes are incompatible in the sense that they require more decision time by the operator and continue to yield errors even after long practice periods. These effects have been previously demonstrated in Chapanis and Lindenbaum's (1959) and Chapanis and Mankin's (1967) studies.

Although it is easy to conceive of more compatible control-burner designs, such as a square arrangement of control knobs that corresponds to the square of the burners, if one assumes that for design purposes the traditional design of four burners in a square associated with four control knobs in a row is desired, then research should be directed to finding the best possible linkages within that design.

The results of this study demonstrated that no one particular linkage can be considered to be a predominant population stereotype. Nonetheless, some stereotyping of control-display relationships in that situation does exist, but it is limited to the association of left controls for left burners and right controls for right burners. No predominant association was apparent for the relationship between the rear and front burners and the right or left control knobs. In an analysis of the error patterns in an experimental situation, Chapanis and Mankin (1967) also found that most errors were due to confusion within the pairing of front-rear burners with right-left controls.

How do these observations relate to the market of existing ranges? One possibility that might be entertained is that peoples' expectations, or stereotypes, are related to the actual frequencies of the different linkages available today. The results of the store survey cannot be used to this end, since the differential popularity of the different makes and models is unknown. One way to approach this question would have been simply to ask the subjects to describe the linkage arrangement available on their own ranges. However, in a preliminary survey it turned out that many of the people asked were not certain what the actual control-burner linkages were in their own homes. This result is also indicative of the lack of standardization and/or logic employed in the design of ranges today.

While the correspondence between expectations and actual linkages is difficult to

show, divergences between the two were easily apparent. The most conspicuous was the predominance of Type IX linkage which was fairly common on the market but which was not selected by any one of the 222 subjects in this study. Thus, the only strong population stereotype that was observed in this study was violated in the most common linkage available on the market. It is also interesting that of all the 49 models surveyed, none used the burner design that Chapanis and Lindenbaum (1959) documented to be the best in terms of subjects' reaction times and error rates.

#### CONCLUSIONS AND RECOMMENDATIONS

The results of this study taken together with those of the previous studies show the existence of some user expectations on the one hand, and lack of standardization and responsiveness to these expectations on the part of the manufacturers on the other hand. Because the control-burner linkage is not an esthetic design factor, there appears to be no reason not to change these linkages so that they would conform to a population

stereotype and be standardized across all makes and models.

One way of developing a stereotype is standardization, which, in the absence of a previously established population stereotype, can be arbitrary. To illustrate, on-off switches in the United States are standardized so that "on" is up and "off" is down. Accordingly, the population stereotype in the United States corresponds to this arrangement. In Europe, on the other hand, the relationship is reversed, and people expect it to be reversed. In the move toward standardization of control-burner linkages, it is recommended here that the final linkage be one of Types I-V, which are the only designs that do not violate the right-left population stereotype.

#### ACKNOWLEDGMENTS

Partial results of this study have been reported by Acton in the *Human Factors Society Bulletin* issue of July, 1976.

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