A Life Cycle Assessment: Comparing Fixed and Modular Structures. The right thing to do—environmentally speaking—can also be the smart thing to do—operationally and financially speaking. That is the conclusion of a life cycle assessment that compares the environmental impact of two interior buildout options.

The first option consisted of fixed casework combined with architectural walls. Both elements involved the construction of permanent, built-in millwork and steel-stud-and-gypsum-board walls.

Researchers compared the first option against a second that consisted of modular casework and modular walls. Once assembled, these elements have the appearance and performance of permanent construction, but they can be rearranged without the waste and mess of demolition.

In contrast to other similar studies, this research measured the effects of these two approaches on

- Global warming potential,
- Primary energy demand, and
- Waste generation.

While total cost of ownership typically considers purchase cost along with the ongoing cost of operations and utilities, this life cycle assessment (LCA) considered something else: the impact on the environment of producing, installing, and reconfiguring or replacing casework. It looked at multiple aspects of the product's impact, from raw materials to manufacturing processes. In addition, it considered the waste generated from manufacturing, construction, and demolition.[1]

The assessment also took into account the impact to the environment on an ongoing basis. What impact does casework have over time, and how might renovations and reconfigurations, for example, affect waste and energy consumption?

Data for the assessment was gathered from a number of sources. The model for the LCA calculations is Bluewater Health, a hospital organization in Ontario, Canada. This hospital organization is undergoing a significant construction project, combining two facilities under one roof for a total of five floors of new construction and five floors of renovation to the existing facility. Like a growing number of healthcare organizations, this hospital counts environmental responsibility among its core values. Such organizations have come to understand that a sustainable approach also impacts financial results. Yet making a quantifiable case for instituting sustainable practices has been difficult.

Bluewater Health wanted an objective accounting of the environmental impact of its purchasing decisions and ongoing operations related to casework. The hospital will also be applying for silver LEED certification, so this data will be important through the submittal process. The analysis will be helpful, as well, for other organizations considering LEED points and certification.

An independent research firm was engaged to conduct the LCA. The firm's researchers used installation measurements for the modular casework and modular walls based on existing energy records and product specifications. Fixed casework statistics were compiled from a database of information on materials. These statistics included details such as costs of materials and construction and installation energy requirements.

The researchers then created the LCA model with a proprietary software system, which assesses the cradle-to-grave environmental life cycle impact.

Facility Layout and Scope for the Life Cycle Assessment

The blueprints, specifications, and interior construction figures for the hospital became the basis for the buildout scenarios. These included the following:

- Exam rooms—246 treatment, isolation, and procedure rooms, each with similar functions and product layout
- Interview rooms—77 consultation, dictation, social work, assessment, and work rooms, each with similar function and product layout
- Nurse reception—46 registration areas
- Nurses' stations—38, with different product and layout from nurse reception areas
- Pharmacy—1 large pharmacy
- Laboratory—1 large lab and 5 satellite stations
- Walls—6,117 linear feet, used in multiple areas

Rates of change were measured using three different scenarios: conservative, mid-point, and observed. Casework and walls have a high replacement rate in healthcare applications, so three scenarios were developed to determine additional materials required and waste generated during remodeling and replacement. The scenarios include a range of replacement rates over a twelve-year time span, from slower change rates to more rapid replacement rates.

Observed change rates are based on client experiences and field research. These change rates were reinforced by the experiences of the VP of Redevelopment at Bluewater Health. The conservative change rates were based on the minimal amount of change a hospital would make. Not all healthcare facilities change things as often as our observed rates suggest, particularly facilities built with fixed millwork and conventional walls.

All three scenarios were used to measure material replacement, global warming potential, energy consumption, and waste generation over a 12-year span. (See figure below.)

	Conservative Replacement Scenario		Mid-point Replacement Scenario		Observed Replacement Scenario	
	Casework	Walls	Casework	Walls	Casework	Walls
Year 1	5%		5%		5%	
Year 2	2%		2%		2%	
Year 3	2%	15%	2%	15%	2%	15%
Year 4	2%		2%		2%	
Year 5	20%		35%		50%	
Year 6	2%		2%		2%	
Year 7	2%	25%	2%	25%	2%	25%
Year 8	2%		2%		2%	
Year 9	2%		2%		2%	
Year 10	60%	50%	80%	50%	100%	50%
Year 11	2%		2%		2%	
Year 12	2%		2%		2%	

Casework: Initial Buildout Comparison

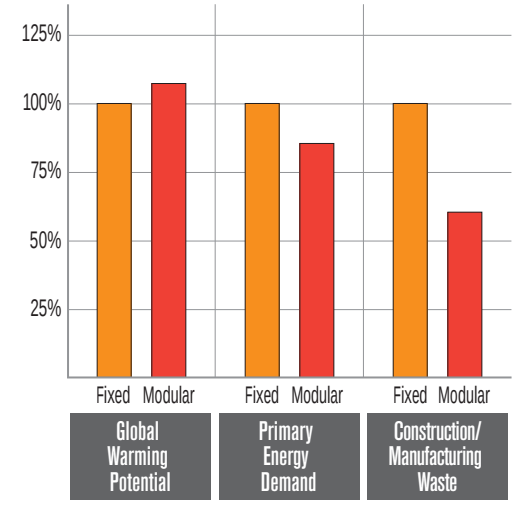

Figure 2

Casework: Global Warming Potential

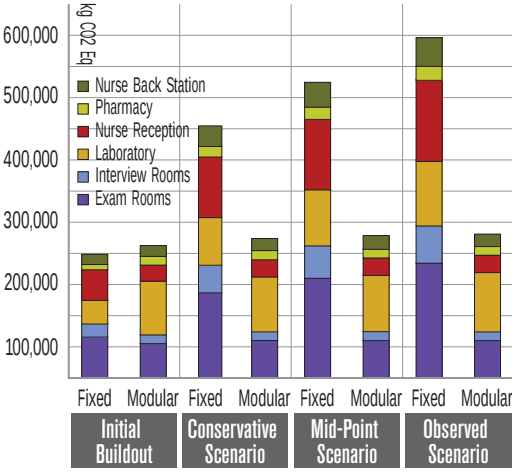

Figure 3

Casework: Primary Energy Demand

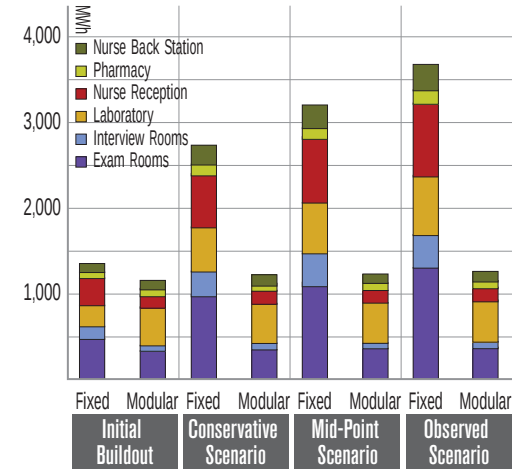

Figure 4

Comparing the Impact of Fixed and Modular Structures on the Environment

Researchers analyzed three key areas of modular (modular casework and modular walls) and fixed (millwork and fixed walls) structures. Each area relates to the effect of these structures on the environment.

1. Influence on climate change using global warming potential (GWP) as an indicator.
   - Measures greenhouse gas emissions, such as CO2 and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, magnifying the natural greenhouse effect. Measurement unit = kg CO2 equivalent (1 kilogram = 2.2 pounds).

2. Energy use using primary energy demand (PED) as an indicator.
   - Measures total amount of primary energy extracted from the earth, including petroleum, hydropower, and other sources, needed to produce the materials and manufacture them in their final form. Takes into account the efficiency of electric power and heating processes. Measurement unit = MWh (megawatt hours).

3. Waste using construction/manufacturing waste (C/MW) generation as an indicator.
   - Measures waste generated during materials production, construction, and demolition. Measurement unit = kg (1 kilogram = 2.2 pounds).

Finding #1—Impact Is Similar at the Outset, Then Diverges

At initial buildout, environmental impacts are similar for both modular and fixed casework.

Yet over their entire life cycle, modular casework and modular walls contribute less to climate change, primary energy consumption, and waste generation when compared to the impact of fixed casework and architectural walls. (See figure 2.)

The initial installation of modular casework generated slightly more GWP than fixed millwork. This is due to the material makeup of modular products, primarily higher levels of plastic and steel than fixed casework, which uses more wood. Within the first year, however, fixed casework surpasses modular casework in its GPW impact.

Approximately 205,000 kg of CO2 equivalents are emitted from modular casework at initial buildout. Just slightly less than 200,000 kg of CO2 emissions are emitted from fixed casework. Contrast that initial comparison at 12 years: CO2 emissions from modular casework have remained fairly static from initial buildout and are measured at approximately 220,000 kg of CO2 equivalents; fixed casework is measured at approximately 540,000 kg of CO2 equivalents, two-and-a-half times its initial measurement.

Primary energy demand represents the amount of energy consumed to produce the materials and manufacture them in their final form. The PED, for example, considers

Casework: Construction/Manufacturing Waste

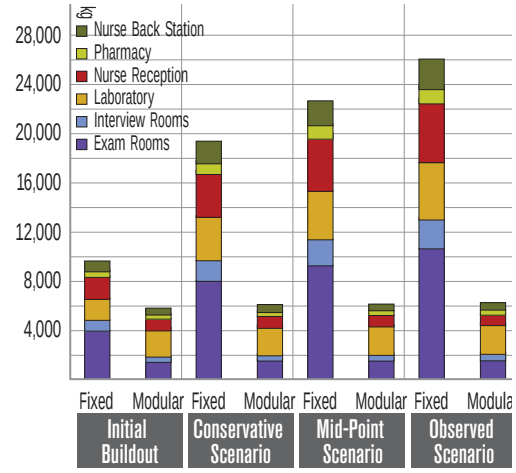

Figure 5

Casework: Remodel Waste/Reuse

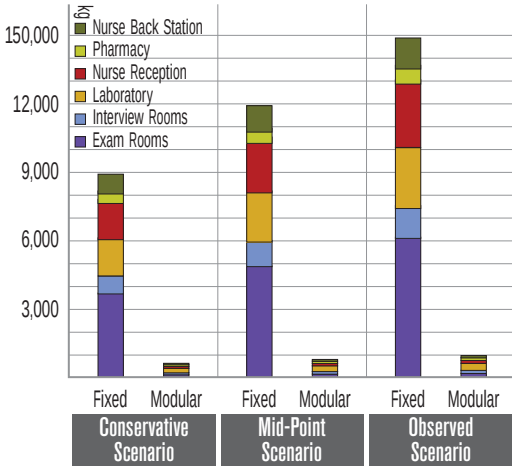

Figure 6

Observed Material Replacement Scenario Over Time

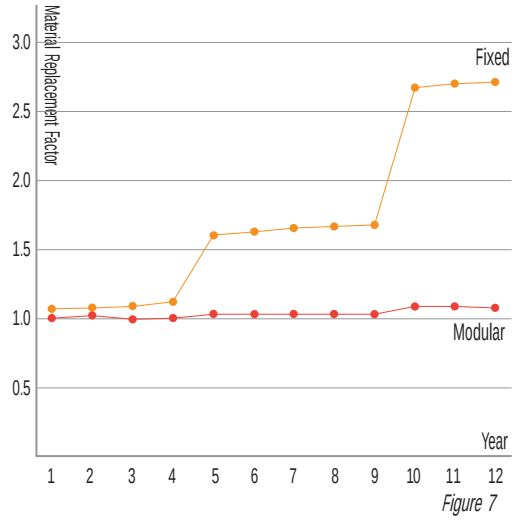

Figure 7

the energy associated with wood, from growing trees to processing the wood. PED measures both fossil and renewable primary energy.

Modular casework always consumes less primary energy, from the initial buildout through year 12 and for all replacement scenarios.

Waste generation measurements considered construction and manufacturing phases as well as remodeling of the hospital. This assessment shows the advantage of modular casework over fixed: Since modular casework is 95 percent reusable, remodel waste is negligible. On the other hand, 100 percent of fixed casework must be replaced.

The conservative scenario measures remodel waste of modular casework at approximately 5,000 kg. By comparison, remodeling fixed casework results in nearly 90,000 kg sent to the landfill. Construction/manufacturing waste is significantly different between fixed and modular casework. The conservative scenario measures approximately 6,000 kg of modular casework waste versus approximately 19,500 kg of fixed casework waste.

The accompanying charts break down the environmental impact by specific areas. The size and materials required for the laboratory represent the largest portion of modular casework to GWP, PED, and C/MW, while exam rooms for the fixed millwork contribute the largest portion of GWP, PED, and C/MW. (See figures 3-6.)

Finding #2—Product Replacement Yields Dramatically Different Results

Consideration of product replacement yields dramatically different results when comparing modular to fixed casework. Modular casework is reusable, keeping product replacement low and landfill waste to a minimum.

Because modular casework is reusable, only a small portion—5 percent—of new product is required during replacement. The same is not true for fixed casework: 100 percent must be replaced, and 100 percent of the discarded product becomes landfill waste. Material replacement is a significant factor in the life cycle assessment of the two approaches in this study. The following chart highlights the difference in material replacement over a 12-year period. (See figure 7.)

Because fixed casework cannot be reused, 100 percent of it must be replaced for new construction or any renovation, large or small. From an environmental perspective, that means that 100 percent new products must be produced, impacting raw material demands and energy consumption. It also means that 100 percent of the discarded product will end up in a landfill.

By contrast, modular casework is highly reusuable. Over a 12-year period, modular casework will use up to 151 percent fewer materials than fixed casework, primarily because new products don't need to be produced.

After only five years of use, a significant replacement increase occurs with fixed casework.

Walls: Initial Buildout Comparison

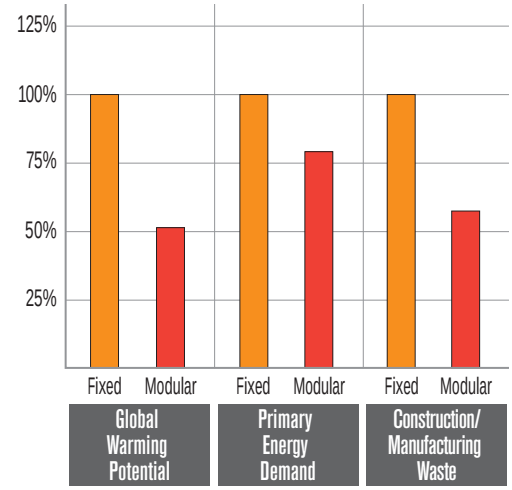

Figure 8

Walls: Global Warming Potential

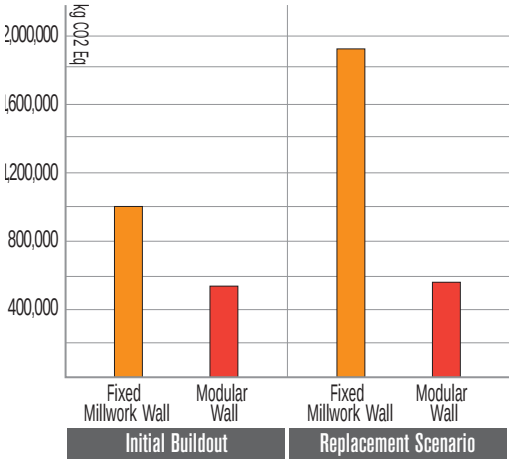

Figure 9

Walls: Primary Energy Demand

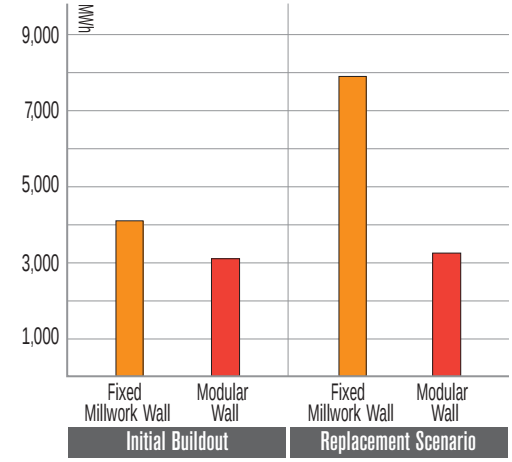

Figure 10

A similar jump occurs at the 10-year point. The modular casework, on the other hand, stays relatively stable, requiring only a five percent replacement of product over the 12-year span.

Finding #3—Fixed Walls Have a Greater Environmental Impact

Both modular and architectural walls had the largest overall environmental impact on the hospital buildout in this study.

However, modular walls have less impact in all environmental categories compared to the steelframe-and-gypsum-board walls. Modular walls account for significant reductions in waste and significant increases in change without product replacement. In addition, the construction downtime in renovating spaces with architectural walls is considerable. (See figure 8.)

The amount of modular walls specified for Bluewater Health is significant: 6,117 linear feet. This makes a compelling argument for using modular walls when environmental impact is considered. Even a hospital that uses half as many feet of modular walls will realize a positive environmental impact.

The differences between the two wall approaches increase when replacement scenarios are considered. In all cases, the impact of modular walls from initial buildout through replacement is negligible. Fixed walls present a different picture. Environmental impact nearly doubles from initial buildout to replacement for global warming potential, primary energy demand, and construction/manufacturing waste. (See figures 9-12.)

Conclusion—Modular Casework and Modular Walls Reduce Impact

Regardless of a hospital's rate of change, modular casework and modular walls will always yield better results for their impact on the environment when compared to fixed casework and architectural walls. In addition, modular casework and modular walls supports a hospital's need or desire to change, whether due to expansion, renovation, or process improvements. Initial construction yields positive results as well.

Modular casework and modular walls support change in another way: Reuse of products positively affects the bottom line of a hospital organization. Fixed casework and architectural walls essentially mean that a construction or renovation project is a start-over.

In fact, Bluewater Health, the hospital that serves as the model for this LCA assessment is already using some of its purchased laboratory products in its existing lab. The hospital was able to purchase products ahead of move-in, avoiding potential future price increases, and benefiting from the advantages of modular products in its lab processes. When the time comes to relocate to the new laboratory, the products will go along. No waste generated, no additional purchases required: The right way—and the smart way—to operate a complex and environmentally responsible hospital.

Walls: Construction / Manufacturing Waste

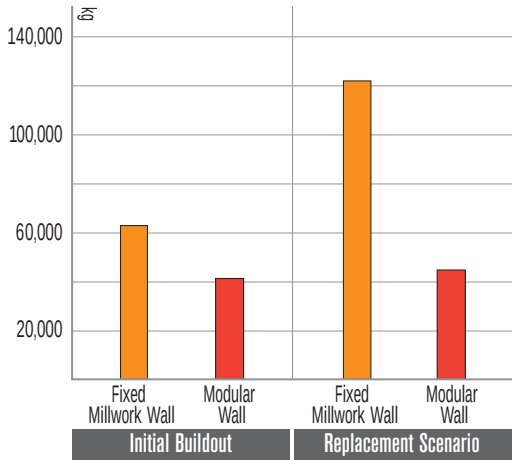

Figure 11

Walls: Remodel Waste / Reuse

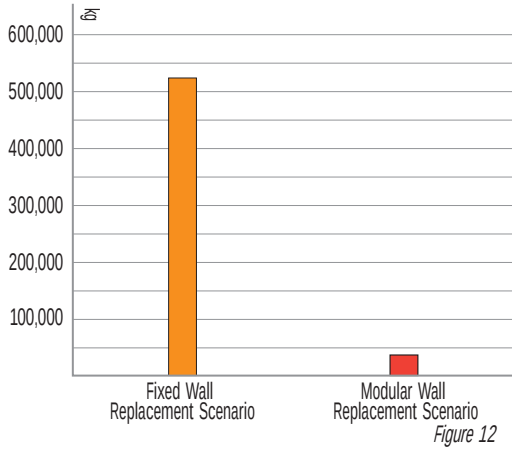

Figure 12

Notes

[1] Herman Miller provided the modular casework and wall products for this life-cycle assessment. The modular casework products included the Action Office®, Ethospace®, and Co/Struc® systems. In addition, Herman Miller provided modular walls from its Wall Alliance Partners, including M-Wall and V-Wall® systems. This study compared these products to custom millwork and built-in architectural walls. Therefore, the results of this research, while valid for these Herman Miller products, should not be generalized to other modular furnishings.