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Modular co-ordination cuts design and building costs

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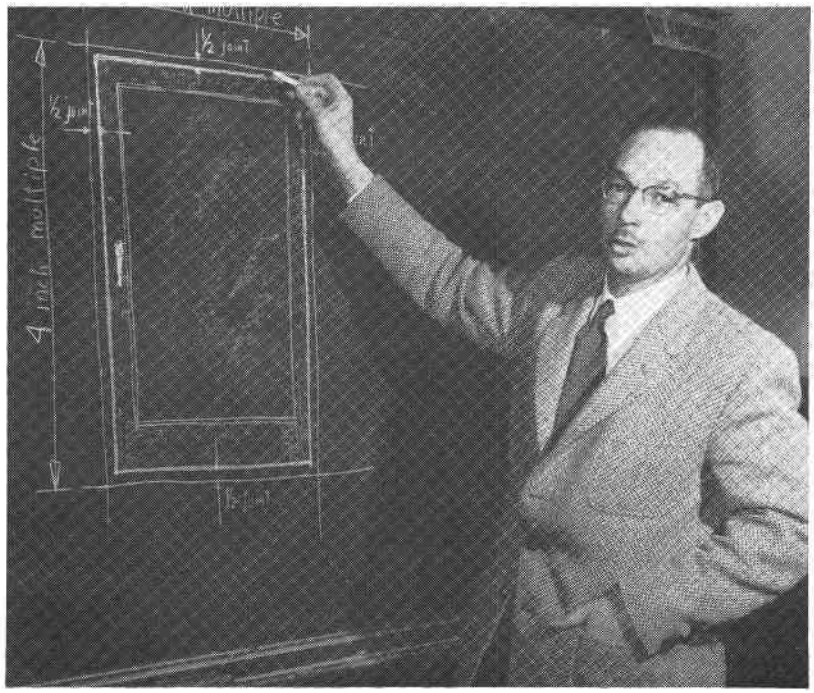


Architect Kent (r) is modular co-ordination's staunchest campaigner in Canada. He is modular consultant to Ottawa's Div'n. of Building Research, has organized a modular exhibit which DBR uses at trade shows. And he regularly carries the cause to architectural and building conventions (the latest: CCA's annual meeting in Montreal this month).

Geoffrey Frazer

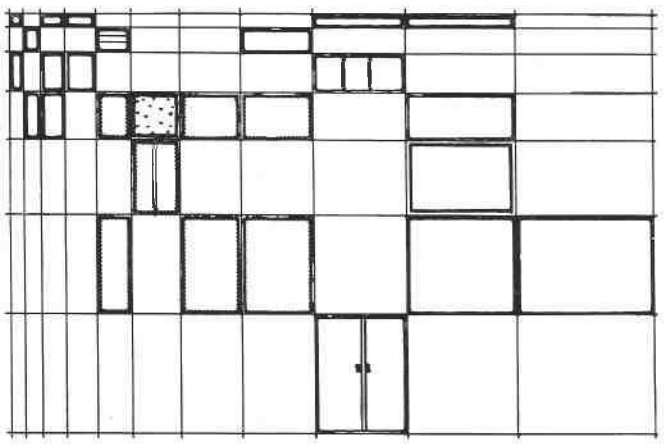
Modular co-ordination cuts design and

by Prof. Stanley R. Kent,
School of Architecture, University of Toronto.

SURELY EVERY BUILDER looks to the day when he can pick up the telephone and order any common building component, knowing that is a stock size and that it will fit with other components in his building. And surely every manufacturer in the building industry looks to the day when he can stabilize his production by not having to make a large variety of sizes for common building.

Unco-ordinated Components

The reason why this is not so today is that the building industry originated with the master craftsman, traditionally a fitter of components. Since site cutting and fitting has been the accepted way, manufacturers size components to suit themselves. When glass was relatively expensive and difficult to cut, it was supplied to window makers in round inch sizes. They sized their millwork to avoid cutting glass. So sash, frame and ultimately wall opening were all fixed by glass size. The result: no relationship to natural brick openings.



Modular range of components in which size of any single component or sizes of components in any single range are part of a co-ordinated range of sizes. The framework results from compounding of modular sizes arranged horizontally and vertically.

What are the natural brick openings? Clay bricks were first sized to suit a mason's hand grip and lift. But hands seem to be changing. First North American bricks followed the English 3″ x 4″ x 9″ size; today's are one third smaller. And Ontario bricks, for reasons unknown, are between the two. So there are many natural openings, and much cutting and fitting.

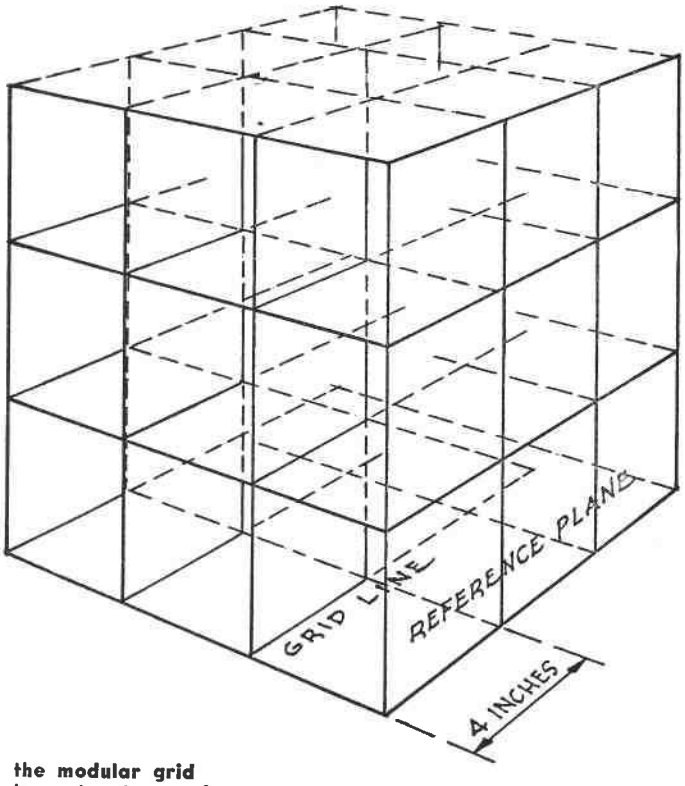
In the lumber industry, plywood appears to derive its 4' size from the logger's cord. The unusual size of American glazed ceramic tile, 4¼″ x 4¼″, has been obtained from placing a square diagonally within a 6″ x 6″ square. The only advantage claimed for this size is that only eight tile are required to set up a square foot rather than nine of the 4″ x 4″ English tile.

Many stock sizes of insulating glass, made by one Canadian manufacturer, have come from large orders of a window manufacturer for units to fit his patented wood sash and frames. The frames derived their sizes from the standard American brick. Here was co-ordination, but its application was restricted to patented sash and American brick.

These few examples demonstrate that no consideration is given to establishing a pattern of sizes that will assist the builder in adding components together without unnecessary cutting or fitting. The only way this problem has been *simplified* is by providing an ever increasing range of sizes for playing a selection game.

Some definitions :

Standard modular space grill : a reference space grid with planes spaced at the standard module of 4". ***Standard modular component*** has standard or specified dimensions which, when used with its joint fits the standard modular space grid. ***Manufacture dimension :*** manufacturer's catalog dimension may deviate within specified limits due to uncontrollable factors in manufacture. It's set out on drawing with understanding that deviations will be taken up by the joint. ***Standard modular dimension :*** (a) dimension used once or repeatedly is a multiple of standard module of 4". (b) sum of a manufacture dimension and joint. ***Deviation :*** the difference between an actual dimension, and the corresponding manufacture dimension. Difference may be positive, negative, or zero. ***Limit dimension :*** maximum permitted oversize dimension (upper limit), or undersize dimension (lower limit), relative to manufacture dimension. ***Tolerance :*** difference between permitted oversize (upper limit) and permitted undersize (lower limit).



the modular grid
is an imaginary reference space grid with planes spaced at the standard 4" module. A modular component, plus its assembly joint, exactly fits the grid, never creeps out of position in it.

building costs

It is most apparent, therefore, that if the building industry is going to improve in efficiency, a method must be established for sizing *all components in building*. The method should (a) ensure dimensional fitting together for erection simplicity, (b) provide scope for a variety of arrangements for good planning and design, and (c) put a limit on the range of sizes for economical manufacturing.

These are the factors which have been considered by many organizations throughout the world; the American Standards Association; the Manufacturers' Association of Sweden; the British Standards Institution; and other groups in 12 countries participating in a joint project on modular co-ordination.

Modular Range of Sizes

For adding components together, there has to be a common denominator, such as 4′, 2′, 6″, 1″. But if this denominator is large, say 4″, and this is applied to all components in their three dimensions, imagine how wasteful of space and inflexible would be the planning and design. If the denominator is small, say 1″, then there still exists a large range of possible sizes. After much experimentation and investigation, the dimension of 4″, has been agreed on as the most suitable for all purposes in building.

With this as the denominator, repetitive interval, or *module*, a range of sizes for components can be set up by having horizontal and vertical dimensions multiples of this module. The application of this range of sizes, enabled American metal window manufacturers to reduce the number of window sizes from 30,000 to 300; Italian manufacturers of prefabricated residential floor joists to reduce dimensional variety from 46 types to 7 types; and a Canadian manufacturer of precast sills to cut production costs.

Modular Components

Establishing a range of sizes is the first step. Then, remembering that it is *installed* components which are being added together, consideration must be given to the assembly joint. It is the component size, plus the joint size, which must add up to the modular size in the range. No component, therefore will have actual measurements of 4″ multiples, such as 32″, but rather 32″ *minus the joint for common installation,* unless the joint is an interlocking type like tongue and groove. *By establishing this standard, the builder can order modular components in 4″ multiples and know proper allowance has been made for the installation joint.*

Co-ordination : U.S. and Sweden

With such a rational system having been worked out, one may ask why it has not been picked up by all big industries, especially in the U. S. where the system originated. But it was only in 1936 that Mr. Bemis put forth the idea; 1941 when modular standards on masonry were published by the American Standards Association; and the war and post-war years created such a competitive race for expansion that manufacturers would not stop to change sizes.

In spite of these facts, the building industry, one of the nation's largest and widespread over the entire area of Canada, has made great strides toward co-ordination. Greater headway, however has been made in smaller countries; notably Sweden. Here manufacturers banded together and co-ordinated over 100 of the common building components —windows and frames, doors and frames, kitchen cabinets and counters, mechanical and electrical equipment, and masonry. A 10 centimeter (3 15⁄16″) module is used.

Canadian co-ordination

In Canada, the conditions for co-ordination in building are among the most favorable in the world. Here's why:

1) The 4" modular system has been proven in Canadian, American and European building, as the best method.

2) The geographical distribution of the major building activity is confined to eight distinct localities and so communication and organization for a change-over are greatly assisted.

3) The modular concept is being accepted by a growing number of companies, both Canadian and U.S. subsidiaries.

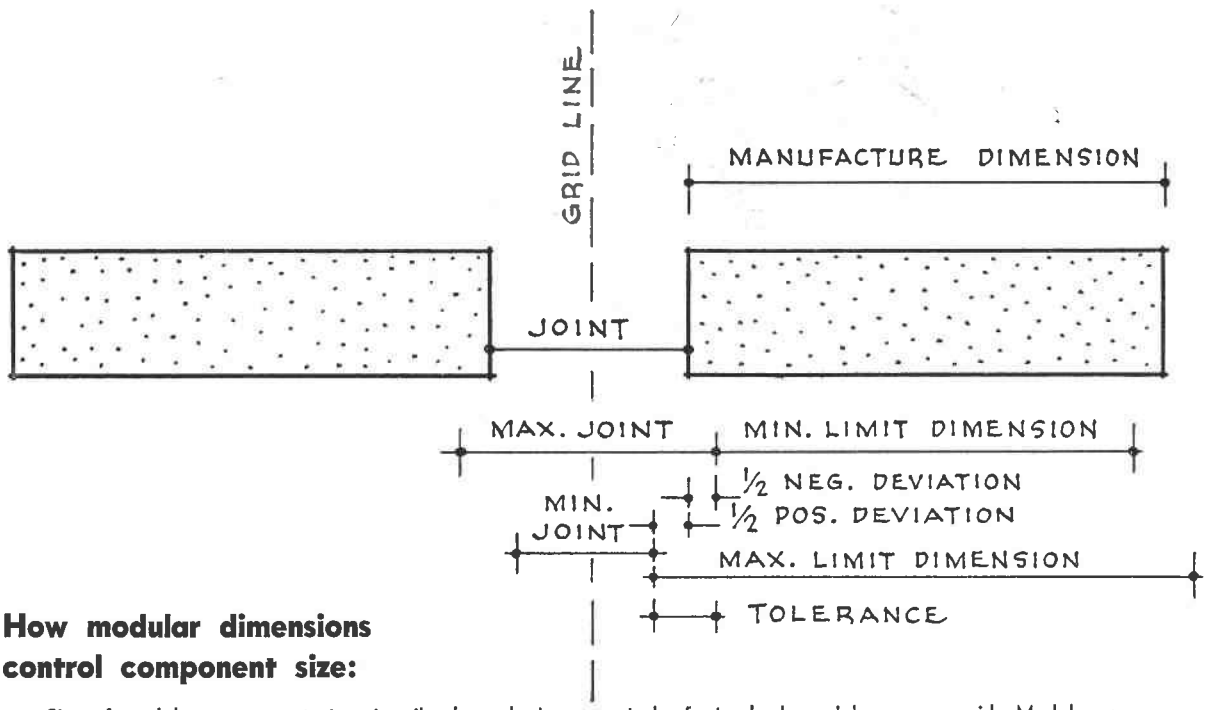
4) The 'most-repeated' components, masonry bricks and blocks, are lacking Canadian standards for sizes, and as many manufacturers are now seeking standard sizes, the way is clear to adopt modular.

Within the last year, three large, clay brick manufacturers have begun producing modular units, and there are indications that others will soon follow.

Should you or shouldn't you ?

If you are a builder and wonder whether or not you should jump into modular co-ordination, then consider these easily hidden factors which run up your building costs. Do the bricks you're using, which because of their size are fewer per sq. ft. of wall to buy and slightly less to lay than a smaller modular unit, cause many fractional dimensions for openings and increased costs in purchasing and installing windows, window sills, doors, and milk boxes ? Do you find costly job errors result from the use of fractional dimensions ? Do you find excessive waste from cutting materials to make them fit ? Do you look to the day when you can order any common building component and know it is stock size which will fit with other components ? *Then ask for modular dimensioned components from your supplier.*

If you are a manufacturer, then consider these factors. Can you use your machines for long production runs, or perhaps continuous production, or are they being used as large and expensive hand tools ? Do constant changeovers to different sizes cause delays in deliveries ? Is the next new size going to be a 'white elephant' as it is 'unfitable' ? Are you looking for storage space to keep your multiplying number of sizes ? Are your inventory costs rising ? Do you look to the day when production will be stabilized ? *Then make your components modular to a modular range of sizes.*



How modular dimensions control component size:

Size of modular components is primarily dependent on control of standard modular space grid. Modular components are of modular dimensions such as 8 by 8 by 16", 2⅔ by 4 by 12"; 5⅓ by 4 by 8"; 48 by 96 by 1". Fractional dimensions are modular because they fit a multiple of 4", i.e., 16".

In every case, modular dimension includes size of component and its joint. Therefore, component size and joint size must be worked out together so the sum does not exceed modular dimension.

Having determined desirable modular dimension for a component, assume a manufacture dimension and a joint dimension. I. E.: a standard modular component of modular dimensions 8 by 8 by 16" may have a manufacture size of 7⅝ by 7⅝ by 15 5/8" and a joint of ⅜"; or a standard modular component of modular dimensions 48 by 96 by 1" may have a manufacture dimension 47 15/16 by 95 15/16 by 1" with a joint on two sides of 1/16" and a joint of 0" on the third.

Next consideration is feasibility of accurately maintaining manufacture size in manufacturing component, and what deviations from manufacture dimension is reasonable practice consistent with quality manufacture, bearing in mind that as manufacture dimension is increased joint dimension must be decreased (as their total must remain the same) and, likewise, as manufacture dimension is decreased joint dimension must be increased.

If, for example, permitted tolerance is plus or minus ⅛" in 7⅝ by 7⅝ by 15 15/16" unit, upper limit would be 7¾" with joint becoming ¼"; lower limit would be 7½" with joint becoming ½".

Manufacturer must now decide whether tolerance of ¼" in manufacture dimension causing a 50% variation in the joint size, is good practice for assembling of the product, then vary the assumed manufacture dimension or deviations accordingly.