

AN ERGONOMIC EVALUATION OF
KITCHEN DESIGN IN NEW ZEALAND

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ABSTRACT

An ergonomic evaluation of thirtyfive kitchens in relatively new dwellings in Christchurch suburban areas was undertaken. Biographical details, kitchen activities, and information relating to problems and difficulties encountered in working in the kitchens was obtained from each of the housewives in a structured interview. Following this, a number of measures of different areas and fitments within the kitchen were made, and an illuminometer reading taken.

In comparing the findings with overseas and New Zealand standards, a number of measures were found to be outside those recommended. Similarly, with respect to the comments received from the housewives, certain design features and space provisions appeared to be inadequate. Those dwellings built without the design involvement of the owners seemed to be more at fault than those in which the owners were involved. Likewise, ownership flats and those dwellings financed by the Housing Corporation were frequently found not to conform to the recommended standards.

Overall, the results indicated a lack of awareness of the needs of the housewife, and thus it is recommended that builders, architects, subdividers and homeowners themselves, be educated regarding the ergonomics of kitchen design.

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"We should remember that the kitchen is the great laboratory of the household, and upon that which is prepared, there depends greatly the health of the family, and that the influence of a well-ordered one upon the members of the household, especially the servants, is great. That it should be of good size in comparison with the house, well lighted and well ventilated, and that there should be a plentiful water supply goes without saying"

- MRS. BEETON, 1860

CHAPTER I

INTRODUCTION

The study of ergonomics is concerned with man and his working environment. It considers the relationships between the worker, the workspace and the work itself. Its objective is to create optimal environments that meet the physical, emotional and intellectual needs of those working in them, whilst maintaining an efficient standard of production.

Till recently, much ergonomic research has concentrated on purely industrial situations. However, when one considers that domestic workers comprise a very large proportion of the population, it becomes clear why the kitchen must be regarded in the same way as any industrial setting, requiring the application of the same ergonomic principles that should govern environmental conditions, equipment design and workplace layout as on the shop floor. Invariably, considerations such as these, will be of importance, not only for the health and well-being of the worker, but also for the rest of the household as a whole.

1. REASON FOR INVESTIGATION AND ITS PURPOSE.

The primary reason for this investigation was to provide a body of knowledge applicable to the kitchen, which would improve the lot of the housewife in her

day to day activities. The situation that exists in New Zealand, is such that the majority of woman work in the kitchen either full-time or part-time and regard it as their domain. Consequently, any information that improves the housewife's working environment is in itself adequate justification for carrying out this study.

Secondly, as more and more women take their place in the workforce, so the need to ease the burden placed on these women, as breadwinners and homemakers, is increased. Thirdly, the growing abundance of appliances and mechanical aids for use in the kitchen, requires that the kitchen be ergonomically designed in terms of space layout and storage provision, if confusion is not to arise. Finally, the fact that the kitchen is the site of a large number of accidents reported as occurring in the home, is evidence that prevention in terms of good design is essential. In New Zealand, in 1973, there were 871 deaths from non-transport accidents and 376 of these occurred in and around the home. (N.Z. Health Statistics Report, 1973) Similarly, two years before, of the 26,444 cases of non-transport accidents treated in public hospitals, 11,900 occurred in the home. (Dept. of Health: Medical Stats. Report, 1975) In the light of these considerations then, there can be little doubt that research into the kitchen is a valid field for study.

Literature relating to research on the kitchen in

New Zealand is fairly limited, and indicates an overall lack of knowledge about the state of kitchens as a whole. The few studies that have been done are either outdated or relate to specific types of housing e.g. state rentals, or else are not wholly concerned with kitchen design.

Thus, bearing in mind constraints of time and money, it was decided that a study of kitchens in the Christchurch suburban area would be suitable. The purposes of the investigation were:

- (1) To ascertain the degree to which relevant ergonomic knowledge was incorporated in the design of a sample of relatively new New Zealand domestic kitchens in owner occupied dwellings.
- (2) To relate the adequacy of the kitchens from an ergonomic point of view to the degree of involvement of the housewives in the design of their kitchens.
- (3) To determine the degree of satisfaction of these housewives with their kitchens.
- (4) To relate the ergonomic adequacy of kitchens to the primary lending body, providing mortgage finance.

A review of the literature relevant to the ergonomic study of kitchen design both overseas and in New Zealand

will be given, followed by a more precise explanation of what was involved in investigating each of the kitchens. Finally, the results, discussion and conclusions, will be presented.

CHAPTER 11

LITERATURE REVIEW

Domestic research can be divided into two distinctive but very much related areas of study. One area examines the existing situation in the home: it looks at habits and patterns of daily living and presents data about the dimensions and layout of rooms and fitments, as they are found in the ordinary home. The other concerns itself more with laboratory work and scientific experiments that examine the physiological and anatomical needs of the worker, in order to produce various recommendations that will make different household tasks easier. In New Zealand most of the research which has been carried out, has been of the former type, due partly to the lack of interest and available facilities, but more especially to the abundance of data that has come from overseas. Needless to say, work done overseas has been in both areas of investigation. Data collected in Scandanavia, England, France, Germany, Holland and U.S.A. has provided much of our knowledge about the physiological, psychological and social needs of the domestic worker. The following review then, attempts to correlate some of these findings (both overseas and in New Zealand), in order to present a clear picture of what exactly is known in this field at present.

1. KITCHEN USAGE

Research about people's domestic habits, although

of a sociological rather than ergonomic nature, provides information about people's requirements in terms of how kitchens should be planned and equipped. Through an examination of the uses to which the kitchen is put, builders, architects, and homeowners can design new kitchens so that the needs of most household groups are satisfied.

Extensive surveys, reported by Grandjean (1973, pp.44-61) have been carried out in a number of European countries with respect to these considerations. All have clearly shown that the kitchen is used for a large number of activities other than meal preparation and cleaning up. Between 1960 and 1965, for instance, a survey of 2500 Swedish households (Grandjean 1973, p.47) indicated that as well as dining, the kitchen was used for ironing, sewing, homework, and as a children's play area. Another study of 160 households carried out at the same time in Switzerland by Bachtold (Grandjean 1973, p.48) revealed that of those surveyed, over half used their kitchens for breakfast, midday and evening meals, and for washing and ironing. A smaller number also used their kitchens as a play area, and for studying, reading and knitting. A later survey in 1966, by Henz and Vogt, (Grandjean 1973, p.50) also of Swiss households, showed that seventy-seven percent of those questioned said they took meals in the kitchen, while smaller percentages mentioned cleaning shoes, sewing, mending, hobbies, washing clothes, school homework and children's games as usual kitchen activities. Ironing and laundering were mentioned by a majority of householders in a more

recent English study, as being performed in the kitchen, with lesser numbers describing its use for play and relaxation. (Grandjean, 1973, p.60)

Of particular interest are the numbers of households using the kitchen for dining. Obviously if the kitchen is to be used for all three meals, it will require a more involved design, and layout than one which is to be used solely for meal preparation. The previously mentioned study by Bachtold found that whether meals were taken in the kitchen or not, was related to the kitchen area: in kitchens more than eight square metres, three-quarters of those surveyed, ate in the kitchen whereas only 40-50% did so in the smaller kitchens. This study also found that eating in the kitchen was related to income level. Of those in the middle and lower income levels, 70% had all their meals in the kitchen, whereas higher income families tended to eat only breakfast there. The other Swiss study (Grandjean, p.51) found that 72% of those questioned ate at least one meal in the kitchen, as did Huser et al, 1970 (Grandjean 1973, p.53) when surveying 332 houses, also in Switzerland. Two French researchers, in 1965 revealed that over 50% of those taking part in the survey ate their evening meal in the kitchen, and that overall, the larger the kitchen, the more often meals were taken there. (Grandjean, 1973 p.54) Domestic research by Hole and Attenburrow in England in 1947 and 1961, (Grandjean 1973, p.60), indicated that because the whole family never gathered together at mealtimes, the meals were usually eaten in the kitchen, even if there was a separate

dining room. As in previous studies, size also influenced this decision: the larger the kitchen, the more meals were eaten there.

In New Zealand very little research has been carried out into domestic working habits, although many of the overseas findings would probably apply here. One study however, carried out in Auckland in 1974 for the Society for Research on Women in New Zealand Inc. (Reynolds and Bonny, 1976) showed that of 21 houses surveyed, 17 had kitchens with a defined dining area. The housewives involved, liked this arrangement, and said it worked well, even though in some cases, they felt the dining space was too small.

A completely different perspective on this question of kitchen dining has been provided by an early New Zealand study. As the authors put it, "Architects favour to an equal extent eating in the kitchen, living room and separate dining room, with an odd case using an all-purpose family room. Builders have the dining table in the kitchen or living room in at least 70% of the cases, and occasionally use a separate dining room. The 'home architect' shows the split between the kitchen and living rooms." (Austin and Daish, 1962, p.29)

11. KITCHEN LOCATION AND AREA.

In designing a house, its location with respect to the rest of the rooms in the house and the outdoor environment is an important consideration. Because the kitchen is a high

use room, particularly during daylight hours, it should be situated so that the maximum of sun and light can reach it. In this respect kitchens facing towards the south would be a disadvantage, as very little sun would reach them. A recent Auckland study (Reynolds & Bonny, 1976, p.40) found that kitchens had often ended up facing west, "partly because the lounge had had priority in orientation, and partly because there exists a belief that the main rooms should face the street wherever the sun or view may be." This study also found that in some cases adjacent houses were placed at minimal distances from the boundaries with kitchens facing each other. As a consequence, the housewives had curtained off their kitchens in order to gain adequate privacy. In terms of rubbish disposal and easy accessibility of supplies, the kitchen also needs to be situated near an outside doorway, preferably near the driveway. Similarly, visual accessibility to children both inside and outside the house is important. Findings from domestic research overseas have provided little information about kitchen accessibility and child surveillance.

Kitchen area, however, has been widely investigated both here and overseas. Considering the different uses to which the kitchen is put; as discussed earlier, the need to ensure that adequate space is available, is imperative. Investigations in Sweden, between 1960 and 1965 (Grandjean 1973, p.47) indicated that big kitchens were popular, those with 17m^2 of floor area rating more highly than those with 9m^2 . Similar findings were drawn from the work of Henz and

Vogt (Grandjean 1973, p.50). The commonest kitchen sizes lay between 4 and 10m² (76%), yet more than half of those questioned, would have preferred a kitchen area of between 8 and 10m². Huser et al, (Grandjean 1973, p.53) found that opinions concerning kitchen sizes related not only to the total areas, but to the dimensions. Narrow kitchens, i.e. those less than 1.8m wide were rated lower than wider kitchens of the same area. Overall, kitchens with a total area of 9.3 or 13.7m² and with a breadth of 2.4 or 3.7m were assessed as just right by 77% and 89% of the people respectively. All in all, results from overseas studies point to the fact that kitchens of less than 8m² are not suited to most households. On this basis, Grandjean (1973, p.143) has recommended that the following rules be considered as applying to households of 3-4 persons:

	KITCHEN AREA IN M ²	
	Minimal	Desirable
- working kitchen without a dining alcove	8	10
- kitchen with a dining alcove*	12	15

* These latter recommendations are based on the figure of 8m² plus added space for a dining table.

New Zealand studies have generally indicated that kitchens here are too small. One study (Reynolds and Bonny, 1976) found that the biggest fault with the houses surveyed was the smallness and poor arrangement of both the working kitchens and dining areas. The authors reported further

that many of the existing kitchens were built in such a way that expansion or alteration would have been difficult. Another study, (Austin and Daish, 1962) speculated that builders devote proportionally less (7-9%) of the total area to the kitchens than architects, and the 'home architect' was midway between them. It is interesting to note, that in the light of Grandjean's recommendations above, that the minimum kitchen size permitted in New Zealand is 4m^2 (NZS 1900 Model Building By-Law, 1960). A booklet on kitchen planning published by the Department of University Extension, University of Otago (Carpenter & King, 1974) reports that most kitchens would be larger than this: in small houses, flats or motels, with under 100m^2 floor space, the work area is usually between 5.5 and 7.5m^2 ; in the average house of $100-120\text{m}^2$, the work area is between 7.5 and 9m^2 , while in larger houses above 140m^2 , the work area varies from $9-11\text{m}^2$.

III LAYOUT AND POSITIONING OF WORK CENTRES

Four work centres need to be incorporated into the design of all kitchens: the preparation centre for storing and mixing; the cooking centre, for cooking and baking; the serving centre for serving food; and the sink centre, for preparing food, and cleaning up. Technical requirements, individual to each house, will affect the design, but regardless of these, certain standard principles should apply. Transit studies, based on the idea that with a suitable kitchen layout, the amount of walking can be reduced and the working time shortened, have aided in

deciding these principles. A study carried out by Joan Ward & her associates (1971) determining the percentage of time spent by British housewives at each of the main workcentres, indicated that the sink and its surround was the most used workcentre. Further studies have shown that the most frequent movements are those between the sink, the main working surfaces, and stove (Grandjean, 1973, p.36). Movements to the fridge and storage centres are almost equally as common. On the basis of these findings then, the sink should ideally be placed in a central position within the whole layout, with the other centres spaced around it. In fact, both overseas and in New Zealand, the commonly accepted layout is that of bench, sink, bench, stove and bench (referred to as the Parker Morris sequence).

In America and New Zealand, one test of the efficiency of any layout has been to measure the distances between the fridge, sink and stove. Generally speaking, the work reviewed by Grandjean (1973) has suggested that "the sum of these distances should not exceed 7m in small to medium sized kitchens, nor 8m in big kitchens" (Grandjean 1973 p.86) The recommendations laid down by the New Zealand Standards Association (NZS 4101, 1974) are somewhat smaller, in that they state that the sum of these distances should be between 3.6 and 6.6m. More specifically, they recommend that the work triangle should have sides as follows:

between fridge and sink	1.2-2.1m
between sink and stove	1.2-1.8m
between stove and fridge	1.2-2.7m

(NZS 4101, 1974, p.22)

In Germany, the "Fadenstudie", or line studies method has been used. Here, all the paths followed in the course of a particular job are recorded and marked by a line. In assessing, such a procedure, a number of criteria are established: few paths crossing each other; few long paths; high density of paths to a few working places; and closely adjacent starting points with dense bundles of lines radiating from them, so as to allow ample freedom of movement (Grandjean, 1973, p.87)

The recent report on housing in Auckland (Reynolds and Bonny, 1976) showed that all the kitchens in the survey were based on the Parker Morris sequence, although there was rarely a bench on both sides of the stove. In fact, they found that most kitchens had their stoves up against a corner where there was insufficient room to stand comfortably in front of them, or space in which to turn saucepan handles for safety. Likewise, there tended to be insufficient distance between the sink and stove, and as a consequence, everything removed from the oven or from the elements had to stand on the sink bench.

Factors other than those already mentioned, also need to be considered when positioning work centres. Because, as previously stated, the time spent at the sink is proportionally more than at any other work centre (and the tasks performed there, tend to require longer periods of continuous work compared with other zones) the need for good natural lighting would seem to be important - placing the

sink below a window would thus be desirable. This would ensure too, that the housewife had visual access to outside happenings, a factor of particular relevance to those with children,

Sinks, as well as stoves, should be installed away from corners; as again problems arise because of insufficient standing room.

From a safety point of view, stoves should not be placed directly under a window where curtains may constitute a fire risk, or where the housewife has to reach across the elements to clean and open it. Likewise they should not be placed under cupboards, where the same risks apply.

Any doors leading to the kitchen, should open in such a way that they cover up blank ends of cupboards or appliances rather than the front ends. Doors of cupboards within the kitchen itself should also be checked to ensure that they do not block other cupboards or walkways.

Positioning of cupboards so that the risk of accidents is minimised needs to be considered too. Free standing upper cupboards, which are below head height and without counters or shelves below them constitute a hazard because the head may impact against them when standing up after stooping. This is similarly a constant risk with open doors of upper cupboards.

Finally, provision of space for future requirements needs to be taken into account. An evaluation of state rental design (S.A.C. Research Report, 1974) found, for example, that families often had to put their deep freezer in the dining room, as there was inadequate provision for them in the kitchen. Similarly the report by the Society for Research on Women, (Reynolds and Bonny, 1976) found that freezers were put in the garage or else in one of the bedrooms because of lack of available kitchen space.

IV. WORKCENTRE AND SPACE DIMENSIONS.

Ergonomic researchers have spent considerable time and effort in determining the various dimensions for all the work surfaces concerned. Generally speaking, the physical effort required for most kitchen tasks is not great, especially when considering the small amount of time spent at each task. In fact, from the point of view of energy consumption, housework is only a moderately heavy occupation. (Grandjean, 1973, p.27) Recently, a number of researchers have begun to use heart rate in the analysis of tasks facing the housewife. The results to date show that the average heart rate during housework is quite high - high enough to conclude that there are a number of tasks in which static effort has a far greater effect on heart rate than it does on energy consumption. (Grandjean, 1973, p. 29) It is not surprising, therefore, that many housewives claim to experience a certain amount of physiological strain on particular muscles as a result of standing in some positions, or through prolonged use of specific limbs or body segments. This being the case, it is clear that the dimensions for

certain areas should be determined in such a way that the minimum amount of strain is placed on the body. Unfortunately however, many appliances and kitchen units are based on the requirements of the 'average' user and as such contribute to much of the physiological strain that occurs. The ideal would be equipment adjustable to the needs of persons no matter what their stature.

Research then, aimed at determining more accurate dimensions with respect to workcentres has been quite extensive.

(i) Heights

Two early American studies (Grandjean, 1973, pp.78-79) found that preferred working heights ranged from 80-90cm depending on the type of activity involved. Work by Steidl and Brattan (Grandjean, 1973, p.79), also with American subjects looked at preferred heights of elbows above working surfaces, and revealed that the preferred distance was linked with the height of the elbow above the ground. More precise work by Bloch & Gfeller, 1951, (Grandjean, 1973, p.79) established that a working level of 10cm below the elbow was most convenient when standing. As a consequence of their findings, they recommended a height of 93cm for the sink and 83cm for the stove. Investigations in Britain (Ward, 1971) have been quite thorough in this area: four measures of assessing preferred heights were used - electromyography, which measured muscle activity; anthropometry, where subjects were photographed against a scaled grid in order to measure

the angular deviations of the main body segments; centre of weight determination, determined from the previously mentioned photograph; and a subjective measure based on a 10-point rating scale. On a basis of a combination of the above, optimal heights for the three main workcentres, were recommended as follows:-

sink	90-105cm
work bench	85-100cm
stove	85-100cm

Of these the most critical, was the sink height. Grandjean (1973) when discussing all the different findings decided that there was much to be said for a uniform height for all benches, reducing the risk of unnecessary accidents through having raised edges. Consequently he has suggested a uniform height of 90cm for all workcentres.

The recommendations in New Zealand for heights fall very much in line with overseas studies. One reference (Carpenter & King, 1974) suggests that work surfaces should be 8-18cm below the worker's elbow height, while more specifically the New Zealand Standards (NZS 4101, 1974) advise the following:

sink	95-100cm
work bench	85-95cm
stove	90cm
cooking surface	80-85cm

As mentioned above, the whole question of whether uniform heights or different heights is more practical from an

ergonomic point of view, presents quite a dilemma. In many cases, compromises of pull out, work benches or boards at lower levels could be incorporated. Perhaps more importantly, it should be stressed that a single height based on the average user will be too high for 25% of the population and too low for another 25%. The need for adjustable benches and flexible heights certainly should be considered.

(ii) Lengths.

On the basis of scientific evidence and numerous studies, Huser et al (Grandjean, 1973, p.148) have put forward recommendations for appropriate work centre lengths as given below:

Work Centre.	Front lengths in cm.	
	Minimal	Desirable
Main working surface	80	100-120
Bench near stove	40	60
Bench near fridge		60
Second working surface	100	120
Sink with two washbowls:		
each bowl length	2 x 35	
Sink with one bowl	40	
Sink with one bowl:		
drying surface	60	80

Those put forward by the New Zealand Standards Association (NZS 4101, 1974) are as follows:

Work centre	Front lengths in cm.
All fitments	30, 40, 50, 60cm. and combinations thereof
Food preparation bench	90 - 120
Sink bench unit with minimum 30x40 sink	150 - 300
Sink bench at right of sink	90
Sink bench at left of sink	70 - 90
Appliance space	60 + (n x 10) when n is a whole number
Abutting cooking facilities	50 - 60

(iii) Widths

Bench widths should relate to the type of work that is to be carried out there, and the dimensions of any appliances that are going to be used. Generally speaking, the width should be slightly larger than the housewives forward reach which will allow room for storage of any equipment on the bench itself. Values calculated from Swiss, French and American records, suggest that most women, have a working field of 36cm, and a grasping field of 50cm, when working on a surface 3-5cm below the level of their elbows. (Grandjean, 1973, p.74) Bearing this in mind, Huser et al (Grandjean, 1973, p.147) recommend that the depth of surfaces for putting things down on, and for working should be 60cm. New Zealand standards (NZS 4101, 1974) recommend the following:

Food preparation bench	50-60cm
Sink bench	50-60cm
Appliance space	50-75cm

Recent reports (Reynolds and Bonny, 1976) found that often benches were very narrow, which meant that the stove and fridge protruded beyond the front edge of the bench. The narrowness of the benches was also confounded in a number of cases by overhead cupboards, making it difficult to use the benches at all.

Overall, it can be said that benches should provide ample room for working without being too small so as to create a feeling of 'cluttering'. However sufficient bench space is not the only requirement: an evaluation of apartment kitchens for instance found that although architects and builders had attempted to provide sufficient total frontage, in doing so, they hadn't left enough uninterrupted space, which meant that a lot of the area provided was impractical and virtually unuseable. This report also noted, that in some cases, kitchens lacked counter space on one side of the sink, or else there was a tendency to limit common counter space between the stove and the fridge (Hoag, 1975)

In a recent Auckland study, insufficient bench space was the most frequent complaint about the kitchen. (Reynolds and Bonny, 1976, p.37) This statement was also backed by another report on state rentals (S.A.C. Research Report, 1974) Tenants in the 'open circulation plan', 'separate dining room', and 'atrium' style of housing, found bench space to be

limited. Although the lack of space on one side of the stove did not appear to worry those in the "split level" style of housing, the research report suggested that such an arrangement was not as convenient as it should be.

V. CLEARANCES.

Clearances should be assessed for different parts of the room so that work is not hampered in any way. Particularly important, are those distances between work surfaces and upper cupboards, although those between various work centres themselves, need to be adhered to as well. British recommendations (Department of Environment, Design Bulletin 24, Pt.II) suggest that there should be a minimum of 120cm between opposite work centres or walls, while between work surfaces on adjacent walls, a distance of 90cm. The minimum clearance between inward opening doors and the front of work centres should be 40cm, but if the door must be nearer, sliding or outward opening doors would be the best alternative. Although it is not recommended that inward opening doors open near the sides of fitments, the minimum clearance should be at least 110cm and that between fitments at right angles with the door opening between them should be 75cm. New Zealand standards (NZS 4101, 1974) suggest similar dimensions:

between work surfaces and upper cupboards	30 - 45cm.
between cooking surfaces and upper cupboards or ventil- ating hood	50 - 60cm.
for toe space	10 x 10 - 20cm

between opposite work centres	120 - 150cm
between work centres and/or appliances at right angles	75 - 90cm
from dining or work table to wall for a passage way	90 - 100cm

VI STORAGE NEEDS

Kitchen storage requirements probably rank second in importance after work centre and space dimensions. Most of the literature available, recommends cupboards in which the user can adjust shelf heights and spacings to suit individual and changing requirements.

British reports (Dept. of Environment, Design Bulletin 24, Pt.II) define the principles generally employed for determining suitable storage heights as follows:-

"a) frequently needed articles should be placed in a zone which extends from arms outstretched at shoulder height to the tips of the fingers when arms are down at attention.

b) light items can be placed in a zone extending higher to the full reach of arms and lower to the hand height associated with half trunk bending.

c) the zones above and below these should be set aside for the dead storage of seldom used articles.

d) the need to be able to hold the articles safely when placing and removing, and when reaching to the back of shelves, dictates a shelf location about 10cm shorter than the comfortable heights determined by these rules of the thumb methods."

On the whole, most of the available literature would

tend to back up these recommendations, however a few other points should be noted. It must be remembered that the housewife's reach will be limited by cupboards or shelves that are situated over work surfaces, and that consequently items need to be stored with this in mind. Often it is much easier if drawers or pull-out trays rather than shelves are used, and for obvious reasons most people would find it more convenient to keep heavy items that are frequently used, stored on the bench, or at least as close as possible to bench level.

Designing large deep cupboards is highly impractical - the best idea for efficient storage is to have single rows in cupboards, single layers in drawers and single stacks on shelves. The use of partitions and vertical divisions in drawers should also make for easier accessibility.

In terms of specific dimensions, Grandjean (1974, p.149) recommends between 40 - 50cm for the space between upper and lower cupboards. He also suggests that the frontal length for all cupboards for a household of 4-5 persons should take from 5-5.9m inclusive of two high cupboards. The total shelf area of all kitchen cupboards should be at least $6m^2$.

Heights, widths and frontages for storage are recommended by the New Zealand Standards Association (NZS 4101, 1974) as follows:

a) Height from floor.

(1) Lower shelves and drawers.

Items in constant use	60 - 90cm
Items in regular use	45 - 60cm
Items used infrequently	10 - 45cm

(2) Upper shelves.

i. With workspaces in front.

Items in constant use	130cm and lower
Items in regular use	160cm and lower
Items used infrequently	180cm and higher

ii. Without workspace in front.

Items in constant use	180cm and lower
Items used infrequently	210cm and higher

b) Width (front to back)

(1) Lower shelves and drawers.

Full width	50 - 60cm
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(2) Upper shelves.

Full width	30 - 35cm
Half width	10 - 15cm

c) Length for lower storage.

Minimum	180 - 240cm
Medium	240 - 300cm
Liberal	300 and above

Investigations in Auckland, (Reynolds and Bonny, 1976) found that because the kitchens studied were so deficient in space, it was not possible to store equipment and food close to where it would be most used - consequently those surveyed, placed things wherever they could. A number of shorter than average women complained that generally they couldn't take

full advantage of cupboards above the first shelf. Overall most of the women took note of the principles defined above (or as best they could with the limited space), storing things according to their frequency of use. Complaints then, included too few cupboards, even fewer drawers, shelves in cupboards too far apart for efficiently organised storage, shelves too narrow for dinner plates, and no provision for bulk storage of any kind. This then, would appear to be one area needing improvement in New Zealand housing.

Storage for waste material, both organic and inorganic must be considered. Some area under the bench, or at least in a convenient, but out of the way corner is necessary, otherwise it can become a safety hazard.

VII LIGHTING.

Ergonomic considerations which apply to lighting generally apply in the kitchen also. Obviously the maximum use of natural lighting is desirable. In New Zealand, the Model Building By-law (NZS 1900, 1964) specifies that kitchen window space should not be less than six-tenths of a square metre, and that half of it should open. Natural lighting, however, will not always be entirely adequate, and hence provisions for artificial lighting must be made.

There are four requirements for good lighting in the kitchen: general lighting for the room as a whole, individual workcentre lighting, cupboard lighting, and

lighting in equipment (such as ovens and fridges). Most sources tend to agree that illuminance levels of 200-300 lux is the most practical. A single central lighting source should be considered as background lighting only. Such lighting will not provide sufficient illumination for work areas, and in most cases will result in people working in their own shadow. Separate lighting over each of the different work centres would be ideal, but perhaps expensive, however a compromise would be to place lights in the ceiling zone immediately above the front edge of the work centre. Fluorescent tubing seems effective in spreading a large amount of light over a greater area, however such a choice must ultimately rest with the kitchen designer. Cupboard lighting is an expense most homeowners cannot afford. Nevertheless, a reasonable level of general lighting should illuminate cupboards sufficiently. Lighting inside appliances is usually not a matter for the housewife, but will rest with the manufacturers.

Reference to the work of the Society for Research on Women (Reynolds and Bonny, 1976) showed that in almost all the homes surveyed, light fittings were hung in the middle of the rooms, creating the problems mentioned - clearly improved lighting layout is indicated.

VIII ELECTRICAL OUTLETS.

Sufficient electrical outlets need to be provided for present and future needs - too many outlets are better than not enough, for the lack of outlets only leads to doubling up of appliances and eventual overloading.

At least four outlets are currently required in British housing, however this is likely to change as more electrical appliances become available and their use more widespread. (Dept. of Environment, Design Bulletin 24, Pt.11)

Outlets should be placed above benches and where needed elsewhere. In all cases, caution must be taken to see that they are situated out of reach of very young children, even though some of the new safety plugs available present fewer safety risks.

IX THE INDOOR CLIMATE.

(i) Heating

Air temperatures should be kept fairly constant - however this is often difficult because of the extra heat produced by cooking and baking operations. For sedentary workers the air temperatures suggested by Joan Ward and her associates (1974) for thermal comfort is between 15.6°C and 20°C (as should be found at the meal table for instance) The temperature should be some degrees lower if more active work is involved: a recommendation of between 12°C and 15°C would seem appropriate. Similar conditions are advised by the National House Builders Registration Council Standards in Britain (Dept. of Environment, Design Bulletin 24, Pt. 11) and this is also the standard expected in most local authority dwellings there. Various overseas investigations have offered the following guidelines for indoor air temperatures during the winter months (Grandjean, 1973, p.187):-

Country	Air temp.	Year of study
England	15.5 ⁰ C	1945
England	12.5 ⁰ C	1961
Germany	20 ⁰ C	1959-1969
France (degree of comfort)		
high	22 ⁰ C	1962
Sweden	20 ⁰ C	1967
Holland	17-19 ⁰ C	1963
Switzerland	Min. 18 ⁰ C	Desirable 18-20 ⁰ C

These studies then, provide guidelines for desired heating conditions within the kitchen.

Unfortunately, although these temperatures are desirable, it is doubtful whether they are necessarily maintained. One British survey for instance, (Joan Ward, 1974) found that when external temperatures were 15⁰C or more, internal temperatures rose higher even than the temperatures suggested for sedentary workers. This problem of over-heating has been considered by a number of researchers, and consequently, recommendations for some form of intermittent heating has been suggested. Such a system would heat and cool quickly in response to changes in room temperature.

The different types of heating available provide a choice for the homeowner that will depend on the type of kitchen and the amount of activity that takes place there.

(ii) Ventilation

Ventilation is needed in the kitchen for two main reasons: firstly to remove smells from cooking, and also

to maintain general air freshness. Removing the various smells needs to be done without creating draughts and without spreading the smell throughout the room. Perhaps the best and cheapest method is to open windows. However this is not always the only solution - "Rapid air movement takes place when doors and windows are open, but this does not usually result in a direct air flow from sources of pollution to the air outside - cross draughts develop and grease-laden steam and smells are widely dispersed often to other parts of the home. This in turn requires large amounts of fresh air to dilute the waste products to an unobjectional level. Windows and doors alone cannot usually be relied on to do this." (Dept. of Environment, Design Bulletin 24, Pt.11)

The alternatives available include extractor fans, cooking hoods and general air conditioning, each with its various advantages and disadvantages. Hence their installment will largely be a matter of the personal tastes and finances of those concerned.

Guidelines suggested by Grandjean (1973, p.187) partly based on the work of others and partly on the basis of his own considerations are as follows:-

	No. of air changes per hr.		Type of Ventilation
	Minimum	Desirable	
Small kitchens less than 20 cubic metres	10	20-30) preferably
Medium kitchens, 20-30 cubic metres	8	15-25) plus
Large kitchens more than 30 cubic metres	0	10-20) mechanical) ventilation

The report on state rentals in New Zealand (S.A.C. Research Report, 1974) commented about the lack of any obvious method of preventing cooking smells reaching the rest of the house. Whether this is a general feature of most houses in New Zealand, has yet to be investigated.

X NOISE.

The noise levels in most households are increasing, and in the future it is obvious they will need to be carefully controlled. Noise can be classified as either external or internal, i.e. noise from outside the house and noise from within. Eliminating external noises is very difficult once the house is built, and so awareness of this problem in the design stages is essential. Internal noises generally come from many of the appliances that are available - care must be taken in selecting the least noisy types of equipment. The University of Otago's extension studies bulletin (Carpenter and King, 1974) provides a very competent guide for noise control in New Zealand.

Preventing noise from reaching other parts of the house when working in the kitchen, is a very important consideration for the worker - it should be noted, that in this respect, open plan housing is at a disadvantage.

XI KITCHEN SURFACES

Getting down to final details in planning, the homemaker must consider the most appropriate surfaces for each of the work areas. A seven point checklist should apply in all cases: Is the material durable; unaffected by kitchen

operations; easy to care for; quiet and pleasant to use; safe - slip and skid-proof; attractive in appearance; and economically sound in relation to service? (Carpenter and King, 1974) Floor coverings in the kitchen must above all be easy to clean, and for this reason carpet is not recommended. Cork flooring is not recommended either. What is required though, is something that is warm, quiet and resilient, non-slip and resists dents, abrasions, heat, moisture, grease and stains. Most of the wall surface materials available are suitable for any purpose and thus the final decision will once again be a matter of personal preference and cost. Cupboards and drawers are more durable and easy to clean, if they are covered inside and out (where practicable of course) In so far as work surfaces are concerned, the main requirement is that they be water and heat resistant. Avoiding glare off shiny surfaces should also be borne in mind. Generally speaking, as with wall surfaces, there are numerous bench top materials available on the market, and thus the choice must be a personal one.

Kitchen design is not just a simple task of building a sink, bench, cupboards, and leaving room for the various appliances. It should require the precise knowledge and planning that goes into the design of any other workplace. Each fitment and piece of equipment should be designed with the individual worker in mind. Hopefully then, this review will have given the reader some idea as to the different recommendations and standards that have built up through much research and general commonsense over the years. No doubt as more and more people realise the importance of the

kitchen within the home and its very close association with the welfare of those who live in it, standards of design will improve to the extent that ultimately the kitchen will enhance the potential of each individual who works in it.

CHAPTER III.

METHOD

As outlined in the introduction, the purpose of this investigation was primarily to ascertain the degree to which relevant ergonomic knowledge was incorporated in the design of a sample of relatively new New Zealand domestic kitchens in owner-occupied dwellings.

Information provided by both the Christchurch City Council and the Waimairi County Council indicated seven areas where the building of new housing had been in progress (Figure 1.) Four houses and one ownership flat were selected from each area, making a total of 35 dwellings. Initially each of the areas was examined, then dwellings from different parts of the area were selected at whim by the investigator. Because of the ill-defined nature of some of the areas, and the limited size of the sample, systematic sampling techniques were not employed. Overall, the response from the housewives was enthusiastic, however, seven refused for various reasons.

The investigation itself, was divided into two parts; the first part being a structured interview probing the following:-

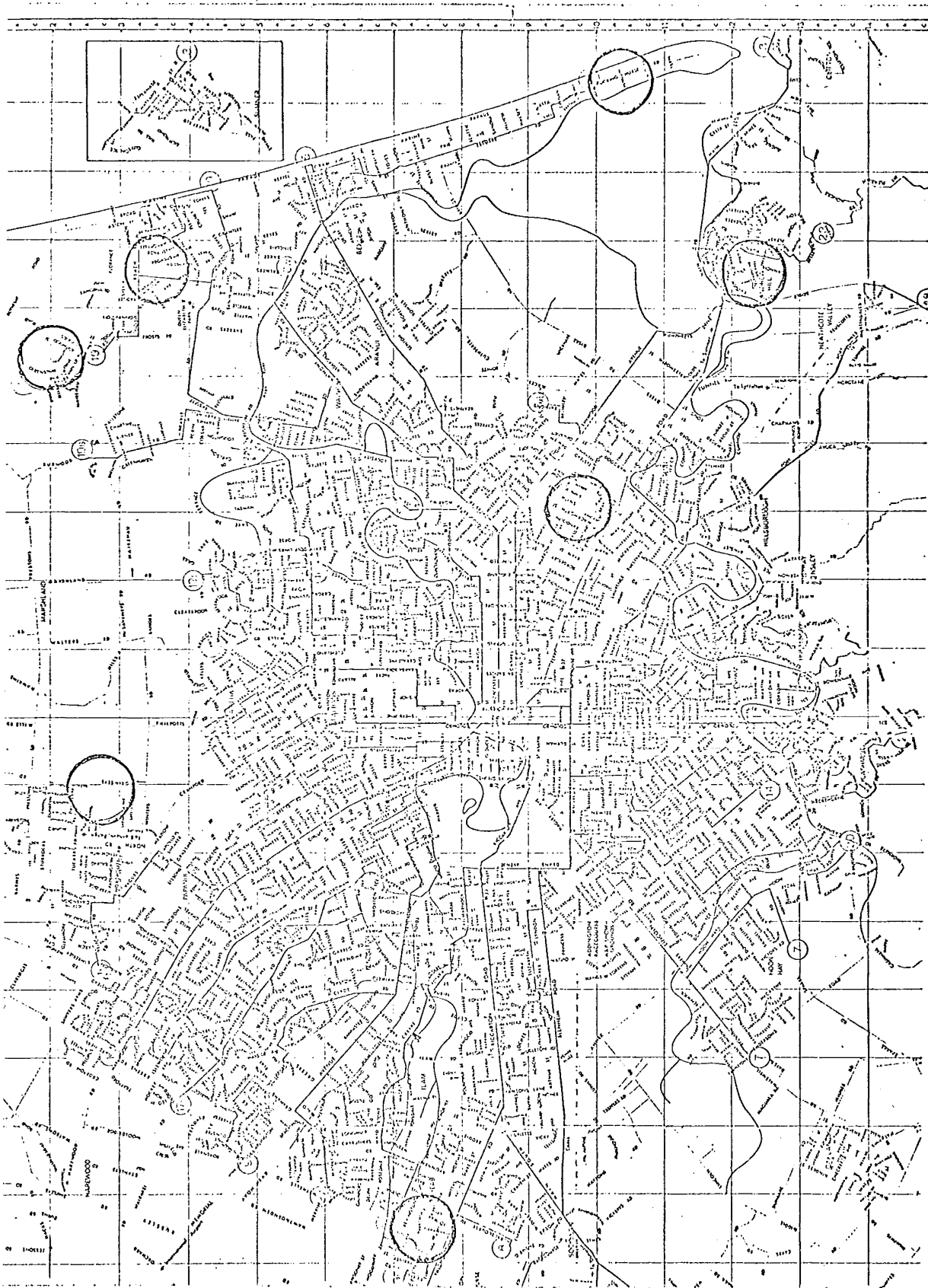


FIGURE 1. MAP OF CHRISTCHURCH WITH LOCATIONS SAMPLED, CIRCLED.

- (1) biographical details
- (2) kitchen activities
- (3) comments relating to problems and difficulties.

(See Appendix I for exact questions).

Information on biographical details was obtained merely to provide an indication of the nature of the sample involved. Likewise, the question on kitchen activities was asked in order to find out the kinds of activities that are carried out in most New Zealand homes. Comments from the housewives, with respect to any problems or difficulties they found in working in their kitchens provided the basis for a subjective evaluation of the kitchens.

The second part of the investigation involved taking a number of measurements of various aspects of the sample kitchens. (See Appendix 2 for details of the information collected). This appeared to be the most feasible way of deciding, whether from an objective point of view, the kitchens studied had incorporated any relevant ergonomic knowledge in their designs. Following this, details about the different facilities provided were examined. This information related to the electrical outlets, the lighting, heating, ventilation and waste disposal. Evening illuminance levels were measured in all the houses by means of a Toshiba photocell illuminometer, over three different work centres: the general preparation bench, the stove (elements) and the sink.

From each of the houses surveyed, a diagrammatic sketch was made, the purpose of this being to aid the investigator in recalling features of kitchen layout at the time of data analysis and presentation.

Interviews were conducted from June 13 to October 10, 1977. These took place either in the evening or during the weekend, so that the sample would not obviously be biased against women who were not fully employed in the home. All illuminance levels were measured indoors with artificial lighting, this necessitating a return visit to houses where interviews had been completed during the day. On average, data collection took slightly more than half an hour per dwelling.

CHAPTER IV

RESULTS.

Unless otherwise specified the results refer to all 35 dwellings included in the survey. The original investigation was modified slightly after the first five kitchens had been measured, and as a consequence, some of the findings refer to only 30 kitchens. Likewise most measurements have been converted into centimetres in line with overseas reports, and also because this metric unit is probably more comprehensible than millimetres, given the dimensions encountered. Finally, the word 'dwellings' will be used throughout when referring to both houses and ownership flats.

1. BIOGRAPHICAL DETAILS.

(See Appendix 3 for complete details)

A breakdown of the different ages of the women surveyed, is given in Table 1. Sixty-nine per cent were between 20 - 34 years.

TABLE 1: AGE OF HOUSEWIVES.

AGE-GROUP	FREQUENCY.
20-24	5
25-29	8
30-34	11
35-39	2
Over	9

Forty-three per cent of the participants were from two-person households, twenty per cent from three-person, twenty-nine per cent from four-person, and the remaining from five-person households. A comparison of age-groups with numbers in households, revealed that generally those in the 20-29 year age-group were involved in small households, while those in the 30-39 year age-group were involved in larger ones. All those interviewed over 39 years, came from two-person households.

The ages of any children ranged from less than a year old to 13 years, with the median age being 4 years.

With respect to employment, 43% percent of all women were engaged in some form of employment outside the home, 23% were employed fulltime, and 20% part-time. All the young married women without children worked, whereas the older married women (those in the over 40 age-group) were generally unemployed. Of those women with pre-school children, none were engaged in full time employment, most being unemployed. (85% in all) Fifty-seven percent of those with school-aged children were in part-time employment.

Occupations of the husbands were converted by means of the Elley and Irving, 1976, Scale, to ratings of socio-economic status. These ratings ranged from 1-5 with the mean being 3.3. Mean ratings for the seven areas sampled, ranged from 2 to 4. (It should be noted

that similar ratings are not available for women)

Eighty percent of the dwellings surveyed were mortgaged. Of the remaining few, five were freehold, and the other two were rented. The Housing Corporation was the mortgagee of 57% of the mortgaged dwellings and the Savings Banks accounted for a further 29%.

The ages of the dwellings ranged from less than a year old to nine years old, with 91% being five years old or newer.

In response to the question about who actually designed the kitchens, a number of varying replies were received (See Table 2.) Fifty-one percent of those interviewed, said they were not involved in the design of their kitchens, 34% were involved, and the remaining five houses could not be conveniently classified.

TABLE 2: OWNER INVOLVEMENT IN KITCHEN DESIGN.

	Frequency
No owner involvement in design	18
Owner involvement	12
- Owner designed	7
- Architect and owner designed	3
- Builder and owner designed	2
Miscellaneous	5
- Second owners	2
- Rented dwellings	2
- Altered original design	1

In 13 of the 18 dwellings financed by the Housing Corporation design responsibility rested entirely with the builder or subdivider.

All, but one of the seven ownership flats were designed without the involvement of the owners. The exception was an older couple who had designed two flats and kept one for themselves.

II. KITCHEN LOCATION, TYPE, AREA AND ACTIVITIES.

(See Appendix 4 for detailed results of subsequent findings)

Forty-eight percent of the kitchens surveyed faced southwards, 37% faced east and the remainder were almost equally divided in facing north and west. Two of the three houses designed by architects in conjunction with the owners faced south, and five of the six ownership flats designed without the involvement of the owners, also faced south. In the interview, only two of the housewives complained about climatic conditions. Both were in dwellings that faced south, but although one said the kitchen was often too cold to work in, the other said in summer it was too hot.

In four dwellings only were the kitchens not situated near an outside doorway. Of those who had children, 50% said that it was not possible to adequately supervise the children playing, while they were working in the kitchen. Seven of the 13 housewives in kitchens financed by the Housing Corporation said their kitchens were not designed for

adequate supervision, and eight of the 12 housewives in kitchens built without the design involvement of the owners said their kitchens were similarly not well designed.

Forty-three percent of the kitchens surveyed were open working kitchens (i.e. kitchens with a defined dining space, open to the kitchen or separated by a buffet or dresser), 40% were dining kitchens (i.e. single family rooms in which both the cooking and the meals took place) and 17% were enclosed kitchens (i.e. kitchens which were adjacent to the dining room or dining/lounge and separated from it by single or double doors) (See Reynolds and Bonny, 1976, P.39)

Seventeen of the 18 kitchens designed without the involvement of the owners were dining or open working kitchens, whereas only 54% of the kitchens designed by the owners were likewise. None of the ownership flats had enclosed kitchens, with five of the seven having dining kitchens. Overall, 50% of the kitchens financed by the Housing Corporation were dining kitchens, 31% were open working kitchens, and the remaining three kitchens were enclosed. As a consequence in only six of the dwellings, did the respondents have to walk through a doorway to reach their dining tables.

The areas of the kitchens ranged from 5.07m^2 to 14.83m^2 , all larger than the minimum size permitted in New Zealand of 4m^2 . Generally speaking, the dining kitchens were larger than either the open working and enclosed

kitchens, except in the case of the ownership flats which were smaller regardless of kitchen type. If Grandjean's (1973) recommendations that the minimal size of kitchens without a dining alcove be 8m^2 and those with 12m^2 , are accepted, then almost half (43%) of the kitchens surveyed were too small. Nine of the 21 kitchens without a dining alcove were too small, and similarly six of the 14 kitchens with a dining alcove were too small. Of the seven ownership flats, the six built without the design involvement of the owners were likewise too small. In the interview only two respondents specifically stated that they wanted larger kitchen areas.

Forty percent of those interviewed, took all their meals in the kitchen, and a further four households took breakfast only in the kitchen. With respect to the latter finding, a small number of houses had bar stools and used some of the available bench space for this purpose. One housewife did her laundry in the kitchen and similarly in only one household was the kitchen used as a study area. Forty-three percent of the respondents ironed in the kitchen, six used it as a play area, and five used it for relaxation. These activities took place only in the dining kitchens, with the exception of five enclosed and open working kitchens, which were used for ironing. As has been found in overseas studies, there was a tendency for those with larger kitchen areas to use their kitchens for dining while those with smaller kitchens did not.

III. INTERNAL LAYOUT.

Three-quarters of the kitchens surveyed were rectangular. Of the remaining few, three were square, two were galley kitchens (long narrow kitchens with benches on opposite sides), one was L-shaped, and a further three were irregular shapes.

Work triangle clearances were measured between the three main work areas. New Zealand standards (NZS 4101, 1974) suggest clearances of 120-210cm. between the fridge and sink, 120-180cm. between the sink and range, and 120-270cm. between the range and fridge. Measurements from five of the dwellings, (as previously mentioned) were not taken because they were not included in the original questionnaire. Half the kitchens surveyed had fridge to sink clearances outside the range suggested, eight shorter than the minimum and seven larger than the maximum. Half the dwellings financed by the Housing Corporation were outside the range suggested, and two of the three dwellings designed in conjunction with architects were also outside the desired range. No differences with respect to owner involvement in designs were noted. Similarly, with reference to the clearances between the sink and range, 50% of the kitchens surveyed were outside the recommended range, with 13 of the 15 being less than the minimum. Also, two of the three dwellings designed in conjunction with architects, were outside the range. Only 37% of the clearances between the range and the fridge were inadequate, the majority of these being less than the minimum. Similar findings pertained to the ownership flats.

Of the six flats measured, three had clearances below the minimum on each measure. For efficiency, the sum of these distances should be between the limits of 360-660cm. according to the New Zealand standards (NZS 4101, 1974) while according to Grandjean (1973) they should not exceed 700-800cm. With respect to the latter, only one kitchen exceeded these dimensions, the owners being involved in the design, along with an architect. Seven kitchens had total work triangle dimensions outside those suggested by the Standards Association. (NZS 4101, 1974), three below the minimum and four above the maximum. Three were financed by the Housing Corporation, four designed by the owners, and two designed without owner involvement.

In 74% of the dwellings surveyed, the sink and stove were located such that it was not necessary to cross the kitchen floor carrying hot water or hot food, in 20% the sink and stove were located at right angles, and only in two dwellings were the sink and stove opposite each other.

Eighty percent of the women stated in the interview that their kitchens were designed such that general traffic was kept out of the work area. However from the investigator's point of view, only 40% were justified in believing that this was the case. As a consequence, the investigator felt that fifty-six percent of the dwellings financed by the Housing Corporation were poorly designed in this respect. Similarly, also from the investigator's point of view, comparing the degree of involvement with this particular design

feature, 72% of the kitchens built without the design involvement of the owners, were inadequate, while only 42% of those kitchens designed by the owners were similarly inadequate (which in itself is a fairly high percentage) Once again, from the investigator's point of view, five of the seven ownership flats were designed such that general traffic was not kept out of the work area.

The stove was positioned away from the door in 63% of the households, however in the remainder when the housewife was standing at the stove or opening the oven door other people could not enter or pass through the kitchen. This was the case in six of the seven ownership flats. Fifty percent of those dwellings designed without owner involvement, and a third of those designed by the owners had stoves positioned next to the doorway. All, but two of the kitchens surveyed, had no window opening above the stove.

In the interview, only three of the housewives reported that the position of the stove was such that it was not possible for them to place saucepans on the element without the handles projecting over the stove edge. One respondent who had a split level oven felt that the position of the oven next to the elements prevented this, while the other two mentioned problems created by the stove being close up against the wall.

Because of the design of most stoves, available at

present, almost all those interviewed said that stove controls were out of the reach of children. The only household where this was not the case, had a split level oven, and the children could reach the element controls.

There was no place provided for oven cloths or pot holders in 69% of the dwellings surveyed. Sixty-two percent of the dwellings financed by the Housing Corporation had no such provisions. Likewise two of the three dwellings designed by the owners in conjunction with architects, and 12 of the 18 dwellings designed without owner involvement were also without places for oven cloths or pot holders. Only three of the 12 dwellings designed by the owners had made specific provision in this respect, and similarly only one of the seven ownership flats.

Fifty-six percent of those interviewed stated they had problems with doors interfering with one another or the worker. Half the kitchens designed without owner involvement, and a third of the kitchens designed by the owners, had these problems. Five of the seven ownership flats, similarly said that some doors interfered with others. Specific problems mentioned, included: stove doors opening next to the kitchen door; laundry doors opening into the kitchen, blocking other cupboard doors and the fridge; overhead cupboards opening such that the entranceway to the kitchen was blocked; fridge doors opening into the entranceway; cupboard doors interfering with each other; and finally, one woman who had a split level oven mentioned

difficulties associated with cupboards placed under the oven.

Fifty percent of the respondents who felt their needs were likely to change in the future (26 of those surveyed) said there was not adequate provision available for these needs. Just under half the people in dwellings financed by the Housing Corporation, made comments related to this problem, as did 11 of the 15 respondents in dwellings not designed by the owners. Only one respondent who had been involved in the design of her kitchen, mentioned inadequate provision for future needs. The three housewives in ownership flats, who considered that their future needs were likely to change, all said adequate provisions had not been made. One of the respondents specifically mentioned the fact that there was no provision for freezer space, another mentioned inadequate bench space, and a further six respondents said they needed more storage space.

IV. WORKCENTRE AND SPACE DIMENSIONS

Benches were classified in terms of the activities for which they were used: general preparation area; cooking area; sink area; and serving area. In every case, kitchens were designed with the sink bench as the focal point of the kitchen. All kitchens had a uniform bench height for all areas, which, with the exception of five kitchens was 90cm, the height recommended by Grandjean. (1973). Comparing the bench heights with the New Zealand standard (1974) for work benches of 85-95cm, all but one of the kitchens surveyed had

benches with heights in this range.

Total bench lengths ranged from 165cm-752.6cm. Although neither the overseas nor the New Zealand literature recommends total minimal bench lengths, such a recommendation can be obtained by summing bench lengths for various fittings and activities. On the basis of Grandjean's (1973) data, he would perhaps recommend a minimum total bench length of 280cm, and that derived from the New Zealand standards (NZS 4101, 1974) 320cm. Seventeen percent of the kitchens surveyed had total bench lengths less than Grandjean's minimum, and 30% had total bench lengths less than the New Zealand recommendations. Five of the seven ownership flats were below the New Zealand standards. In all, eight women specifically mentioned the lack of bench space as a problem, but only two of these had inadequate space in terms of the New Zealand standards (NZS 4101, 1974). Sink bench lengths ranged from 145cm-387.5cm, all within the recommended length suggested by the New Zealand Standards Association (NZS 4101, 1974).

Bench widths varied from 46.2cm to 90cm. Grandjean (1973) recommends a minimum bench width of 60cm, while the New Zealand standards (NZS 4101, 1974) suggest 50-60cm for both sink and food preparation benches and 50-75cm for benches used for appliance space. Sink bench widths varied from 46.2cm-60cm. In terms of Grandjean's recommendations, only three of the houses surveyed would be adequate, while only 40% would be adequate compared with New Zealand standards.

Seventy-five percent of the dwellings financed by the Housing Corporation had inadequate bench widths in terms of the New Zealand standard; 90% of the dwellings built without the design involvement of the owners, and likewise 33% of the dwellings designed by the owners had inadequate sink bench widths. Of the eight kitchens with benches classified as cooking benches, only one was inadequate with respect to Grandjean's recommendations, but all were adequate as far as the New Zealand standards were concerned. Nineteen of the 22 dwellings which had general or food preparation benches were smaller than the minimum stated by Grandjean (1973), but only eight were outside the range specified by the New Zealand Standards Association (NZS 4101, 1974). Of these eight, five were financed by the Housing Corporation, and six were built without the design involvement of the owners. Twelve of the sixteen dwellings with serving benches were inadequate compared with Grandjean's (1973) recommendations, while only four were inadequate from the point of view of the Standards Association (NZS 4101, 1974).

Benches were not level with the stove in two of the kitchens investigated. In reply to a question concerned with provisions for putting down hot dishes beside the stove, 63% of the housewives said they placed a board on the bench for this purpose, four said they put dishes straight on to the bench, three put them on the oven top, two placed them on the table, one on the window sill, and the remaining three had a specific tiled area available. Of the three dwellings where tiled areas were incorporated into the design, two

were designed by the owners, while the other, an ownership flat was not.

V. CLEARANCE AND STORAGE NEEDS.

Clearances between work surfaces and upper cupboards ranged from 30-80cm. (Five of the dwellings were not measured, and two did not have upper cupboards). Grandjean (1973) recommends a minimum of 40cm and a maximum of 50cm for this space, while New Zealand standards (NZS 4101, 1974) give 30-45cm as desirable measures. According to New Zealand standards, 64% of the 28 dwellings surveyed would have clearances that were too wide, and likewise 40% would be too wide by Grandjean's recommendations. A further two dwellings had clearances below the minimum suggested by Grandjean. Nine of the dwellings financed by the Housing Corporation were wider than the measures suggested by the New Zealand Standards Association, and 11 of the 17 dwellings built without the design involvement of the owners were likewise too wide. Six of the nine kitchens which had been designed by the owners also had clearances outside the range recommended, as did four of the six ownership flats surveyed. Only three housewives, however, particularly remarked that they were not satisfied with these clearances, but in each case they said the space available was too small, and as such bench space below could not be utilised to its full extent.

Recommendations by the New Zealand Standards Association (NZS 4101, 1974) for toe space i.e. the vertical space between the floor and the lower cupboards, lie between 10-20cm,

Seventy-two percent of the 29 dwellings in which this was measured, were below 10cm. Eight of the 13 dwellings financed by the Housing Corporation had inadequate toe space, as did 11 of the 17 dwellings built without owner involvement, and nine of the 10 owner-designed dwellings. The three architecturally designed houses and four of the six ownership flats also were below the recommended measure.

When the investigation was carried out, the different heights of the storage units were measured. However, because New Zealand standards (NZS 4101, 1974) allow measures from 10-210cm and higher, which in effect means from the ground to the ceiling, the relevance of comparing findings seemed minimal. Despite the standards, 51% of those interviewed felt that the cupboards were not related to their heights - all but one felt that overall some of the cupboards were too high, even taking into account long-term storage needs. The other respondent said that some of the cupboard space available in her kitchen was too low and deep to be practical. Ten of the 16 housewives in dwellings financed by the Housing Corporation made comments as related above and 12 of the 18 housewives in dwellings in which they had no design involvement reported similar problems. Four of the housewives in self-designed dwellings said that cupboards were not related to their heights, with only one mentioning that it had been designed that way so as to use as much of the available space as was possible, even if in many respects it was not practical. Forty-one percent of the women, who had problems with high cupboarding said they used a stool to

reach high cupboards and the others said they used a dining chair.

Widths for lower storage shelves ranged from 30-60cm compared with the acceptable New Zealand standard (NZS 4101, 1974) of 50-60cm. Eighty-seven percent of the dwellings measured had lower storage widths less than that recommended. Of the four dwellings with adequate storage widths, three were designed by architects and one was designed by a couple living in an ownership flat. With reference to the high shelves, widths ranged from 25-75cm, as compared to the New Zealand standard (NZS 4101, 1974) of 30-35cm. Seventy-one percent of the dwellings measured, had adequate upper storage widths. Four of the eight dwellings which were designed by the owners had widths wider than that recommended. Similarly, three of the six ownership flats were designed with upper storage widths greater than that recommended.

New Zealand recommendations (NZS 4101, 1974) for minimal lower storage lengths are 180cm, and for maximum lengths 300cm and above. Only one of the dwellings surveyed had frontal storage lengths of less than this - an ownership flat in which the owners had no design involvement. Lengths ranged from 152.5cm-432.5cm. In all, six housewives said they needed more storage space.

In almost all cases, heavy objects were stored in cupboards under the sink, just below where they would be used. Only three householders said they stored mixers, etc. on the

bench, and a further three specifically mentioned storing them in pantries. Of these, one of the housewives said that the mixer was used in the pantry, while the others had to move them each time they were used.

Specific storage for small heaters in the kitchen appeared to be minimal. Heater locations included: beside the table; below the bench; below a window; below the stove; and in a corner - all areas which presented definite safety hazards. Space for storage of kitchen tidies was equally inadequate. Twelve respondents had kitchen tidies in the kitchen, and in almost all cases these were situated in places where obviously problems could arise, e.g. in one of the dwellings the kitchen tidy was positioned in front of the fridge and had to be moved each time the fridge was opened. A further four respondents placed all their rubbish in bags attached to cupboards under the sink, while the remaining 19 households indicated that there was no provision in the kitchen for waste disposal.

VI. LIGHTING AND ELECTRICAL OUTLETS.

Illuminance readings were recorded in lux over the three main workcentres. Recommendations both overseas and in New Zealand agree that illuminance levels of 200-300 lux are adequate, however, readings varied from 1-10 lux to 1000 lux. Only five of the 35 dwellings had adequate illuminance over the general preparation area, with another four readings being too bright, and the rest being below that recommended. With respect to the cooking area, two dwellings

only, had adequate readings, with another three readings being too bright, and the rest inadequate. Similarly, the majority of readings over the sink were below 200 lux, with five being too bright and two being within the recommended levels. Twenty-one of the dwellings had one central light source, four had one light directly above the sink, and the remaining ten dwellings had light sources over different areas of the kitchen.

When questioned about the adequacy of day and night lighting, 86% of the respondents said that it was adequate. All five of the respondents who said lighting was inadequate, had inadequate illuminance when measured with the light meter.

Seventy-four percent of the dwellings surveyed had more than four electrical outlets available, which in all but one house, included two outlets on the stove. Generally, where the owners were not involved in the design of their kitchens, less points were installed. Four housewives complained that they did not have enough outlets available, none of these being involved in the design of their kitchens.

VII. HEATING, VENTILATION AND NOISE.

Sixty-six percent of those surveyed had some form of heating in the kitchen, while the others relied on heat filtering through from other parts of the house. Of those who had heating, twelve had bar heaters, nine had central

heating and three had incinerators.

Specific provision for ventilation, was made in fifteen of the dwellings surveyed. Twelve had extractor fans, two had a hood over the cooking area itself and one had a general purpose fan. Sixty percent of those interviewed said there were adequate means available to prevent cooking smells reaching other parts of the house. Ten of the 16 housewives in dwellings financed by the Housing Corporation said they did not have adequate means of ventilation and likewise eight of the 18 housewives in non-owner designed dwellings said they were without adequate ventilation.

With respect to noise from the kitchen reaching other parts of the house, 63% of the respondents said there were adequate means available to prevent this. Half the dwellings financed by the Housing Corporation had problems with noise, according to the housewives concerned, while seven of those in kitchens they had not designed themselves, also had problems.

CHAPTER V.

DISCUSSION AND CONCLUSIONS

This investigation was designed as a pilot study aimed at examining from an ergonomic point of view, a sample of new or relatively new New Zealand kitchens. Only 35 dwellings from one New Zealand city, and with no checks against sampling bias, were incorporated in the investigation. As such, the generalisability of the findings with respect to New Zealand housing as a whole is limited.

Nevertheless, the results do reveal many interesting facets of new kitchen design in Christchurch. Most dwellings, avoid such glaring faults as sink on one side of the room and stove on another, and have uniform and appropriate bench heights but even so a number of design shortcomings were revealed. A few of these shortcomings would incur additional costs if they were to be alleviated in future kitchens e.g. increased kitchen areas, bench widths and lengths, storage provisions and illumination levels. However, the majority would involve only some rearrangement within the dwelling or within the kitchen itself, and therefore, apart from possibly larger plumbing and drainage lines, would not be expected to increase the basic cost. These design features include; location of the kitchen in terms of accessibility to sunlight and adequate supervision of children, more appropriate work

triangle clearances, improved internal layout in terms of keeping general traffic out of the work area, location of the stove so as not to obstruct traffic, provision for pot holders and oven cloths, proper positioning of kitchen, cupboard and appliance doors so they do not block one another or entranceways, provision of space for future needs and for a heat resistant surface next to the stove, proper positioning of above bench cupboards, suitable storage heights and adjustable shelving, and finally, adequate storage for heavy objects, heaters and a kitchen tidy.

With respect to increased costs as regards larger kitchen areas, etc, the homeowner should consider these features not as luxuries, but as necessities like the education of children or adequate health care. It would be far better to have a greater financial burden initially than to have an inefficient working environment in future years.

1. IMPLICATIONS OF THE STUDY.

(i) New Zealand Standards

Much of the judged adequacy of the design of the new kitchens rested with both the overseas and New Zealand standards. Ideally, standards should incorporate the best objective knowledge based on research. However, in some respects, whether the standards used, did in fact incorporate all the available knowledge, is questionable. Notably, differences in the recommendations suggested by Grandjean and those suggested by the Standards Association provide

some speculation as to which standard is more appropriate. Also in some instances, the results indicate areas where the standards are not observed, yet there were few complaints from the housewives, e.g. sink bench widths were too narrow compared with the New Zealand standard yet there were few complaints. Similarly, clearances between work surfaces and upper cupboards, toe-space clearances, and lower shelf widths were outside the ranges recommended in the New Zealand standards, but few complaints were made. The question can be asked then, whether the standards are unrealistic or whether the housewives are unaware that they have inadequate kitchens, because they have accepted these features as standard, and have learned to cope with them? The former would seem to be true in a number of cases, if for instance the standard relating to clearances between work surfaces and upper cupboards is typical. According to this standard, most of the clearances were too big, yet the housewives said they were adequate or complained that they were not big enough, as smaller clearances prevented them making full use of the bench space below.

Likewise, in other cases, the relevant standards were met, but the housewives complained, e.g. total storage lengths and storage heights were adequate compared with the standards, but were minimal and too high from the housewives' point of view. Generally, standards are based on the dimensions of the average user, and as such will always be inadequate for those in the lower 25% of the population and those in the upper 25% - thus it is perhaps understandable

that those with larger families, would have found storage provisions to be inadequate. At present, in New Zealand, the only specifications that must be rigidly followed in designing and building a new kitchen are those found in the New Zealand Standard 1900 Model Building By-Law (1964). This standard states minimum requirements only, such as provision for a sink and draining board, adequate cooking facilities and adequate food storage facilities. Other regulations which apply are the Drainage and Plumbing Regulations 1959, and the New Zealand Electrical Wiring Regulations 1961. Thus, the New Zealand Standard 4101, referred to throughout this report is not in anyway compulsory, and Council building inspectors make no reference to it, when examining new or remodelled kitchen plans. Clearly, some provision for ensuring that these standards are conformed to, needs to be made. Further, provisions for a re-examination of these standards in the light of the findings mentioned, needs to be made, if the standards are to be adhered to more rigidly.

(ii) Involvement

Where owners were involved in the design, the kitchen was more likely to conform to the standards, and as such, the owners were generally more satisfied with their kitchens as practical working environment. Where the owners were not involved, design responsibility rested with the builders, building company or subdivider. Compared with owner involved kitchens, those kitchens provided by professional builders were obviously substandard, and in many cases reflected a

low degree of ergonomic knowledge and design competence. It would appear then, that builders need to have a greater liaison with prospective owners, or at least with those concerned with examining the ergonomic aspects of design e.g. the Building Research Association, and the Standards Association. Only through a greater awareness of the needs of the housewife can the standard of design be improved to a more acceptable level.

Only three houses in the sample involved professional architects. These generally conformed to the standards, although two of the houses faced south, had work triangle clearances below those recommended, and had no provision for pot holders and oven cloths.

Overall, then, the findings indicate that there is a need to make builders, architects and potential homeowners aware of the conclusions relating to research about house and flat design. The question is when and how this is to be done, and who should take the responsibility for ensuring that this valuable educational function is fulfilled.

(iii) Ownership Flats

When compared with houses, the kitchens in ownership flats violate New Zealand standards with high frequency, and commonly display other aspects of inadequate design. In particular, their kitchens are usually smaller than the minimum recommended by Grandjean (1973), work triangle clearances are below standard, general traffic is not kept

out of the work area, stoves obstruct entranceways when opened, cupboard doors interfere, and space for future needs is limited. While these flats may be ample for the requirements of young couples without children, or for retired couples, the increasing prevalence of this type of housing for young families must be regarded as a noticeable decline in the standard of New Zealand family housing, and in the standard of living of many New Zealanders, as a whole.

(iv) Housing Corporation

The results indicate, that the Housing Corporation, frequently provides finance for dwellings containing many examples of bad design, which deviate from the New Zealand standards. In particular, dwellings financed by the Housing Corporation reflect problems in supervising children, non standard work triangle clearances, kitchen traffic problems, lack of provision for oven cloths and pot holders, lack of provision for future needs, inadequate storage and bench space, cupboard doors interfering, inadequate clearances between benches and upper cupboards, lack of provision for a kitchen tidy and heater, and generally poor night-time illumination. Quite clearly the Housing Corporation should more rigidly enforce better standards of design than they are doing at present. This is particularly imperative when considering that most of those seeking finance from the Housing Corporation would not for various reasons be able to gain assistance elsewhere. Thus the Housing Corporation is in effect ensuring the perpetration

of a system where builders supply, and potential owners have to accept what from a practical design point of view is an inferior product.

Overall, then, in line with previous studies, (e.g. Reynolds & Bonny, 1976) although the kitchens surveyed, were not grossly inadequate, there were a number of design features which did not incorporate all the available ergonomic knowledge. In particular, those dwellings financed by the Housing Corporation and likewise those dwellings built without the design involvement of the owners seemed to be at fault more often. Generally, where the owners had some involvement in the design of their kitchens, they expressed a greater degree of satisfaction with them.

In conclusion, the findings of this investigation suggest the need for a greater liaison between the housewife and those involved in kitchen design, and a greater appreciation on the part of builders and subdividers in particular, and of all involved in house design, of standards and knowledge relevant to the design of a functionally elegant as well as aesthetically pleasing kitchen, if the housewife is to carry out her job efficiently with the least strain and discomfort. Only in this way, will the standard of design in all New Zealand kitchens improve.

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APPENDIX 1.

BIOGRAPHICAL DETAILS

Address:

Age-group: 20-24

25-29

30-34

35-39

Over

Number in household:

Children:

Ages:

Outside Employment:

Husbands Employment:

Kitchen Designer:

Is your place freehold?

Who do you have your first mortgage with?

- Housing Corporation
- Canterbury Savings Bank
- other savings bank
- solicitor
- building society
- money club
- insurance company
- Public Trust

Age of house:

KITCHEN ACTIVITIES:

What activities are carried out in the kitchen?

- meal preparation and cleaning up
- dining
- laundering
- ironing
- play area
- relaxation

APPENDIX 1.

HOUSEWIFE'S COMMENTS:

- PROBLEMS AND DIFFICULTIES

1. Is there enough workspace for each kitchen activity?
Can more than one operator work at the various centres?
Can one worker pass another with ease?
2. Is general traffic kept out of the work area?
3. Are all the kitchen cupboard and appliance doors hung so they don't interfere with one another or the worker?
4. How is food carried to the table?
5. Where are the heaters and kitchen tidy kept?
6. Where are the heavy objects kept?
7. Are all the cupboards related to your height?
8. How do you reach high cupboards?
9. Are there enough plug sockets to prevent overloading?
10. Is there a place near the stove for oven cloth and pot holder?
11. Can hot dishes be put down beside the stove?
12. Are all the benches the same height?
Are the benches around the stove level with it?
13. Are the sink and stove located so that it is not necessary to cross the kitchen carrying hot water or hot food?
14. Is the stove away from the door? Are there windows opening above it?
15. Can saucepans be used so their handles do not project over the cooking area?
16. Are stove controls out of reach of children?
17. Are work surfaces well lit by day and night?
18. Is there adequate space for future needs?
19. Is it possible to adequately supervise children inside and outside the house?
20. Do climatic changes affect the performance of any of the activities?
21. Are there adequate means to prevent cooking smells and noise reaching other parts of the house?

APPENDIX 2.

KITCHEN MEASUREMENTS.

Size and Shape of kitchen:

- Approx. size
- Shape

Dimensions of Workspaces:

- General preparation area
- Cooking area
- Sink area
- Serving area

Clearances:

- Between work surfaces and upper cupboards
- Between
 - 1) fridge and sink
 - 2) sink and range
 - 3) range and fridge
- For toe-space

Dimensions of Individual Storage Units:

- Lower shelves
- High shelves
 - 1) with workspaces in front
 - 2) without workspaces

Details of Facilities Provided:

- Electrical Outlets
- Lighting
 - 1) general preparation area
 - 2) cooking
 - 3) sink
- Heating
- Ventilation
- Waste disposal

APPENDIX 3:

BIOGRAPHICAL DETAILS

AREA	HUSBAND'S OCCUPATION	SOCIO-ECONOMIC RATING	WIFE'S OCCUPATION	AGE-GROUP	NO. IN HOUSEHOLD	CHILDREN
1 ST. ANDREW'S HILL	Company Director	2	School Teacher	25-29	2	-
	Company Director	2	Part-time nurse aid	30-34	4	2-7, 9 years
	Commercial Real Estate Agent	2	-	30-34	4	2-10, 12 years
	Car Salesman	3	Part-time typist	Over 40	2	-
	Manager of Plastics Firm *	2	-	Over 40	2	-
2 AVONHEAD	Retailer (Owner)	3	Part-time retail work	25-29	3	1-5 years
	Administration Controller (NAC)	2	Cosmetic firm Manageress (part- time)	25-29	3	1-2 years
	(Retired) *	-	-	Over 40	2	-
	Director of Factory Industrial Engineer	2 1	- -	Over 40 Over 40	2 2	- -
3 NORTHCOTE	Bank Clerk	3	Book-keeping Machinist	25-29	2	-
	Seaman *	4	-	30-34	3	1-1 year
	Motor Mechanic	4	-	30-34	5	3-3, 5, 6 years
	School Teacher	2	-	30-34	4	2-3, 5 years
	Painter & Decorator	5	-	30-34	3	1-3 years
4 PARKLANDS	Carpenter	4	Telephonist	20-24	2	-
	Student Teacher (primary)	2	Kindergarten Teacher	20-24	2	-
	Plumber	4	-	25-29	4	2-2, 4 years
	Manufacturing Jeweller *	4	Clerical Worker	25-29	2	-
5 SOUTH BRIGHTON	-	-	-	30-34	3	2-2½, 5 years
	Computer Consultant (part-time tech. lecturer)	1	Teacher	30-34	4	2-8, 10 years
	Salesman	4	Part-time office Clerk	35-39	4	2-10, 13 years
	Welder	5	-	35-39	5	3-8mths, 10, 11 years
	M.E.D. Worker Pastry Cook *	4 4	Restaurant Hostess	Over 40 Over 40	2 2	- -
6 NORTH BRIGHTON	Concrete Worker *	4	Part-time retail	20-24	3	1-10 mths
	Driver/Operator	4	-	20-24	4	2-3, 7 years
	Car Partsman	5	Hairdresser	25-29	2	-
	Fitter & Turner	4	-	30-34	4	2-5, 7 years
	Clerk	3	Part-time Nurse	30-34	4	2-6, 9 years
7 LINWOOD	Printer	4	-	20-24	5	2-½, 3 years (1 boarder)
	Crane Operator	4	-	25-29	4	2-3, 4 years
	Telephone Technician	4	-	30-34	3	1-3 years
	Core-maker *	4	-	Over 40	2	-
	(Retired)	-	-	Over 40	2	-

* Ownership flats.

APPENDIX 4.

DETAILED RESULTS OF FINDINGS.

Key:

- H.C. Dwelling financed by the Housing Corporation.
- A. Dwelling designed with the involvement of an architect
- B (NI) Dwelling designed without the involvement of the owners-builders responsible for the design.
- I. Dwelling designed with the involvement of the owners.

TABLE 1: NUMBER OF KITCHENS FACING VARIOUS DIRECTIONS.

	NORTH	SOUTH	WEST	EAST
Houses: H.C.	2	3		8
A.	1	2		
B (NI)		5		7
I.	3	3		5
Flats: H.C.		2	1	
B (NI)		5	1	
I			1	
TOTAL NOS.	3	17	2	13

TABLE 2: NUMBER OF RESPONDENTS REPORTING DIFFICULTY IN
SUPERVISING THE CHILDREN, FROM THE KITCHEN.

	NO DIFFICULTY	DIFFICULTY
HOUSES: H.C.	6	7
A.	2	
B (NI)	4	8
I.	5	1
FLATS: H.C.	1	1
B (NI)	1	2
TOTAL NOS.	13	13

TABLE 3: NUMBER OF KITCHENS OF VARIOUS TYPES

	TYPE OF KITCHEN		
	ENCLOSED	DINING	OPEN WORKING
HOUSES: H.C.	3	6	4
A.	1		2
B (NI)	1	7	4
I.	5	2	4
FLATS: H.C.		2	1
B (NI)		4	2
I.		1	
TOTAL NOS.	6	14	15

TABLE 4: NUMBER OF KITCHENS OF ADEQUATE AREA BY GRANDJEAN'S
(1973) STANDARDS.

	KITCHEN TYPE			
	Open Living and Enclosed		Dining	
	Adequate	Inadequate	Adequate	Inadequate
Houses: H.C.	5	2	4	2
A.	3			
B (NI)	3	2	6	1
I	6	3	1	1
Flats: H.C.		1		2
B (NI)		2		4
I			1	
TOTAL NOS.	12	9	8	6

TABLE 5: NUMBER REPORTING VARIOUS ACTIVITIES IN KITCHEN AS A
FUNCTION OF KITCHEN TYPE.

ACTIVITIES	KITCHEN TYPE		
	ENCLOSED	DINING	OPEN LIVING
Dining - breakfast	3		1
- all meals		14	
Laundry		1	
Ironing	2	10	3
Play Area		6	
Relaxation		5	
Study Area		1	

TABLE 6: NUMBER OF KITCHENS WITH ADEQUATE AND INADEQUATE
FRIDGE TO SINK CLEARANCES (NZS 4101)

	Adequate	Inadequate	
		Too big	Too small
Houses: H.C.	7	3	2
A	1	1	1
B (NI)	5	3	4
I	5	3	2
Flats: H.C.			2
B (NI)	3		2
I		1	
TOTAL NOS.	15	7	8

TABLE 7: NUMBER OF KITCHENS WITH ADEQUATE AND INADEQUATE SINK
TO STOVE CLEARANCES (NZS 4101)

	Adequate	Inadequate	
		Too big	Too small
Houses: H.C.	8		4
A	1	1	1
B (NI)	8		4
I	4	1	5
Flats: H.C.	2		
B (NI)	2		3
I		1	
TOTAL NOS.	15	2	13

TABLE 8: NUMBER OF KITCHENS WITH ADEQUATE AND INADEQUATE
STOVE TO FRIDGE CLEARANCES (NZS 4101)

	Adequate	Inadequate	
		Too big	Too small
Houses: H.C.	8	1	3
A	3		
B (NI)	9	1	2
I	7		3
Flats: H.C.	1		1
B (NI)	2		3
I	1		
TOTAL NOS.	19	1	10

TABLE 9: NUMBER OF KITCHENS WITH INADEQUATE TOTAL WORK
TRIANGLE CLEARANCES (NZS 4101)

	Too big	Too small
	Houses: H.C.	1
A		
B (NI)	1	1
I	2	1
Flats: H.C.		
B (NI)		
I	1	
TOTAL NOS.	4	3

TABLE 10: NUMBER OF KITCHENS ADEQUATELY DESIGNED FROM THE POINT OF VIEW OF KEEPING TRAFFIC OUT OF THE KITCHEN WORK AREA.

	Homeowner's perception		Investigator's perception	
	Adequate	Inadequate	Adequate	Inadequate
Houses: H.C.	11	2	6	7
A	3		3	
B (NI)	9	3	3	9
I	10	1	7	4
Flats: H.C.	3		1	2
B (NI)	5	1	2	4
I	1			1
TOTAL NOS.	28	7	14	21

TABLE 11: NUMBER OF KITCHENS WITH STOVE NEAR DOORWAY

	Away from doorway	Near doorway
Houses: H.C.	10	3
A	3	
B (NI)	8	4
I	8	3
Flats: H.C.		3
B (NI)	1	5
I		1
TOTAL NOS.	22	13

TABLE 12: NO. OF KITCHENS WITH ADEQUATE PROVISION FOR OVEN CLOTHS OR POT HOLDERS NEAR THE STOVE.

	Adequate provision	Inadequate provision
Houses: H.C.	5	8
A	1	2
B (NI)	5	7
I	3	8
Flats: H.C.	1	2
B (NI)	1	5
I		1
TOTAL NOS.	11	24

TABLE 13: NUMBER OF KITCHENS IN WHICH KITCHEN CUPBOARD AND APPLIANCE DOORS INTERFERED WITH ONE ANOTHER OR THE WORKER.

	No interference	Interference
Houses: H.C.	9	4
A	3	
B (NI)	7	5
I	8	4
Flats: H.C.	1	2
B (NI)	2	4
I		1
TOTAL NOS.	19	16

TABLE 14: NUMBER OF KITCHENS JUDGED BY THE HOUSEWIVES AS
HAVING ADEQUATE SPACE FOR FUTURE NEEDS.

	Adequate	Inadequate
Houses: H.C.	7	6
A	2	
B (NI)	4	8
I	6	1
Flats: H.C.		2
B (NI)		3
I		
TOTAL NOS.	13	13

TABLE 15: NUMBER OF KITCHENS WITH ADEQUATE TOTAL BENCH LENGTHS

	Grandjean's standards		NZS 4101	
	Adequate	Inadequate	Adequate	Inadequate
Houses: H.C.	12	1	11	2
A	3		3	
B (NI)	11	1	10	2
I	9	2	8	3
Flats: H.C.	1	2	1	2
B (NI)	4	2	2	4
I		1		1
TOTAL NOS.	29	6	25	10

TABLE 16: NUMBER OF KITCHENS WITH ADEQUATE GENERAL PRE-
PARATION AND COOKING BENCH WIDTHS

		General prep. bench				Cooking bench			
		Grandjean		N.Z.S. 4101		Grandjean		N.Z.S. 4101	
		Ad.	Inad.	Ad.	Inad.	Ad.	Inad.	Ad.	Inad.
Houses:	H.C.	2	8	6	4		3	3	
	A	2		2			1	1	
	B (NI)	1	6	3	4		3	3	
	I	2	4	4	2		4	4	
Flats:	H.C.		1		1				
	B (NI)		2		2				
	I		1	1					
TOTAL NOS.		3	19	14	8	1	7	8	-

TABLE 17: NUMBER OF KITCHENS WITH ADEQUATE SINK AND
SERVING BENCH WIDTHS.

		Sink bench				Serving bench			
		Grandjean		N.Z.S. 4101		Grandjean		N.Z.S. 4101	
		Ad.	Inad.	Ad.	Inad.	Ad.	Inad.	Ad.	Inad.
Houses:	H.C.		13	3	10		6	5	1
	A	1	3	3			1		
	B (NI)		12		12		8	7	1
	I	1	10	8	3	2	3	3	2
Flats:	H.C.	1	2	1	2	1		1	
	B (NI)	1	5	2	4	2		1	1
	I	1		1					
TOTAL NOS		3	32	14	21	4	12	12	4

TABLE 18: NUMBER OF KITCHENS WITH ADEQUATE CLEARANCES
BETWEEN BENCHES AND UPPER CUPBOARDS

	Grandjean's standards			NZS 4101		
	Ad.	Inadequate		Ad.	Inadequate	
		Too big	Too small		Too big	Too small
Houses: H.C.	6	5	1	4	8	
A	1	1	1	2	1	
B (NI)	8	4		4	8	
I	3	4	1	3	5	
Flats: H.C.	2			1	1	
B (NI)	3	2		2	3	
I		1			1	
TOTAL NOS.	15	11	2	10	18	-

TABLE 19: NUMBER OF KITCHENS WITH ADEQUATE TOE-SPACE
CLEARANCES (NZS 4101)

	Adequate	Inadequate
Houses: H.C.	4	7
A		3
B (NI)	4	8
I	1	8
Flats: H.C.	1	1
B (NI)	2	3
I		1
TOTAL NOS.	8	21