

Someone's in the kitchen

The Ergonomics of Cooking and Kitchen Design

By Tamara Mitchell



Believe it or not, ergonomics actually started in the kitchen. Lillian Moller Gilbreth was an inventor, author, industrial engineer, industrial psychologist, and mother of twelve children.¹ She patented many kitchen appliances including an electric food mixer, shelves inside refrigerator doors, and the trash can with foot-pedal lid-opener.¹ Gilbreth is best known for her work with her husband on time and motion studies. But after her husband's death, Lillian was an industrial engineer for General Electric, working on kitchen design improvements. She interviewed over 4,000 women to design the proper height for stoves, sinks, and other kitchen fixtures. Today much of the advice in kitchen design is derived from her ideas.

As with many products, kitchen gadgets and cookware products the user is often an afterthought. Architects and product designers often make functionality and aesthetics a higher priority than usability. But things are changing due to our aging population. The principles of ergonomics are rapidly rising in importance for home design in the real estate market.² There is a current shift away from treating the disabled and older people as special cases, toward integrating their needs into the design of buildings, public spaces, products and services. The term “aging in place” is a buzzword in the home design industry for people who don’t want to move away from their home, neighborhood, friends, and community as they get older. It has led to incorporating ideas that reduce sources of strain. These improvements are often very beneficial for everyone, not just seniors who want to live in their homes as long as possible.^{3,4} An entire new program in the UK is geared toward studying and implementing innovations to facilitate a healthy, active, and prosperous later life in today’s society, funded by their Big Lottery Fund.⁵



User-centered design and inclusive environments involve a whole process of observation and analysis of the users, prototyping, evaluation and iteration of the design.⁶ Crucial to this is consultation with user groups, putting people who represent a diversity of age, ability, gender and community at the heart of the design process.⁶ Inclusive environments are:⁶

- Welcoming to everyone
- Responsive to people’s needs
- Intuitive to use
- Flexible
- Offer choice when a single design solution cannot meet all user needs
- Convenient so they can be used without undue effort or special accommodations and so that they maximize independence

When looking for hazards in the kitchen environment, ergonomic risks are pretty much the same as in any other environment. Specifically, identify and avoid:¹

- Awkward postures
- Repetition
- High force
- Mechanical compression
- Extended duration of task
- Vibration
- Temperature extremes (especially cold)

Kitchen design

All residents of a home use the kitchen, so it needs to be accessible by the least able and the most able person as well as the smallest and tallest, not just the primary user.⁷ If you are remodeling your kitchen or designing a kitchen from scratch, there are many things that can improve comfort. Designing a large kitchen is just as challenging as designing a tiny kitchen, though the problems are different. A small kitchen must have very careful consideration of every element of placement, storage, and traffic flow. A large kitchen also requires careful consideration of placement to reduce fatigue from walking back and forth between work centers and storage. Even if you aren't remodeling your kitchen, there are lots of ways you can reconsider things such as storage arrangements.

Work Centers. In kitchen layout, the most basic concept is to minimize walking back and forth a lot, with clear pathways between work centers. In addition, when more than one person is in the kitchen, it's important that they don't step over each other when working. When there is only one cook, 42" is the recommended work aisle, but to accommodate two cooks, 48" is recommended.¹⁰ No major traffic patterns through the kitchen should cross through the work triangle.¹⁰ Consider each task and design work centers around them, taking into account the associated major appliance and its surrounding work area. Traditionally, the three work centers were the range, the sink, and the refrigerator and these were arranged in a triangle.¹⁰ With added appliances, the current

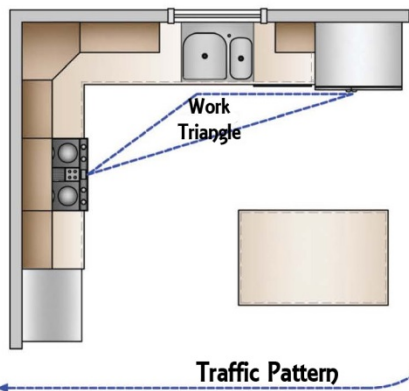
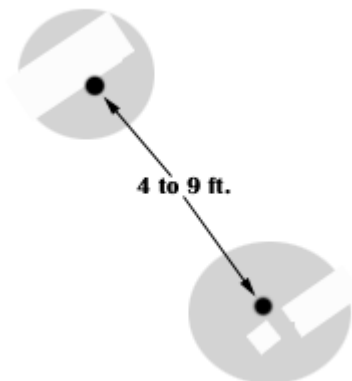


Illustration courtesy Ref. 10



kitchen can have four or more centers including the microwave, a second sink and prep area, and separate areas for the cooktop and oven.¹⁰ The distance between work centers should be more than 4 ft. but less than 9 ft. and an island or other obstacle should not intersect the path by more than 12 inches, and the sum of the three distances should total no more than 26 ft..⁹

To allow for enough space to prepare food, there should be an expanse of counter space at least 36" long and 24" deep immediately next to the sink. The latest design guidelines for accessibility recommend an expanse of 30" of continuous counter space at a height of no more than 30" with permanent or adaptable knee space somewhere in the kitchen.^{9,10} This is intended for wheelchair access, but in

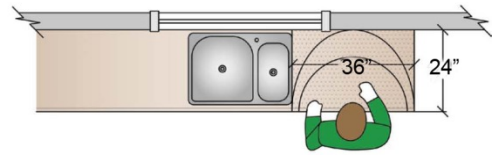


Illustration courtesy Ref. 10

allowing for a stool or chair with knee space is very welcome and rarely provided in the kitchen. Anyone with a fruit tree who has had to stand for hours peeling, coring, and paring bushels of fruit knows that providing the option to sit down would be marvelous! The work height should be higher if a stool or bar-height chair is to be used. As with most seated tasks, the height of the counter should be elbow height when sitting. Counters generally do not provide knee space when sitting.

To plan each work center, divide tasks and match them to appliance/tools/food location. If the kitchen has only one sink, locate it adjacent to or across from the cooking surface and refrigerator.¹⁰ Counter space is needed at each appliance and the width of each of these is described in detail in Reference 10 along with a host of other kitchen layout design principles. Pots and pans should not require burrowing in the back of bottom cabinets. Hang pots and pans on racks on walls or use pullout shelves near the cooktop or range. Heavy mixers and other large heavy items should not require lifting from below or above, and should not require carrying and significant distance to avoid back and shoulder strain. Heavy items should be stored between hip and shoulder height to avoid strain and over-stretching.¹⁰

There are a couple of ways to think about storing dishes, glassware, and flatware. They can be stored near the dishwasher or sink so it is easy to put them away when unloading the dishwasher or drainer. Hopefully this isn't too far from the table, where they will be used to set the table. Storing dishes at the sink area requires fewer trips when serving plates unless there are many people to be served at once and it reduces the likelihood that putting clean dishes away becomes a chore. Dishes could be stored near the stove if you serve plates at the stove. This alternative is more likely to mean many trips across the kitchen when unloading the dishwasher/drain.

Sink/Dishwasher Food Prep Work Center

- Cutting boards
- Knives and peelers
- Collander
- Compost container



Photo courtesy Ref. 11

A prep center at the sink includes a pullout faucet, easy access to knives, cutting boards, and colanders.

This is a clever way to allow easy disposal of compostables. It would have been better to cut the hole farther back so the surface nearest the edge can be used for cutting and the waste can be scraped toward a hole at the back of the board.



Oven/Baking Work Center

- Mixer
- Bake ware
- Flour, sugar, spices
- Measuring cups and spoons



Image courtesy of Ref 12

These are great ways to store baking pans, racks, measuring cups, and spoons, with easy reference to measuring conversions. It allows for quick, efficient access to things without stooping over or noisy, frustrating digging through drawers or cabinets. The measuring equipment storage makes use of the back of a cabinet door in the baking center.



Photo courtesy of Ref. 13

This cupboard is deep enough to include a counter for mixing. The heavy Kitchen Aid mixer doesn't need to be lifted or moved. All baking spices, flours, sweeteners, and leavenings are stored on the narrow shelves above. What would make this even better would be drawers for quick access to utensils and measuring equipment. Roll-out drawers in the cabinets below could store bakeware.

Spices are more often used in baking than in cooking at the stovetop, so storing them in the baking center makes the most sense. Herbs are used more frequently in cooking, so they can be stored near the cooktop. If some spices or herbs are frequently used at the stove also, duplicates can be stored at each work center.

Stove/Cooking Work Center

- Spatulas and cooking utensils
- Herb and seasoning storage
- Oils, beans, pastas, onions, garlic
- Canned foods
- Pots and pans



Photo courtesy of Ref. 14

Herbs, oils, and dry foods need to be stored near the cook top, but away from heat and moisture. A well-organized pantry or cupboard next to the cook top provides easy access while cooking.



Picture courtesy of Ref. 15

A corner lazy susan allows for easy access to pots and pans near a cook top.



Photo courtesy of Ref. 16

Even in very small kitchens, pans, lids, utensils, and frequently-used items can be stored close at hand.



Photo courtesy of Ref. 17

This counter top incorporates knife storage, with a jar for frequently used utensils and cutting board quickly accessible while cooking.

Cabinet storage. Cabinet shelves should be replaced with roll-out trays, especially for stationary bottom cabinets.¹⁸ Lazy susans or swing-outs are best for corner cabinets which tend to be inaccessible.¹⁸



Photo courtesy of 19

Replace cabinet knobs with pulls that are easier to grip.¹⁸



A rolling cart can provide storage of equipment used in more than one work center as well as a work and cutting surface that can be moved around the kitchen as needed to avoid multiple trips between work centers.

This rolling cart from Catskill Craftsman (<http://www.catskillcraftsmen.com>) has shelves for pots and pans or bowls, a drawer that can be used for utensils or knives, a thick butcher-block cutting board top surface, and a towel rod on either end. Food prepared at the sink can be easily rolled to the stove for cooking.



Work surface height and design. Standard counter heights in kitchens and in pre-made cabinets are 36".²⁰
²¹ This is not always the best height for all tasks or for all people, but it is often the best compromise.²⁰

To accommodate the different tasks to be performed in the kitchen and the people of different heights doing them, counter surfaces may either be adjustable or built at various heights.^{22,23} Proper work surface height minimizes excessive forward bending and shoulder elevation.²² For tasks requiring close visual inspection, position the surface height so that hands are slightly higher than elbow height and below shoulder level.¹⁰ For most tasks, the work surface should be slightly below elbow height.¹⁰

Work requiring force, such as kneading bread, rolling dough, or cutting bones, should be done on a surface that is below elbow height unless close inspection is required.²² Adjustable height cooktops, sinks, and cupboards are needed to accommodate wheelchairs or an extremely wide range of user heights.



Photo courtesy of Ref. 24



Photo courtesy of Ref. 25

There are different ways to accomplish a lowered surface for tasks such as rolling and kneading. The custom-built counter above or the pull-out cart shown at left are both effective. The cart has knee space which would allow it to be used in seated tasks.

A cutout design is very useful. It allows a person to get closer to the work at hand without reaching (see illustration at right) and it allows placement of tools and equipment closer to the user. This is rarely used in kitchen design, but it is recommended by OSHA for workers in the poultry processing industry and it would be easy to incorporate in a custom counter or work surface. If a disposal hole is cut out so trimmings can be swept into an under-counter garbage container, the surface is even more effective in eliminating awkward postures.²² Clipped or rounded edges on all counters are much safer than sharp edges.²²

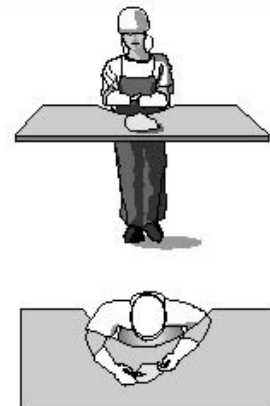


Illustration courtesy of OSHA²²

For wheelchair access or to accommodate smaller than average users, a height adjustable counter mechanism can be added to surfaces including those with sinks or cooktops. This mechanism can be mounted on a worktop with a width of 22" to 24" deep. Height is adjustable approximately $\pm 8.5"$.



Photos courtesy of Ref. 26

Kitchen designers do not generally design either breakfast bars or prep stations that feature footrests or seated workstations. Breakfast bars are generally too high to work well for food prep work because they are above elbow height when seated on a bar stool. This was about the only photo we could find showing a cabinet with custom chair pullout at the counter. It is time to bring this idea back into today's kitchens!



Photo courtesy Ref. 27

Chairs/stools. A chair used during seated tasks in the kitchen should be adjustable so that all people who use the kitchen can be accommodated.²² If using a stool or bar-height chair, there should be a footrest surface in front of the chair that will prevent the legs from being bent at an oblique angle which can cut off circulation to the lower legs (as when resting on a foot ring on the chair). Armrests are not appropriate for a chair used for kitchen use. If height adjustability of the chair is not provided, provide footrest surfaces at a couple of different heights to accommodate users with different leg lengths.²² An adjustable back rest should support the upper and lower back with its natural curvature.²² In a search online, there are virtually no bar-height chairs or stools with all of these features, especially considering that upholstery needs to be cleanable with a sponge or cloth due to food spills. It is not a perfect world, so try to find a stool that you find very comfortable. Rather than simply shopping for looks try to find at least some of these features along with creating a seated work area that will enable you to work comfortably while paring all those apples or making won tons!



Photo courtesy of Ref. 28

Floors. Prolonged standing on hard surfaces can create contact trauma and pain in the feet and legs. Static postures cause blood to pool in the lower extremities, resulting in muscle fatigue and pain. Cooks often stand in one position while cooking or preparing food. Avoid static postures by continually changing your position. Use a foot rest or a stool to help alter your posture, resting one foot and then the other.²³

A cushioned floor surface such as cork, wood, rubber, linoleum, or vinyl is best, and it minimizes breakage when things are dropped.¹⁰ Avoid the use of terra cotta, stone, or ceramic tile.¹⁰

Use anti-fatigue mats or cushioned rugs at areas where standing is common, such as at the sink, the stove, and at the prep station to increase blood flow to



Photo courtesy of Ref. 30

Cork, shown above, is a beautiful, resilient surface that is impervious to water and lasts virtually forever once sealed.

Wear comfortable, cushioning shoes when you know you'll be standing in the kitchen for a long time.^{7,23}

the feet and to reduce fatigue.²² Area rugs and anti-fatigue mats are not practical when the kitchen is to be used by someone with a wheelchair.

Lighting. In addition to general lighting, every work surface should be well illuminated by task lighting.^{2,10,31} Lighting from any source will cast shadows and produce glare on shiny surfaces, which can reduce the visibility of the task and cause eye strain. Have several sources of task lighting to ensure that your hands or other objects don't shade your work.

Be careful about using clear light shades and bright exposed bulbs. They can be a source of eye strain for anyone who looks at them.



Photo courtesy of Ref. 33



Photo courtesy Ref. 32

Natural lighting as shown above from windows or skylights is preferable to artificial light in the daytime. Indirect lighting, light that is bounced off the ceiling and walls, is one of the best ways to provide general ambient lighting in a room when natural lighting is not possible.



Photo courtesy Ref. 34

Controls, reaching, operable parts.

American National Standards Institute provides the rules for operating controls and reach parameters. These are:³¹

- Operable parts should be operable with one hand and not require tight grasping, pinching or twisting of the wrist. The force required to activate operable parts should be 5 pounds maximum.
- Where a forward or side reach is unobstructed, the high reach should be 48" maximum and the low reach should be 15" minimum above the floor.
- Where a forward or side reach is obstructed by a 20" – 25" deep counter, the high reach should be 44" maximum.

Minimize reaching by organizing your work environment so that most cooking processes can be completed within easy reach while keeping your elbows close to your body.²³ Place most commonly used tools within easy reach.⁸ Assemble all ingredients and utensils needed before cooking near the work center, similar to preparing a lab for an experiment.

Use a stepstool to avoid reaching above shoulder height or if you are remodeling and installing cabinets that extend to the ceiling, you might consider pullout steps in the toekick area.^{22,35}

Rules for Tools

To reduce the risk of injury, follow these recommendations when buying and using tools.

1. Use proper tools for the job.
2. Keep shears and knives sharp.
3. Use choppers, processors, and blenders to reduce repetitive motion and force.
4. Try oversized molded and padded grips on knives and other tools to reduce hand fatigue. However, if these alternatives are not easy to grip and hold, use a tool that fits your hand.
5. Angled and pistol grip handles on knives are advised for cuts made with a downward stroke. Such knives keep the wrist in neutral while allowing for sufficient downward force to make a smooth cut. Easi-Grip knives and tools manufactured by PETA (UK) allow the hand, wrist, and arm to be in a neutral position while cutting and chopping with a pistol grip non-slip handle. Available on eBay.com.



Image courtesy of PETA-uk.com



Good: Neutral Wrist

Inline handles are best when the food is resting flat on a tabletop and the cut is to be made parallel to the surface.²² Keep your wrist straight in all directions and hold the knife with a moderate grip.



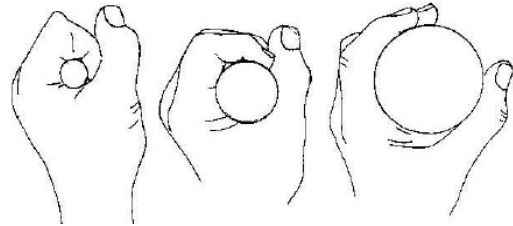
Wrong: Bent wrist

Most knives are inline knives. Please be aware of your wrist angle and the grip on the handle when you are cutting and chopping!

6. Handles on tools should: ^{22,36}

- be perpendicular to the line of action.
- be as long as the length of the palm and extend the entire length of the hand.

- have a non-slip surface, especially when hands are wet.
- be thick enough to allow a power grip, but not too big for smaller hands nor too small for larger hands.
- prevent the transmission of cold, heat, and vibration to the hand and wrist.
- be textured to improve grip and hand force.
- be washable in warm water to remove slippery grease which requires increased force to grip the tool.



Power Grip sizing

Illustration courtesy of Ref. 36

7. Avoid tools with form-fitting ridges for fingers on the handle unless they fit your hand perfectly. People with larger hands find that their fingers overlap the ridges causing pain, soreness and calluses. People with smaller hands have to spread their fingers to match the grooves.

8. Keep finger pinch to a minimum, especially for repetitive work.²²

9. Heavy tools and cookware should have two handles.²²

10. It is important to choose tools that minimize force and strain. Zyliss and OXO are two brands that have applied ergonomics principles in the design of their kitchen tools and gadgets. There are many useful tools to reduce strain in the kitchen on the website Elderlux.com.

(<http://www.elderlux.com/home-comforts/kitchen-accessories-for-seniors/>)



The Beak Ice Cream Scoop

Thin pointed tip allows digging straight forward with a straight wrist and using the large muscles of the arm.

Release ice cream with the press of a button.

Photo courtesy of OXO

Reference material. Cooking and baking often require referring to recipes. Whether you refer to a cookbook, a printed recipe, or an electronic device, a stand or holder of some type will keep the recipe at an angle and distance that is comfortable to read. You can refer to any of our notebook stands or you can seek out a holder or stand that is specifically made to hold a book and/or tablet. The stand at right is sturdy enough to hold a large cookbook with tabs to keep it open at the right page, it's able to hold a tablet in either vertical or horizontal orientation, it has a notch at the bottom for a power cord, and it folds up flat so it can be stored on your cookbook shelf. If you refer to a printed recipe, you can even mount a clip on the outside of a couple of kitchen cabinets that can hold the recipe at eye level or mount a cork board on the inside of a cabinet to hold recipes and notes as shown below.



Photo courtesy of JosephJoseph.com



Picture courtesy of Ref. 37



Picture courtesy of Ref. 38

CONCLUSION

Arranging your current kitchen or incorporating "inclusive design" principles into a new design is important to enable accessibility to the kitchen for all residents of the home. The kitchen is full of potential sources of strains, repetitive motion, force, and awkward posture, especially if you are a "non-standard" sized person or if you have already overworked certain body parts during the day at work. Making the kitchen fit you, using tools that fit you, reducing potential causes of strain, and following these suggestions to reduce awkward postures, stresses and fatigue will help you to cook comfortably.

This article and all of our articles are intended for your information and education. We are not experts in the diagnosis and treatment of specific medical or mental problems. When dealing with a severe problem, please consult your healthcare or mental health professional and research the alternatives available for your particular diagnosis prior to embarking on a treatment plan. You are ultimately responsible for your health and treatment!

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