“Renewing” UBC Renew

Building Full Cost Assessment into Renovate vs. Rebuild Decisions at UBC

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Summary

A large number of older academic buildings at the University of British Columbia (UBC) are currently being renovated or replaced, as part of ongoing efforts to improve teaching and research space at the university. These improvements are funded through the UBC Renew program, a funding partnership between UBC and the Provincial Ministry of Advanced Education (AVED). Decisions at UBC whether to renovate or replace the existing buildings depend to a large extent on estimated upfront costs, as per instructions from AVED: if the costs of renovation are greater than 67% of the cost of a new building, renovation will not be approved. Staff at UBC Land and Building Services (LBS) and the Sustainability Office became concerned that privileging upfront costs in the assessments may be a barrier to achieving the best possible solution, from the perspective of full social costs (i.e. long-term and more broadly defined economic, environmental, and social costs.) Through the SEEDS (Social, Ecological, Economic Development Studies) project initiative, staff requested student work on a full cost assessment (FCA) framework for UBC Renew.

The purpose of this report is to propose a general FCA framework appropriate for UBC Renew that can be used for evaluating and comparing renovation and new construction options, taking into account social, environmental and economic impacts. In this report, background research is presented, a framework is proposed, and applications to a case study building are explored:

- *Background Research:* The background research consists of a review of the FCA concept and alternative methods for undertaking it, as well as a review of key documents from UBC and AVED which provide context and justification for the proposed framework.

- *Proposed Framework:* The proposed FCA framework consists of a multiple accounts evaluation (MAE) format combined with tools used under the auspices of 'life cycle thinking' in the construction industry. The methods embedded within the framework include life cycle costing and life cycle environmental impact assessment, in addition to cultural value/heritage assessment and user comfort and amenity assessment. Recommended options for implementing the FCA approach in decision-making at UBC include informal 'triple bottom line' and multiple objectives analysis assessments for internal decision-making and communication purposes, and the more formal MAE that would be necessary for developing business cases for submission to AVED.

- *Application:* The G.F. Curtis Law Building (1971 addition) is the subject of two sample assessments conducted for this study. *'A Wider Perspective: Assessing the Curtis Law Building'* and '*Renovating the G.F. Curtis Building: A Triple Bottom Line Assessment*' are companion documents that illustrate some of the principles described in this report. These two documents are offered as a example of how environmental, economic and social issues can be taken into account in decision-making regarding existing buildings.

Taken together, the background research, proposed framework and case study applications provide solid footing for staff in Land and Building Services and the Sustainability Office to begin introducing Full Cost Assessment into the UBC Renew program.

List of Acronyms

ADM	accumulated deferred maintenance
AVED	Ministry of Advanced Education
FCA	full cost assessment
LBS	Land and Building Services
LCA	life cycle assessment
LCC	life cycle costing
LEED	Leadership in Energy and Environmental Design
MAE	multiple accounts evaluation
MOA	multiple objectives analysis
NPV	net present value
SBCA	social benefit cost analysis
SEEDS	Social, Ecological, Economic Development Studies
TBL	triple bottom line
TCA	total cost assessment
UBC	University of British Columbia

1. Aspirations: 'Renewing' UBC Renew

UBC Renew is a program comprised of a series of renovation work packages, which target academic complexes with the highest levels of deferred maintenance at UBC. These buildings, built in the 1960s and 70s, require refurbishment in order to bring down the deferred maintenance debt and improve academic spaces. The significant debt was incurred due to aging infrastructure, a lack of financial resources to maintain physical assets, and an insufficient operations budget for optimizing facility life cycles.

1.1 UBC Renew: Background

Like many other universities across Canada, UBC has a significant deferred maintenance debt. Since 1999, a number of programs have been initiated to address the accumulated deferred maintenance (ADM) debt. Trek 2000 initiatives include Project Scrub (refurbishment of bathroom fixtures) and ClassTrek (classroom renovations); demolition planning; and an extensive energy retrofit through the ECOTrek program. In March 2003, UBC's Board of Governors approved an agreement between UBC and AVED to further address the ADM debt and to accelerate implementation of the Facilities and Infrastructure and Management Plan (FIMP). Named 'UBC Renew', the program is a planning and funding partnership developed between UBC and AVED to address the ADM debt accrued to UBC's older academic buildings.

On a building-by-building basis, the ADM debt can be brought down either through renovation or new construction. At present, AVED places a cap on the level of capital costs it will approve for renovations; if renovation exceeds 67% of the cost of new construction, renovation will not be approved. The conventional costs taken in to account exclude life cycle costs and related costs such as temporary relocation. Thus, the formula AVED uses to guide these decisions places heavy emphasis on the short-term dollar costs, not on more broadly defined dollar costs, long-term dollar costs, or on the environmental and social costs that may be incurred due to demolition and new construction. Concerns that this practice is too limited from a sustainability perspective prompted staff at Land and Building Services to request research into full cost assessment for UBC Renew.

1.2 Moving Forward: Implementing UBC's Vision for Sustainable Development

For UBC, incorporating long-term dollar costs and environmental and social impacts into decision-making is synonymous with a move towards sustainable development. With its visionary document *Trek 2010* and UBC Policy #5, *Sustainable Development*, UBC seeks to incorporate this vision of sustainable development into campus decision-making and operations. Similarly, AVED has provided instruction to the educational institutions in British Columbia to minimize the environmental impact of campus buildings, and has encouraged use of wider assessment methods for strategic planning in its *Environmental Guidelines* and *Capital Asset Management Framework Guidelines*. Thus, goals and policies regarding sustainable development shared by the UBC and AVED could guide decisions regarding older campus buildings, though to date this has not been the case.

This report proposes that the UBC Renew program could itself be 'renewed' by incorporating and implementing the newer visions, policies and guidelines set out by UBC and AVED. The report presents the results of a SEEDS project undertaken to determine a method for full cost assessment of renovation versus new construction options in UBC Renew.

1.3 Report Organization

The report is organized as follows:

- Section Two provides an overview of full cost assessment as compared to other types of cost assessment and options for conducting it;

- Section Three discusses touchstone documents from UBC and AVED;

- Section Four proposes a full cost assessment framework based on multiple accounts evaluation, a choice that was informed by reviewing touchstone documents and considering the optional methods for conducting full cost assessment;

- Section Five discusses applications of 'triple bottom line' assessment and multiple objectives analysis to a building currently under review for renovation or replacement;

- Section Six concludes the report and recommends next steps.

2. Foundations: Full Cost Assessment

Analysis of social, environmental, and economic costs is often referred to as full cost or social cost assessment (McDaniels, 1994). Full cost assessment (FCA) is a decision-support tool that can help users make decisions that benefit more stakeholders over the long term (Canadian Institute of Chartered Accountants, 1997). FCA is an expansion of conventional cost accounting that includes a broader range of costs and benefits than are conventionally considered. FCA is usually compared to two other levels of cost accounting (**Figure 1**); the first level, conventional accounting, examines the direct and indirect financial costs and easily recognized contingent costs. The second level, total cost assessment (TCA) is an expanded analysis that includes a broader range of direct, indirect, contingent, and less quantifiable costs. FCA is the broadest of the three levels because it expands the assessment to include externalities borne by society. These levels of costs are not normally assessed in conventional business practice (Gray, 1993; Schaltegger and Burritt, 2000).

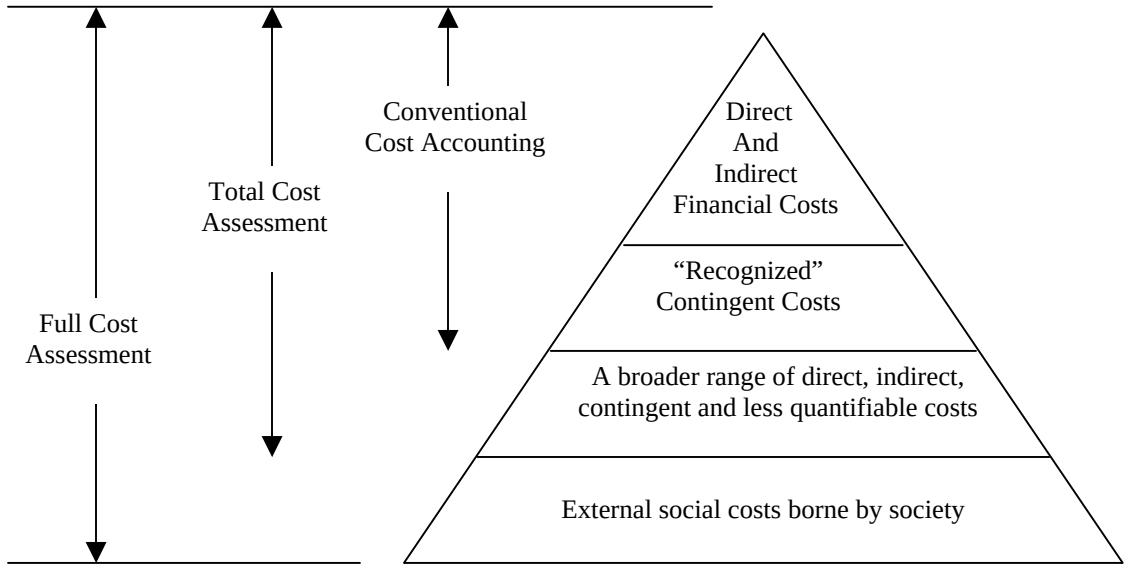


Figure 1: Comparison of conventional cost accounting with total and full cost assessment

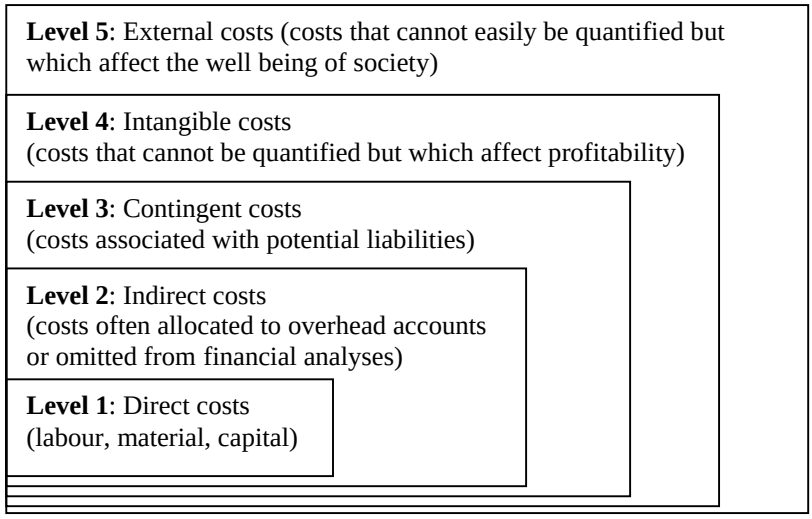
Source: BSD Global http://www.bsdglobal.com/tools/systems_tca.asp

2.1 Expanding the Scope of Cost Assessment in UBC Renew

With its focus on a limited array of first costs (the direct and indirect financial costs and to a lesser extent recognized contingent costs), the current decision protocol for the UBC Renew program can be said to be limited to conventional cost accounting. Expanded cost assessment will require changes to the information collection and decision process, including methods of assessing those costs that are difficult to quantify and cannot be successfully captured in dollar terms. **Figure 2** depicts the different types of costs that can be taken into account depending

upon the purpose of the assessment. Assessments at higher levels involve more effort than those at lower levels, as there are more variables, more assumptions, and the time horizon is extended. In order to incorporate full costing into UBC Renew, all five levels of costing will need to be practiced for renovation and rebuild alternatives. In decisions of this nature, FCA entails efforts to quantify the broadly defined social costs and benefits of decision alternatives to help make informed choices (Sheltair, 1998). As shown in **Table 1**, FCA includes the broadest range of beneficiaries, the widest range of cost elements, the longest time horizon, and considers the most levels of costs.

Figure 2: Costs Included or Excluded in Cost Assessments



Source: Sustainability Ventures Group, 1998 for Sheltair Group Inc.

Table 1: Time Horizon and Range of Beneficiaries Covered in Cost Assessments
Source: Sustainability Ventures Group, 1998 for Sheltair Group Inc.

	Conventional Cost Assessment	**Total Cost Assessment**	**Full Cost Assessment**
Range of payers/beneficiaries	Narrow	Broad	Very Broad
Range of cost elements included	Narrow	Moderate	Wide
Time horizon	Relatively short	Moderately long	Very long
Levels considered	Primarily Levels 1 and 2	Levels 1, 2, 3 & 4	All 5 Levels

2.2 Alternative Approaches to FCA

The body of literature addressing FCA contains dissimilar instructions for how full costing should be conducted, and also for how costs and benefits are to be quantified and compared. Historically, the issue of monetization, or costing in dollar terms, has been the subject of strong disagreement amongst economists, policy-makers and decision-makers in both the private and public sectors. In the public sector, some argue that not all costs borne by individuals and society can be measured in dollars, and alternative assessment protocols have emerged in support of this argument. McDaniels and Roessler (1994a) proposed that there are two underlying conceptual approaches for public decisions using full cost assessment: social cost/benefit analysis (SBCA), as practiced by economists, and multiple objectives analysis (MOA), as practiced by policy analysts and decision analysts:

- SBCA is a public sector analytical framework that is intended to determine social profits or efficiency gains from the viewpoint of the overall economy or society as a whole. All values in SBCA are measured in dollar terms to allow for comparisons amongst different types of costs and benefits. Critical limitations for SBCA include: dealing with values for 'goods' that have no market within which to price them; its single objective focus (economic efficiency); and lack of consideration of winners and losers (distribution of costs and benefits).

- MOA is more broadly based than SBCA, while SBCA can still be used as one of the tools employed within it. MOA refers to a conceptual framework, a set of techniques, and a process for obtaining insight into complex decisions. Monetization is confined to those decision aspects that readily lend themselves to it; other aspects are measured in 'natural' units, and the measures are not intended to be combined across categories. One of the drawbacks of MOA, however, is that not as many analysts or public sector employees are as familiar with it as they are with SBCA.

McDaniels (1994b) recommends the MOA approach as a superior framework for representing environmental and social values, though SBCA is the more widely known approach, particularly in regulatory and legal contexts. Decision analysts anticipate that the MOA framework will gain popularity and use with escalating public interest in sustainable development (conceived of in the mainstream as comprising three distinct areas, economy, environment and society.)

2.3 Multiple Objectives Analysis

Multiple objectives analysis is a structured decision analysis approach that, like other decision analysis approaches, specifically acknowledges the role of values, or 'what we care about' in decision-making (Hammond et al, 1999). 'Decision analysis' refers to a conceptual framework, techniques, and a process for working through complex decisions and gaining insight. Given the scope of issues taken into account in FCA, an approach that acknowledges complexity and the role of values is particularly well suited to the task. The literature on decision-making identifies a common sequence of steps that allow for complex decisions to be approached in an orderly fashion:

1. Identifying the decision that must be made;
2. Clarifying the underlying objectives or considerations that are important to achieve in making the decision;
3. Identifying the alternatives to be considered;
4. Determining the impacts that the alternatives will have on the underlying objectives (from step two);
5. Evaluating the attractiveness of the impacts of the alternatives;
6. Selecting a preferred alternative (McDaniels, 1994).

Value judgements are most critical in the second and fifth steps, while the third and fourth steps largely involve technical information. Once the decision has been clearly stated, objectives should be established. Objectives that are common to many planning problems around sustainability and sustainable development for buildings and infrastructure can include minimizing environmental impacts, minimizing adverse social impacts, maximizing social benefits, minimizing ownership costs of facilities, and maximizing economic benefits (i.e. local or regional income and employment.) By addressing a wide range of views and concerns explicitly and clearly, the decision process takes on more openness and can also inform debate.

Stakeholders and decision-makers can be asked what they consider to be important, what measurements should be used, and what tradeoffs they perceive to be critical aspects of the decision at hand. MOA does not require that values for non-market goods be measured in dollars. Biophysical objectives can be cast in units that are more 'natural' and relevant to the study than dollars, while the dollar cost impacts of the different alternatives will still be captured in the financial metrics. Evaluating the desirability of the alternatives in terms of their impacts on objectives will require some critical thinking. In order to set priorities amongst objectives, decision-makers will need to consider the performance levels of one objective that would be acceptable to trade off against another (i.e. Is it 'worth it' to pursue this alternative if these are the consequences?) Tradeoffs between objectives are cast in terms of what the decision-makers in the government and institutional sector view as appropriate to make on the public's behalf.

MOA provides an overall framework within which both full and partial analyses can be integrated. Complete MOA would require a thorough and quantitative treatment for all of the six steps listed above. However, considerable insight can be gained by partial analyses that could involve just one or two steps plus an adequate amount of qualitative probing. The strength of the general approach lies in the way it provides a logical method for working through complex problems, acknowledging the role of values and the wide array of issues that may be important to consider in resolving problems in an optimal way.

3. Touchstones: UBC and AVED Visions, Policies and Guidelines

In order to be successful, the new FCA framework for UBC Renew should introduce conceptual frameworks and relevant tools while referring to existing policies at UBC and AVED. Remaining close to policy and guidelines while finding practical tools that work is a key approach used in this project. 'Touchstones' for the new FCA approach to planning and decision-making already exist in UBC and AVED visions, policies and guidelines, providing supporting evidence.

Trek 2010, UBC's guiding vision, and Policy #5: *Sustainable Development* provide the rationale for incorporating principles of sustainability into all aspects of campus planning and operations, including UBC Renew. *Trek 2010* lays out a course for UBC to become one of the finest universities in the world, and is intended to guide the university in all aspects of its current and future operations, while Policy #5 provides more detail on how this is to be achieved. While UBC and AVED are committed in principal to bringing all of the *Trek 2010* goals to fruition, specific programs, such as UBC Renew, are not currently embracing all possible *Trek 2010* goals. The following key excerpts from the partnering organizations can be drawn on to support arguments for changing the way decisions are made at UBC.

3.1 Touchstones From the University of British Columbia

With its visionary document *Trek 2010* and UBC Policy #5, *Sustainable Development*, UBC announced its intention to incorporate principles of sustainable development into campus decision-making and operations.

3.1.2 Trek 2010

Trek 2010, begins with a vision statement**:**

> "The University of British Columbia, aspiring to be one of the world's best universities, will prepare students to become exceptional global citizens, promote the values of a civil and sustainable society, and conduct outstanding research to serve the people of British Columbia, Canada, and the world."

The vision is then divided into five sections; People, Learning, Research, Community and Internationalization. Each section contains goals and strategies that will help UBC realize its vision. The goals span concern for the research, teaching and working spaces at the university to making commitments to fostering global citizenship.

Three strategies that directly pertain to the link between providing high quality building spaces, adhering to the principles of sustainable development, and fostering global citizenship are:

- Continually review and enhance the quality of UBC's physical environment—its buildings, academic facilities, and natural setting; (from "People")

- Ensure that the principles of sustainability as expressed in UBC Policy #5: *Sustainable Development* are incorporated into all levels of strategic planning and university operations; (from "People")

- Ensure that all students develop a greater awareness of their responsibilities as global citizens and of the issues surrounding social, environmental, and economic sustainability. (from "Learning")

3.1.3 UBC Policy #5: Sustainable Development

UBC Policy #5: *Sustainable Development* begins with the following two statements of purpose:

- "To develop an environmentally responsible campus community that is economically viable and reflects the values of the members of its campus communities."

- "To ensure integration of ecological, economic and social considerations at all levels of strategic planning and operations within the University."

Further statements in Section Two of the Policy state:

- "UBC seeks ways to conserve resources and reduce waste. This means developing methods to minimize the material and energy intensity of university activities and reducing waste." (2.1.3)

- "UBC has information and reporting systems in support of decision-making based on sustainable development principles including life cycle, social and environmental costing and accountability to stakeholders." (2.1.4) [NB: The system has not yet been developed.]

- "UBC seeks to ensure its long-term economic viability through responsible and effective management, the development of […] innovative methods to calculate for external costs, and to identify cost-savings […]." (2.1.5)

- "UBC implements this policy, mindful of the need to balance ecological, social and economic imperatives in an open and transparent decision-making process with the involvement of all stakeholders." (2.2)

Taken together, these two UBC documents provide principles and a general format (i.e. the 'balancing' of the three imperatives implies a Triple Bottom Line approach) that can be embraced in decision-making.

3.2 Touchstones From the Ministry of Advanced Education

AVED's *Capital Planning and Project Management Branch* website gives public post-secondary institutions access to materials for capital planning and project delivery. Similar in spirit to initiatives taken at UBC, AVED has provided a new direction for public educational institutions

in British Columbia, though not all of the new directions have yet been incorporated into standard practice. Institutions are encouraged to minimize the environmental impacts of campus building construction, operations, and management (AVED's *Environmental Guidelines*) and also to determine the social and environmental costs of proposed projects along with life-cycle financial costing (AVED's *Capital Asset Management Framework.)*

These two documents serve to strengthen the case for environmental performance of building decisions, and to provide possible templates for communicating business cases to AVED.

3.2.1 Environmental Guidelines

The *Environmental Guidelines* report presents a set of environmental guidelines, goals and strategies for post-secondary facilities in British Columbia. The Guidelines express the collective commitment of post-secondary educational institutions in the Province to environmentally responsible building design and operation. Including the Introduction, the Guidelines span six sections: Project Planning and Management; Energy Efficiency; Resource Conservation; Health and Well-being of Users; and Integration of Systems. The introduction to the *Environmental Guidelines* report begins with following statement:

> "Following the publication of the Brundtland Commission's report, Our Common Future, the notion of sustainable development has emerged as a major planning objective. Sustainable development is development without growth in resource use and waste generation beyond the planet's carrying capacity and is only meaningful, therefore, when set against the limits and capabilities of the biosphere. […] It is incumbent on all those responsible for building design and operation to begin to chart this new direction."

The introduction expands upon this statement by proposing an attitudinal shift, comprehensive evaluation of design alternatives, and broader environmental commitment that are now seen to be necessary.

- An Attitudinal Shift: "Sustainability requires first and foremost an attitudinal shift, to embrace new ways of thinking about the processes of production, use and disposal of buildings. In addition, the operational cost of educational buildings over their lifetime represents a considerable commitment of public funds. As such, it is critical that all new facilities be initially designed and constructed, and existing buildings be retrofitted, to the highest possible environmental standards to reduce recurring operational costs." (1.1)

- Comprehensive Evaluations of Design Alternatives: "Designing post-secondary education facilities to higher environmental standards has both capital and operating cost implications. Where possible, cost implications should be assessed on a comprehensive, life-cycle basis." (1.3)

- Broader Environmental Commitment: "University, university college, college and institutes are primarily concerned with education and training. The design and operation of buildings in a more environmentally sound manner must be viewed as part of a much

broader responsibility of universities, colleges and institutes in their role as good environmental citizens." (1.4)

The following excerpts from the Guidelines explicitly highlight the role existing buildings play in sustainable management of public-sector building stock.

- Resource Conservation; Building Re-Use: "Demolition of many buildings occurs long before their useful life has ended because they no longer meet economic and functional criteria. Conserving whole existing buildings or large elements of them reduces the demolition waste sent to landfills and the need for raw material extraction to produce new materials." (4.3.1)

- Integration of Systems; Building Reuse: "Reusing existing facilities rather than providing purpose designed new construction may result in a less than ideal fit between building form and function. The environmental benefits of reusing an existing facility should always be carefully examined and, if beneficial, should take precedent over new construction." (6.1.3)

3.2.2 Capital Asset Management Framework—Guidelines

The *Capital Asset Management Framework Guidelines* support provincial public–sector agencies (including ministries, Crown corporations, school districts, health authorities and post-secondary institutions) to find the best solutions and apply best practices in managing capital assets. The following excerpts from the Guidelines demonstrate that there is adequate support for introducing additional information into the decision process, and for building the business case around that information:

- Assessing Value for Money: "In the broadest sense, the option providing the best value for money is the one that uses the fewest resources to achieve desired service outcomes. Relative value is determined through a rigorous examination of service delivery options and business case analysis, considering a broad range of factors including: service levels, cost, promotion of growth and employment, environmental considerations and other health, safety and economic issues. A value for money assessment must consider both quantitative and qualitative factors." (4.4.2.1)

- When and How to Assess Value for Money and the Public Interest: "Generally the province supports a multiple criteria approach to systematically and objectively assessing value for money and public interest in the planning stages (i.e. when preparing a strategic options analysis or business case)." (4.4.2.3)

- Business Cases: "A business case encompasses detailed assessments (e.g. estimates of the comparative costs and benefits) of a variety of financial factors such as life-cycle costs; non-financial factors such as environmental, job creation, public health or other socio-economic impacts; associated public interests such as access, security and safety." (4.5)

3.3 Linking Touchstones to a New Framework

ADM debt reduction and significant improvement of academic space through the UBC Renew program will help UBC move towards achieving some of the goals stated in the *Trek 2010* Vision. Ensuring that all academic programs meet the highest standards of excellence is supported by continued improvements to all aspects of the learning environment (*Trek Strategy*: Learning, 2). However, *Trek 2010* also includes the goal of incorporating the principles of sustainability as expressed in UBC Policy #5: *Sustainable Development* into all levels of strategic planning and university operations (*Trek Strategy*: People, 1).

Similarly, AVED has provided an opportunity for educational institutions in British Colombia to take decision-making and planning in a new direction. The *Environmental Guidelines* report provides sound footing for the reorientation of priorities, objectives, and practices regarding development of institutional facilities, and the *Capital Asset Management Framework* provides details on how these new directions can be incorporated. Together with the imperatives contained in UBC *Trek 2010* and Policy #5: *Sustainable Development*, a clear link to a new framework and process is provided.

In order to be acceptable to all parties involved in assessing the UBC Renew buildings for renovation or replacement, the FCA framework should be based on visions, policies and guidelines *already in place* in the institutions involved. The document excerpts presented in this section provide the touchstones that give authority to this new framework for decision-making. They also provide support for FCA based on the MOA format discussed in the previous section. In the next section, a framework for 'Renewing' UBC Renew based on the MOA is proposed.

4. Synthesis: Foundations + Touchstones = Framework

Embracing the spirit of *Trek 2010* and UBC Policy #5: *Sustainable Development*, while remaining mindful of methods advocated by AVED and currently in use for assessing buildings, the following effects on finances, environment, and people and culture should be captured by the new framework:

- **Effects on Finances—Dollar Costs (and Benefits)**: total life cycle costs for each option (construction or renovation costs plus demolition costs, plus interim relocation costs, plus operation/maintenance costs) should be assessed; effects on municipal, regional and provincial economic systems may also be assessed in the case of preparing the MAE-based business case for AVED;

- **Effects on the Environment—Environmental Costs (and Benefits)**: total life cycle environmental impacts of renovation versus new construction should be assessed; life cycle assessment attempts to capture the full environmental impact of the alternatives, both on and off campus;

- **Effects on People and Culture—Social and Cultural Costs (and Benefits):** effects on different user groups should be assessed, including potential occupants and others. 'Others' may include the larger UBC community and the community at large, who have an interest in any cultural value (historical, heritage, or architectural merit) that may exist in UBC's older buildings.

Revisiting the material from Section Two, 'Foundations for Full Cost Assessment', and considering it in combination with the touchstone documents in Section Three leads to a defensible conclusion: full cost assessment, employing the multiple objectives analysis framework, is a good choice for 'Renewing' UBC Renew, given UBC's intentions towards sustainable development and AVED's endorsement of multiple criteria approaches for strategic planning and analyses. UBC and AVED have both explicitly acknowledged that economic, environmental, and social aspects of major decisions can and should be taken into account, and that they need not be artificially converted into dollar values in order to inform decisions. These acknowledgements are consistent with full cost assessment within a multiple objectives format.

4.1 Multiple Accounts Evaluation: A Framework for 'Renewing' UBC Renew

Multiple Account Evaluation (MAE) is a multiple objectives analysis framework that was developed by the Province of British Columbia Crown Corporations Secretariat to address the shortcomings of excessively narrow evaluation tools such as social benefit-cost analysis (Crown Corporations Secretariat, 1993). The MAE format was developed to allow for systematic analysis of performance under a number of 'evaluation accounts,' in order to capture the full range of implications of alternative plans or projects. MAE may not determine which of a set of alternatives is unequivocally preferred, as this is not its goal. Rather, the goal is to clearly identify advantages, and disadvantages, and tradeoffs that different alternatives entail. MAE informs and assists decision-making, rather than acting as a replacement for decision-making.

MAE recognizes that provincial entities have a number of different interests and objectives there is no single measure of overall net benefit that can adequately summarize performance in all relevant areas. A systematic analysis of performance under a number of evaluation accounts (e.g. financial performance, customer or public service, environmental impacts, economic development, social impacts) is therefore required to understand the full range of implications of alternative plans or projects.

MAE entails the systematic documentation and assessment of the financial, environmental and other relevant implications for each of the alternatives under consideration. It is conducted by following four steps:

1. Problem definition and identification of alternatives.

2. Specification of evaluation accounts. Judgment is required in deciding which accounts to analyze and at what level of detail:
   - Financial performance;
   - Customer service;
   - Environment;
   - Economic Development;
   - Social.

3. Documentation and assessment of implications under each account: Evaluation procedures are designed to provide summary measures or statements that clearly identify the implications, advantages and disadvantages of the different alternatives. While similar to benefit–cost analysis, the methods used in MAE differ in two important respects. First, it is explicitly recognized that not all benefits and costs can be expressed in dollar terms. Second, even where dollar estimates are developed, it is not generally intended that these be combined into one measure of net benefit. Combining dollar estimates from different accounts can be misleading because of the different bases and reliability of the estimates. It can also mask important information about the components and distribution of the benefits and costs of different alternatives.

4. Presentation and interpretation of the results: Evaluation is intended to indicate the major implications of the alternatives for each account. In order to communicate this information in a clear and consistent way, the key findings should be presented in a summary matrix of results and submitted to key decision-makers. Decision-makers then have the responsibility to provide their own judgements about the relative desirability of alternatives, based on an ‘objectives by alternatives’ matrix summarizing the first two steps.

4.2 Life Cycle Assessment Tools and Methods for Buildings

As the UBC Renew program deals with existing buildings, particular tools and methods are needed to gather the necessary information. The general MAE format is tailored for use in building stock management decisions at UBC by the inclusion of tools that are already being

used in the building and construction sector, such as heritage assessment, life cycle costing, life cycle environmental impact assessment, and building performance assessment from the perspective of users. Each nests within one of the evaluation accounts required for MAE, as discussed above. The FCA framework described in **Table 2** is embedded within the larger decision context, and as such, supplements what is already part of conventional practice. As the intent is to provide *additional* information to the existing decision process at UBC, the components of the decision that are assumed to already be accounted for (i.e. issues such as technical feasibility) are not explicitly included.

Table 2: Full Cost Assessment Framework for UBC Renew

Issues **What is important?**	**Objectives** **What are we trying to achieve?**	**Measures** **How are we going to measure it?**
Financial Performance	Minimize overall life cycle costs of supplying building space for teaching and research	Calculate all of the related dollar costs associated with each alternative: ➢ Determine Global Project Costs (include demolition costs + relocation costs, etc.) ➢ Use Life Cycle Costing (construction costs + operations and maintenance costs + end of life costs)
Environmental Impacts	Minimize environmental impact: ➢ Minimize resource and energy consumption over building life cycle	Conduct Life Cycle Environmental Impact Assessment for each alternative: ➢ Use Athena Environmental Impact Estimator Software
Occupant Satisfaction (Customer Service)	Maximize satisfaction with teaching and research space: ➢ Maximize health, comfort and amenity ➢ Maximize worker productivity	Conduct Building Performance Evaluation for each alternative; engage with different stakeholder groups: ➢ Produce summary statement of impacts on potential user groups
Cultural Relevance	Protect or create socially/culturally significant building stock ➢ Old: Retain significant stock ➢ New: Reflect and express culture	Conduct assessment of the cultural relevance for each alternative, if applicable: ➢ Perform Heritage/Architectural Merit Assessment of existing building, if needed ➢ Produce summary statement of architectural merit/expected cultural contribution of new construction

Results of the full cost assessment should be summarized in an 'objectives by alternatives' matrix (**Table 3**) for the consideration of decision-makers, and can be used for communication with stakeholders who are concerned with the decision at hand.

Table 3: Objectives by Alternatives Matrix for UBC Renew

Issues and Objectives	Alternative A: Renovation	Alternative B: Demolition and New Construction
Issue: Financial Performance **Objective:** Minimize life cycle costs of supplying building space for teaching and research		
Issue: Environmental Impacts **Objectives:** Minimize adverse environmental impacts		
Issue: Occupant satisfaction and customer service **Objective:** Maximize satisfaction with teaching and research space		
Issue: Cultural Relevance **Objective:** Protect (or create) socially/culturally significant building stock		

The multiple objectives format that MAE exemplifies allows decisions amongst alternatives to be captured in such a way that issues important to a wide variety of stakeholders can be considered within one framework. This general template could be used for less formal TBL assessment, or more formal MAE for communication with AVED. If used for communication with AVED, the original evaluation account labels may be used instead (i.e. 'customer service' and 'social' and 'economic' in addition to/instead of the accounts used above. This is a matter of discretion, but should be confirmed in consultation with AVED).

This framework requires a broader range of measures and tools that staff at UBC and AVED may be unfamiliar with. The measures of occupant satisfaction and cultural relevance/heritage assessment proposed are fairly common (architectural consultants will likely have experience

with these assessments), while the alternative measures of financial and environmental impact proposed in this report require further explanation.

4.2.1 Life Cycle Costing

Life cycle costing, as applied to buildings, is a method of evaluating alternatives based on initial and ongoing costs over the expected life of the building project; the purpose is to estimate the *total cost* of building ownership. It takes in to account all costs of acquiring, operating, and disposing of a building, building component, or a building system. LCC is especially useful when project alternatives that fulfill the same performance requirements but differ with respect to initial costs and operating costs, have to be compared in order to select the one that maximizes net savings (Emblemsvag, 2003).

a. Costs Included:
There are numerous costs associated with acquiring, operating, maintaining, and disposing of a building or building system. Building-related costs usually fall into the following categories:

- Initial costs—purchase, acquisition, construction costs
- Fuel costs
- Operation, maintenance, and repair costs
- Replacement costs
- Residual values—resale or salvage values or disposal costs
- Finance charges—loan interest payments

b. Costing Equation:
The basic costing equation for LCC can be expressed as follows (Natural Resources Canada 1980):

> LCC = first costs plus all future costs (operation, maintenance, repair and replacement costs and functional-use costs) minus salvage value (i.e., value of an asset at the end of economic life or study period).

As life-cycle costs are spread over many years they must be converted to a common value, 'net present value' (NPV), in order to make them comparable over a period of time. In converting future values to present values, 'discounting' is performed by applying interest (discount) formulae to the estimated costs or benefits of a given project.

c. Application to Existing Buildings:
According to the National Research Council of Canada (1980), LCC application to existing buildings should involve:

- Comparison of total life cycle costs and savings of rehabilitating the existing building versus tearing it down and rebuilding it;
- Determining how much of any given retrofitting measure or a combination of various retrofitting measures should be used in order to achieve maximum savings, given certain constraints of budget, level of amenity, etc.; and
- Determining which method of retrofitting or rehabilitating a building should be used to achieve maximum savings from a given level of investment costs.

d. Resources for Staff:
The following texts are specifically tailored for applications to entire building facilities, and also to their individual components:[1]

Boussabaine, A and Kirkham, R. (2003) Whole Life-Cycle Costing: Risk and Responses. Blackwell Publishing

Bull, J.W. (1993) Life Cycle Costing for Construction. Spon Press

Dell'Isola, A. and Kirk, S. (2003) Life Cycle Costing for Facilities. Reed Construction Data

Kirk, S. and Dell'Isola, A. (1995) Life Cycle Costing for Design Professionals (2nd Edition). McGraw-Hill.

4.2.2 Life Cycle Environmental Impact Assessment

Life cycle assessment (LCA) is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle (SETAC, 2003). The basic procedure for conducting LCA entails a goal and scope definition, life cycle inventory, life cycle impact assessment, and interpretation or improvement analysis (UNEP, 1996). LCA can also be linked with environmental targets, where data on emissions such as CO_2 and other greenhouse gases may be highlighted (Cole, 1996; Andersson *et al*, 1998). A life cycle assessment can yield a wealth of detailed information on a wide range of environmental impacts that are of increasing importance to many decision-makers, including fossil fuel depletion, other non-renewable resource use, water use, global warming potential, stratospheric ozone depletion, ground level ozone (smog) creation, nutrification and eutrophication of water bodies, acidification and acid deposition, and other toxic releases to air, water and land (Kibert, 2005). LCA "has been generally accepted within the environmental research community as the only legitimate basis on which to compare alternative materials, components and services […]" (Cole, 1999: 239).

The Athena *Environmental Impact Estimator* (EIE) is an LCA-based software tool that allows for the environmental impact assessment of individual building assemblies, such as walls, roofs, or floors, or whole buildings. The software was developed by the Athena Institute to assist the wide range of practitioners and researchers involved in building design and construction in making decisions about product selection in the early stages of design. It can also be used to decide whether to renovate or replace existing buildings, based on the different environmental effects that are triggered.[2]

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[1] These selections are available from Amazon.com and/or the RS Means on-line bookstore. Book descriptions and reviews are available for all of the titles.

[2] The Athena LCA software was used on a case study building in a companion report. See *'Renovating the G.F. Curtis Building: A Triple Bottom Line Assessment'* for a detailed explanation of LCA to a renovate vs. rebuild decision at UBC.

4.3 Implementing FCA in UBC Renew

MAE can be used in the UBC Renew program in a number of ways, depending on the purpose of the exercise. The level of formality necessary will vary with the intended audience; if used internally, the general MAE format can be retained while the procedure is relaxed (i.e. a multiple objectives analysis or TBL assessment, as described in Section 5). As the TBL format is very flexible and can be modified for different users and audiences, it has become increasingly popular; it also has the benefit of concept recognition, and many people have already begun to equate TBL with sustainability, associating the concept with the popular 'three-legged' stool analogy. However, it will be necessary for UBC to adhere to a formalized procedure and reporting method if it intends to change the way business cases are prepared for AVED.

5. Preliminary Applications: the George F. Curtis Law Building

In order to demonstrate how the expanded assessment approach can be introduced into the decision processes for UBC Renew, two application options are provided along with this report. The multiple accounts evaluation format selected and recommended to 'Renew' UBC Renew will require UBC to commit to providing additional resources, to undergoing substantial institutional changes, and to negotiating changes to practices with AVED. To ease into this transition, and to build support for the new framework in the future, UBC could start with introducing the FCA concept to decision-makers and stakeholders in a low-risk way, where the framework is introduced as a means of bringing additional information about controversial issues to the table. The renovation feasibility study for the George F. Curtis Law Building provided an excellent opportunity to explore the new framework and consider ways to introduce it in the UBC context.

5.1 The G.F. Curtis Law Building

The George F. Curtis building complex is home to the Faculty of Law at UBC. The complex consists of two buildings with distinct architectural styles arranged around a common courtyard; the original building was constructed in 1951, and an addition followed in 1973. In October of 2005, UBC Land and Building Services and the Sustainability Office contracted with a local architectural consultant firm to conduct a feasibility study for the renovation and rehabilitation of the 1973 addition. (Prior to the feasibility study, the 1951 building had already been deemed unsuitable for retrofit, due to seismic deficiencies and other problems.) The intention of the study was to determine the suitability, cost, and level of renovation required to bring the addition into another productive life cycle, and to consider not just the financial implications, but also the social and environmental impacts. While the building had not been earmarked for the UBC Renew program, it may be in the future.

Applications of the framework to the Curtis building began with a 'back of the envelope' assessment, presented as a decision overview based on multiple objectives analysis. The next application was a 'triple bottom line assessment', presented as a contribution to the actual renovation feasibility study. Together, these two documents provide examples of ways to build support for the expanded assessment approach at UBC, supporting internal decision processes first. Subsequent efforts could include formalizing the assessment such that it would form the basis for business cases and communication with AVED.

5.1.1 *Decision Overview*

A decision overview entitled *'A Wider Perspective: Assessing the Curtis Law Building'* is provided along with this report as an example of how the multiple objectives analysis approach could be used to structure multi-stakeholder decisions. This approach is helpful when communicating with a number of interested parties ('stakeholders') from the beginning of a decision process. This approach is intended for use in helping parties with disparate interests move through the decision process together, and in many ways is very similar to the multiple accounts evaluation format: the major difference lies in the thoroughness of the assessment

procedure. The strengths of this approach lie in its transparency and structured method for working through a decision, while challenges exist due to the need for skilled facilitation and ongoing commitment from involved parties.

5.1.2 *Triple Bottom Line Assessment*

A report entitled *'Renovating the G.F Curtis Building: A Triple Bottom Line Assessment'* is provided as an example of how expanded assessments can be applied to a decision process in an informal way, without necessarily changing the way decisions are made. The TBL format can be introduced at different stages of decision processes, whereas the multiple objectives approach discussed below, and likewise the formal MAE approach, are used from the very beginning. As discussed in the attached report, TBL can be introduced at any time in the process (even after it has been completed) though the sooner the format is introduced, the better the chance for the additional information to affect the decision outcomes. The lack of a specific structure or procedure is the key difference between the TBL concept and multiple objectives analysis/Multiple Accounts Evaluations. While appropriate for experimenting with new directions in decision-making and internal communication, TBL is not appropriate for making business cases to AVED. MAE, on the other hand, has the necessary rigour and support necessary for making business cases.

6. Conclusion

At the request of staff at UBC Land and Building Services, the purpose of this SEEDS project was to determine a method for incorporating full cost assessment into the UBC Renew program. Integrating social, environmental and long-term economic issues into decisions regarding UBC's older buildings in a phased approach will lead to 'Renewing' UBC Renew, while fulfilling UBC's objectives to embrace principles of sustainable development in campus operations. This report delivers a framework, complete with supporting rationale and examples, for assessing the full costs of renovation and new construction alternatives. A life cycle approach is combined with the multiple accounts evaluation format to deliver a full cost assessment framework. Via explicit references to guidelines and policies already in place, this particular combination of conceptual framework and methods is intended to resonate with decision-makers at UBC and AVED alike.

This FCA framework provides a template to guide the assessment process through those issues that can be considered as integral to the sustainable development of UBC's existing building stock—effects on finances, the environment, and on people and culture. This framework helps stakeholders and decision-makers in deciding whether the benefits of renovation outweigh new construction, or vice versa. It also serves to bring UBC and AVED policy and guidelines into practice, and it is hoped that it will provide grounds from which to challenge the 67% cut-off point for renovation candidacy in the UBC Renew program. As competing objectives will likely not all be met in a single option, it is likely that tradeoffs will have to be made. This format allows for the transparency that is increasingly being required in public sector decision processes.

6.1 Next Steps…

Staff at UBC Land and Building Services can begin to incorporate the full cost perspective in decisions for renovation versus rebuilding in the UBC Renew program immediately, whether for internal decision support or for external communication with AVED. Initially, staff at LBS may find it beneficial to retain skilled consultants to conduct the assessments and possibly to facilitate discussions with stakeholders. In order to incorporate FCA into decision processes and allow it to have bearing on decision outcomes, the formal MAE procedure will need to be used, and staff at UBC will need to consult with AVED in order to establish new terms of reference. To build support for this significant change, however, the TBL format can first be used in a non-invasive way to demonstrate the benefits of bringing additional information to bear on a decision.

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A Wider Perspective: Assessing the Curtis Law Building

By Alison Aloisio, SEEDS Project Participant

introduction

What should be done with the G.F. Curtis Law Building at the University of British Columbia? Some of the current occupants, the Faculty of Law, feel the building is substandard as it has not served their needs well, and a number of them want a new building built in its place. Meanwhile, there is interest in retaining the building due to its architectural merit, and the space may be highly useful for other faculties or for academic 'Swing Space'. Another facet adding complexity to the issue is uncertainty surrounding the financial and environmental implications of a 'retain and renovate' versus 'demolish and build anew' decision.

At present, there is no standardized, comprehensive process to guide decision-makers through comprehensive assessments of UBC's existing buildings. Nor is there a process for bringing into practice the ambitious visions set out in UBC's Trek 2010 and Policy #5: Sustainable Development, with respect to ongoing management of existing building stock. Under the auspices of the Campus Sustainability Office, a student research project is currently underway looking in to these very issues.

The purpose of this brief look at the Curtis Law Building is to illuminate some of the key issues that need to be investigated to help inform decisions. In order to frame the issues in the analysis, a multiple objective analysis process developed by Hammond, Keeney and Raiffa is used. Their 2002 book *Smart Choices* provides advice on how to move through complex decisions in a clear and logical way.

smart choices

A 'smart choice' is one that helps to achieve key objectives. Once the decision to be made has been identified, key objectives, alternatives, performance measures, consequences and tradeoffs are all worked through. In this case, the decision is 'What should be done with the Curtis Law Building?'

objectives

The **fundamental objectives** are the things UBC wants to achieve, things that do not need to be justified. Some of the objectives listed below are 'new', in that they are not currently found in the existing decision process, though they can be found in key documents (UBC's vision *Trek 2010* and UBC Policy #5: *Sustainable Development*.) These expanded objectives point to new information needs.

what do we want to achieve with this building? why?

- ⇒ Meet teaching and research needs. This is the University's reason for existence. By providing excellent service to students, UBC ensures its own longevity and continues to serve its function of contributing to society.
- ⇒ Minimize costs over building life cycle, to promote financial sustainability.
- ⇒ Minimize environmental impact, to promote environmental sustainability.
- ⇒ Minimize occupant discomfort and adverse human health impacts, to promote health and wellbeing.
- ⇒ Protect significant heritage stock or architectural merit, to promote social/cultural sustainability.

What information about the alternatives do we need?

- ⇒ Effects on UBC and Ministry of Advanced Education ***finances***;
- ⇒ Effects on the ***environment***;
- ⇒ Effects on ***people*** at UBC (students, faculty and staff), and in a wider sense, on the larger ***culture***.

alternatives

We can either look at the decision problem from the perspective of options for the Law building, or we can think about it from the perspective of options for meeting the needs of the Law department. The distinction here is that while the alternative strategies for a single building include renovation or demolition and replacement, departmental needs could be met by adding another alternative—moving to another building altogether. For example, if the objective 'to minimize environmental impact' by reducing material use in construction is given heavy weighting, a building will be renovated rather than torn down, even if existing departmental needs can not be met there. The building may be appropriate for another use, possibly by another department.

alternative a: renovations (in general)

- ⇒ A renovation can either be minimal (know as a 'retrofit') or very extensive, depending on a number of variables.
- ⇒ The LEED rating system, in its Existing Buildings category, awards points for achieving high levels of energy efficiency, as well as for retaining significant portions of the structure.
- ⇒ Renovations may require complete evacuation of the building, or may be done in a phased approach, allowing for partial occupancy of the building during the process.

alternative b: new construction (in general)

- ⇒ New construction can be done using a wide variety of methods and materials.
- ⇒ The LEED rating system awards points for every aspect of the building's planning and construction.
- ⇒ New construction offers a 'clean slate' for meeting departmental needs, but results in site disruption and occupant displacement.

performance measures

Performance measures provide the means for assessing different options, in order to find out whether fundamental objectives are met. They also determine the type of information that needs to be collected. The performance measures that will be used in the new framework are drawn primarily from the **Life Cycle Thinking** approach. Life Cycle Thinking expands the perspectives of stakeholders and decision-makers, serving as a strong base in the transition to more sustainable decision-making, and ultimately to a more sustainable society. The application of Life Cycle Thinking to assessing options for UBC's older buildings sheds new light on opportunities and constraints from a sustainability perspective.

what is important? how are we going to measure it?

Incorporating sustainability into decision-making regarding existing buildings requires expanding the decision frame while allowing for assessment of the possible benefits of maintaining what already exists. The performance measures need to capture all of these issues.

The new decision-support framework needs to guide the decision-makers through a complete process of assessment and alternative selection; a 'toolbox' approach is the best fit for the task at hand. While economic effects can be easily captured by dollar amounts, neither environmental nor social effects can. It is necessary to keep the domains separate, to measure them on their own terms (in natural units) and to maintain a disaggregated approach right to the end of the analysis. The three different domains of sustainability are inherently incommensurable, and therefore should not be amalgamated into one stream at any point.

The performance measures consist of the following:

⇒ **Effects on Finances: Life Cycle Costing**
- Scope: Total cost of building project, including relocation, construction, operation, repair and demolition/reuse
- Quantitative Unit: $ Net Present Value

⇒ **Effects on Environment and Human Health: Life Cycle Analysis**
- Scope: Material sourcing, construction, use, demolition.
- Quantitative Units: various impact indicators for Global Climate Change, Stratospheric Ozone Depletion, Acidification, Eutrophication, Human Toxicity and Ecotoxicity.

⇒ **Effects on People and Culture: Building Performance Assessment (from the perspective of different user groups) and Heritage/Architectural Merit Assessment**
- Scope: UBC students, faculty and staff, cultural and other implications for campus and beyond
- Qualitative Units: Amenity provision, impacts on site and neighbours, impacts of heritage retention or loss.

consequences: 'back of the envelope'

A consequences table, or 'objectives by alternatives matrix,' helps decision-makers to think through the consequences of pursuing different alternatives. As a detailed analysis of each performance measure has not yet been done for the Curtis Law Building, it is not possible to use those exact units in working through the consequences of each alternative. A complete assessment would use the appropriate data and procedures listed in the previous section.

A 'back of the envelope' description of *possible* consequences is described here, in broad and general terms. A very simple classification scheme is used: **+ for a positive result with respect to the objective, ? for unknown, - for a negative result with respect to the objective.**

objectives	***alternative a: renovation***	***alternative b: rebuild***
Objective 1: Meet teaching and research needs	**?** Renovation may or may not be able to meet departmental needs, depending on the occupying department. The current occupants are dissatisfied with the building, though others may be satisfied with it.	**+** A new building would most likely meet all departmental needs, as the design itself would be customized, and would have less restrictions to work with than renovation.
Objective 2: Minimize costs	**+** Life cycle costs include the cost of the renovation itself plus subsequent operation and repairs and temporary department relocation, and are likely to be lower than new construction.	**-** Life cycle costs for this alternative include demolition, temporary department relocation, new construction, operation and repairs, and are likely to be higher than renovation.
Objective 3: Minimize environmental impacts	**+** Renovation reduces the pressure for new material sources, and eliminates the adverse effects of demolition and construction.	**-** New construction involves environmental burdens due to demolition and sourcing new materials.
Objective 4: Protect stock with architectural merit / heritage value	**+** If the existing building is assessed as having significant cultural value, renovation would allow for protection of the stock.	**-** New buildings could be constructed using some reclaimed materials, but the cultural value itself will be lost.

tradeoffs and conclusion

Following the cursory, 'back of the envelope analysis' done in the consequences table, it would appear that renovating is the dominant alternative. However, tradeoffs in an actual assessment will be much more complex and will need to be made by referring to a larger set of objectives. It is ultimately the weighting of the objectives that will determine the decision outcome, whether to retain or demolish the Curtis Law Building. Conflicts abound, and decision-makers will need to carefully consider the tradeoffs.

This brief exercise has illustrated some of the opportunities and constraints that are likely to be met in incorporating the three broad principles of sustainability into decision-making. Opportunities are revealed by bringing more information and a structured process to bear, while constraints are encountered where objectives conflict. The transition to more sustainable campus operations will require changes to each aspect of the assessment and decision-making process. Decision definition, creation and ranking of objectives, alternatives, performance measures, consequences and tradeoffs all change dramatically when the perspective changes.

The multiple objectives anlaysis format delivers on its promise of helping decision-makers make better decisions, by thinking through key aspects of the problem in a structured way. A structured and transparent process will be invaluable as UBC charts a course into new domains.

Renovating the G.F. Curtis Building

A Triple Bottom Line Assessment

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March 13, 2006

Table of Contents

1. Summary

The purpose of this report is to provide supplementary information to the G.F. Curtis Building renovation feasibility study coordinated by UBC Land and Building Services and the Colborne Architectural Group, Pacific Inc. (CAGP) The feasibility study reviewed options for renovating the 1973 addition to the G.F. Curtis Building, for use as academic Swing Space or for continued use by the Faculty of Law.

a. Background

The author of this report, a Masters student at UBC's School of Community and Regional Planning, is currently involved in a closely related SEEDS project with the Sustainability Office and Land and Building Services. Land and Building Services invited the author to observe the feasibility study; to contribute by offering a Triple Bottom Line perspective; and to pilot the use of Life Cycle Environmental Impact Assessment software for renovate vs. rebuild decisions in the UBC Renew program.

b. Method Overview

This Triple Bottom Line Assessment summarizes the results of work undertaken by the various consultants involved in the study. The key sources that were used for this assessment include the December 21, 2005 report authored by CAGP (*G.F. Curtis Building Retrofit Faculty of Law Feasibility Study: DRAFT*) and the February 27, 2006 Heritage Assessment Report authored by Robert Lemon (*UBC Curtis Building Heritage Assessment DRAFT REPORT*). In addition, with the assistance of CAGP, the author of this report piloted the use of The Athena Institute's *Environmental Impact Estimator* software in order to provide necessary information for the environmental 'bottom line'.

c. Summary of Results

The TBL Assessment format used in this study highlights the issues that are of interest in deciding whether to renovate or replace the G.F. Curtis addition. These include the broad areas of economic, environmental and social issues, but are further refined to financial performance, environmental impacts, occupant satisfaction, and cultural relevance. The results of the assessment are presented as follows:

Financial Performance: The "Bottom Line"

> According to costing estimates done to date, renovation is the option with the lowest first costs. Renovation costs are estimated at 77% of costs for new construction, which is problematic with respect to the UBC Renew program's cut-off point of 67%. Costs could be brought lower, or the TBL approach could be used to argue that the 67% cut-off for renovation is itself invalid from a holistic perspective.

Environmental Impacts: The "Bottom Line"

> According to the environmental impact assessment conducted for this study, renovation would result in substantially lower environmental impacts than demolition and new construction.

Occupant Satisfaction: The "Bottom Line"

According to the consultant reports and stakeholder consultations undertaken to date, renovation could deliver a comfortable and usable space for different user groups. Use as Swing Space may be more successful given the Law Faculty's history with the building.

Cultural Relevance: The "Bottom Line"

According to the heritage assessment conducted for this study, renovation would retain an important architectural asset for the UBC community, and the community at large.

d. Conclusion and Recommendations

Taken together, the results of this TBL Assessment suggest that the 1973 addition to the G.F. Curtis building should be retained and renovated. In this study, the building has been deemed an important heritage building with architectural merit; it has been shown to be successfully amenable to various renovation scenarios for different user groups; it is the option with the lowest first costs; and it is the option with the lowest environmental impacts.

The two recommendations that flow from this assessment are as follows:

1. The addition to the G.F. Curtis building should be retained and renovated;

2. Further study could be done to formalize the results for inclusion in the business case or other communication with the Ministry of Advanced Education, taking the form of a Multiple Accounts Evaluation. This could help to support the case that the building is an asset that should be retained.

2. Triple Bottom Line Assessment

Triple Bottom Line (TBL) accounting is a relatively new concept that emerged from the corporate social responsibility movement, and is rapidly gaining recognition as a framework for measuring business performance. John Elkington coined the phrase in his 1998 book *Cannibals With Forks: The Triple Bottom Line of 21st Century Business*. The TBL captures a spectrum of issues, including economic, environmental and social. In practice, "TBL assessment expands the traditional reporting framework to take into account not just financial outcomes but also environmental and social performance."[1] TBL assessment and reporting are voluntary, and to date, no standardized method exists for conducting TBL assessments or subsequent reporting.

2.1 TBL Methods for Different Purposes

The TBL format can be introduced into current practice in different ways and at different stages of the decision process, depending on the purpose of the exercise (for example, TBL can be used for external communication after the fact, or to aid in internal decision-making, or be formalized and used to make a business case to funding partners). While private corporations can decide what will be reported, when, and how, public sector decisions will require that a more formal method needs to be followed.

TBL Assessment bridges the gap between simple TBL Reporting and a fully developed and formalized method appropriate for the public sector. The TBL Assessment method used in this report is conceived as a simplified version of a formal assessment process the author is currently developing as part of a SEEDS[2] project.

It is proposed that using TBL Assessment is an appropriate first step for UBC to make in introducing TBL into its decision processes, and is therefore appropriate for the Curtis Renovation Study at this stage. Subsequent steps might include formalizing the assessment for communication with the Ministry of Advanced Education (AVED) in the form of business cases, following the Multiple Accounts Evaluation format.

TBL Reporting, TBL Assessment, and Multiple Accounts Evaluation are similar but are intended to serve different purposes:

a. Triple Bottom Line Reporting
External TBL Reporting can be used to communicate the performance of an entity to both its stakeholders, and the wider community. Additional assessment and information gathering need not be done for TBL Reporting, and it can be done even after the decision process is complete;

b. Triple Bottom Line Assessment
Internal TBL Assessment can be used to aid in decision-making. Information gaps can be identified and filled as needed, and the assessment can proceed with discussion amongst concerned parties about the alternatives across the three 'bottom lines.' As there is no

[1] Business and Sustainable Development website: http://www.bsdglobal.com/tools/principles_triple.asp
[2] SEEDS (Social, Ecological, Economic Development Studies) projects bring students, staff and faculty together to work on enhancing sustainability at UBC. Information on SEEDS projects is available on the UBC Sustainability Office website: http://www.sustain.ubc.ca/seeds.html

formal method for TBL Assessment, entities can decide what information to collect and how to incorporate it in to the decision process. This is the TBL approach used in this report.

c. SEEDS Project: Full Cost Accounting based on Multiple Accounts Evaluation

The SEEDS project the author of this report is working on is concerned with developing a method for the Full Cost Assessment of options for buildings in the UBC Renew program, across the Triple Bottom Line. The project will deliver to Land and Building Services a usable method, complete with supporting rationale, for assessing the Full Costs of renovation and new construction alternatives, across the TBL.

This project proposes that a Full Cost Assessment/TBL framework and method can be achieved through the application of Multiple Accounts Evaluation (MAE). The MAE format was developed by the Province of British Columbia Crown Corporations Secretariat in 1993 to address the shortcomings of other evaluation tools such as benefit-cost analysis. It requires systematic analysis of performance under a number of 'evaluation accounts,' in order to capture the full range of implications of alternative plans or projects. The use of this format is in fact supported by the Ministry of Advanced Education.

The MAE format is tailored for use in building stock management decisions at UBC by the inclusion of tools that are already being used in the building and construction sector, such as heritage assessment, life cycle costing, life cycle environmental impact assessment, and building performance assessment from the perspective of users. The following effects are captured in the framework and assessment methods:

- **Effects on Finances—full dollar costs (and benefits)**: total life cycle costs for each option (construction or renovation costs plus demolition costs, plus interim relocation costs, plus operation/maintenance costs) should be assessed; effects on municipal, regional and provincial economic systems may also be assessed in the case of preparing the business case for AVED;

- **Effects on the Environment—full environmental costs (and benefits)**: total life cycle environmental impacts of renovation versus new construction should be assessed; life cycle assessment attempts to capture the full environmental impact of the alternatives, both on and off campus;

- **Effects on People and Culture—full social costs (and benefits):** effects on different user groups should be assessed, including potential occupants and others. 'Others' may include the larger UBC community and the community at large, who have an interest in any cultural value (historical, heritage, or architectural merit) that may exist in UBC's older buildings.

2.2 TBL Assessment for the G.F. Curtis Renovation Feasibility Study

The G.F. Curtis building addition (hereafter referred to as building 481) presents an interesting case to decision-makers when the TBL is introduced. The purpose of this section is to describe the TBL Assessment format used and to summarize the results.

The Full Cost/TBL framework described above is modified for this TBL Assessment study by streamlining and simplifying the assessment, in order to highlight the major financial, social and environmental costs and benefits of retaining building 481. Rather than conduct an entirely separate set of assessments, as would be the case with Multiple Accounts Evaluation, information already collected by the consultants involved in the study can be introduced into the TBL format. If further study is warranted, additional assessments can be conducted in subsequent studies.

While it would be ideal if all alternatives for building 481 could be fully developed and assessed across the TBL before decisions were made, in reality cost and time constraints require a staged approach. Thus, it is assumed to be impractical to employ the full assessment framework at high level, strategic planning points in the process. The renovation feasibility study for building 481 is one such strategic planning process, where exploratory studies indicate if there is justification for conducting more in-depth studies. Nevertheless, introducing the TBL format during the decision process such that it may have bearing on the outcome is a significant step.

The TBL Assessment therefore consists of the following elements, which are discussed and summarized in the next section:

1. Highlights of Financial Performance
2. Highlights of Environmental Impacts
3. Highlights of Occupant Satisfaction
4. Highlights of Cultural Relevance

2.2.1 TBL Summary

Please Note: The summary provided here highlights the findings of the consultants involved in the renovation feasibility study, across the TBL. The TBL perspective supplements the other aspects of the decision process, and taken together with those other aspects, provides a holistic perspective. It is not the intent of this TBL summary to repeat all of the information collected by the various consultants on the study team.

Financial Performance

> **The "Bottom Line": According to costing estimates done to date, renovation is the option with the lowest first costs.**
>
> New Construction/Renovation Costs: The preliminary costing reports prepared by the BTY Group indicate that the cost of renovating building 481 is approximately 77% of new construction. This figure is problematic as the UBC Renew program will not approve renovations that exceed 67% of the cost of new construction. CAGP indicated that the figure could possibly be brought in to line with the Renew figure. Alternatively, UBC may want to challenge AVED on the use of the cut-off figure, as it may be a barrier to achieving the optimal solution from a sustainability perspective.
>
> Global Costs--Interim Relocation: Campus and Community Planning estimated that the duration of relocation would likely be the same for renovation as for new

construction. Demolition: As per BTY costing estimates, a demolition cost of $1.5 million should be added to the new construction option.

Life Cycle Operating and Maintenance Costs: These costs have not yet been estimated for the renovation options, so it is unknown what the difference between renovation and new operation might be.

Environmental Impacts

The "Bottom Line": According to the environmental impact assessment conducted for this study, demolition and new construction would result in significantly higher environmental impacts than renovation.

Impacts of new construction vs. renovation: The Athena Environmental Impact Estimator was used to estimate the environmental impacts that could be avoided by retaining the building. Six impact categories were studied. It was discovered that 37,088,704 *additional* MJ of primary energy consumption would occur with demolition and new construction; 448,033 *additional* kg of solid waste would be generated; 198,556 *additional* air pollution index points would be accrued; 1,820 *additional* water pollution index points would be accrued; 1,792,193 *additional* kg of emissions with global warming potential (carbon dioxide equivalents) would be released; and 13,605,304 *additional* kg of raw resources would be used.

It is difficult to determine the order of magnitude difference between the renovation and new construction scenarios given the method chosen for this study. Another study using a different approach (but the same software) would be highly beneficial if more detail is needed. In addition, due to limitations of the method used in this study, the environmental impacts may be *underestimated* by up to 30%. Again, another study would yield more accurate results, though the current results are still meaningful.

Impacts associated with energy use: One area of concern with the environmental performance of renovations vs. new construction lies in the potential differences in operating energy efficiency. As energy use models have not yet been developed for the renovation or new construction options, the differences between them cannot be assessed. However, it is generally assumed that new HVAC systems installed as renovations in existing buildings do not achieve quite the same level of operating efficiency as in new construction.

Occupant Satisfaction

The "Bottom Line": According to the consultant reports and stakeholder consultations undertaken to date, renovation could deliver a comfortable and usable space for different user groups. Use as Swing Space may be more successful given the Law Faculty's history with the building.

The building renovation would create a vastly improved interior space for the occupants. A new HVAC system, new windows, insulation, washrooms, interior finishes, and reconfiguration of spaces would create the equivalence of a new

building, in terms of comfort (i.e. with respect to temperature and noise levels.) However, it is important to note that the satisfaction with the renewed space may differ significantly by user group.

Faculty of Law: The Faculty of Law has occupied building 481 since it was first constructed in1973. The complaints from faculty, staff and student occupants have primarily been linked to issues with the HVAC system (conditions of discomfort relating to temperature and noise.) According to Law administration, the frustration felt over the HVAC system's failings, inflexibility of space for reconfiguration, poor positioning of windows, problems with the library space, and other major issues over the years may not be resolved by renovation. CAGP Option 3 features renovating the building for continued use by the faculty, along with removing some portions of the building and constructing an addition. Law has expressed concern that this scenario may impede their efforts to fundraise for the new building. A formal study consulting student groups and other users was not done at this time, so it is not known if all users currently feel the same way about the building.

Other Users: CAGP indicated that building 481 could be successfully configured into Swing Space. It is likely that the renovated space would perform well for the occupants.

Cultural Relevance

The "Bottom Line": According to the heritage assessment conducted for this study, renovation would retain an important architectural asset for the UBC community, and the community at large.

Heritage Value: In his assessment of the building, Heritage consultant Robert Lemon stated "The Hollingsworth addition to the Curtis Building is an important work of architecture and a landmark on the UBC Campus. Its heritage value, using City of Vancouver criteria, rates it in the "A" category. A rare, excellent example of the concrete late modernist architecture, the detailing shows the imprint of its designer, one of BC's most important architects, Fred Thornton Hollingsworth."

Mr. Lemon goes on to recommend that the building should be listed as a heritage building; that it be retained as part of the site redevelopment alternatives; and that rehabilitation should be done respecting the values of the original design

2.2.2 Conclusion

In each of the "bottom lines" selected for this study, renovation performs very well. The two somewhat problematic areas (renovation costs as compared to new construction, and variable satisfaction with renovation depending on user group) could be resolved through various means. For example, the renovation costs may be able to be brought down to within 67% of the cost of new construction, or UBC may choose to challenge AVED on the use of this figure. With respect to the user group issue, renovation for use as Swing Space would resolve the issue of the Faculty of Law's dissatisfaction with the building—they could be accommodated in a new building next to building 481.

3. Avoiding Environmental Impacts by Retaining the Building

The purpose of this section is to describe the method used to estimate the environmental impacts that can be avoided by retaining and renovating building 481. This portion of the report serves to provide an actual estimate, and also to pilot the use of the Athena software for Land and Building Services and the Sustainability Office.

While both renovation and new construction cause environmental impacts to occur, the degree to which they differ may be significant. Renovations typically include the demolition/removal and replacement of windows, HVAC systems, interior finishes, partitions, and perhaps changes to the envelope, while the structural system and remaining envelope system stay intact. By comparison, demolition and new construction result in substantially more demolition activity, and create demand for additional material extraction, manufacture, transportation, and on site construction.

In order to determine the *difference* in environmental impacts between renovating building 481 and constructing a new building, it is necessary to credit the retention of systems that would remain in the case of renovation (i.e. retaining systems = avoided environmental impacts.) For example, if the roof membranes and windows are to be replaced in the renovation, they need not be accounted for in this assessment method, as they would also be removed in the case of total demolition. Conversely, the foundations, structural components, and envelope systems that would remain in the case of renovation should be accounted for. Thus, it is not the total effects of renovation and new construction options that will be determined in this study, but instead the significant difference between them. This approach saves time and effort, while still allowing for the major environmental impacts to be estimated.

3.1 Method

The Athena software was chosen for use in this study because it is the only North American software that allows for the life cycle assessment of whole buildings and individual building assemblies (walls, roofs, floors and foundations). Also, the author secured a donated copy of the software and access to technical support from the Athena Institute, to be used in class work and thesis research.[3]

The process for estimating the avoided environmental impacts of retaining major components of building 481 is derived from a method developed by the Athena Sustainable Materials Institute.[4] The method has been modified and streamlined to coordinate with quantity survey data supplied by CAGP. Staff at CAGP created a model of the building using the Autodesk Revit software, to supply the author of this report with the quantity survey information necessary for input into the Athena Environmental Impact Estimator software.

[3] The value of the software plus support is approximately $1000.

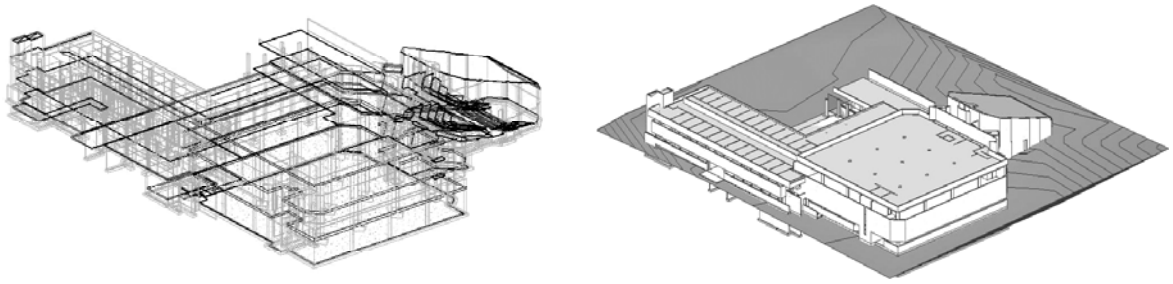
[4] Trusty, Wayne B. *Renovating vs. Building New: The Environmental Merits*. 2004. Presentation to the OECD/IEA Workshop on Sustainable Building, Tokyo Japan. From Athena SMI website: http://www.athenasmi.ca/publications/docs/OECD_paper.pdf

3.2 Quantity Survey

Autodesk Revit is a building information modeller that is used for developing designs and documenting building information. For this study, staff at CAGP modelled building 481 using existing architectural drawings, then extracted schedules of quantities from the modelled information. Only the assemblies that would be retained in the event of a renovation are accounted for. The building assemblies that were quantified for use in this study are limited to: foundations, structural columns, floor slabs, stairs, roofs (minus roof membranes), concrete exterior and interior walls, and steel stud and drywall interior walls. The quantity survey information was provided in the form of tables, broken down by assembly and type (see Appendix). The author converted the information into appropriate units for entry into the Athena software.

3.2.1 Accuracy of Quantity Survey

The majority of the quantity survey consisted of concrete and steel rebar. As the architectural drawings did not specify rebar content, the steel rebar ratios (i.e. pounds of steel per cubic foot of concrete) were estimated by CAGP. CAGP indicated that the estimates may be high, but are still reasonable. The concrete quantities provided by the survey are considered to be accurate within +/- 5 to10%.



Figures 1 a and b: Models of Building 481 generated with Autodesk Revit software

Created by the Colborne Architectural Group

3.3 Environmental Impact Estimation

The Athena Environmental Impact Estimator (EIE) software allows designers and researchers to assess the 'cradle-to-grave' (life cycle) implications of building alternatives in terms of embodied energy use, global warming potential, solid waste emissions, pollutants to air, pollutants to water and natural resources use. Entire buildings or individual assemblies can be analyzed. In addition, annual energy use information can be entered to capture the life cycle effects of energy consumption.

Profiles of buildings are constructed by entering information on the size and composition of recognizable units of a building structure (foundations, floor and roof systems, walls, and

structural support systems.) Users can also add additional basic materials as 'bulk entries', where quantities of concrete, steel, and other materials are known.

The Athena software's outputs consist of life cycle impact data in both graphic and tabular formats, by either summary measures or absolute values. The absolute value tables take the form of large, highly detailed spreadsheets, whereas the graphs are much more compact and easy to interpret. The Athena Institute provides the summary measures option for users due to the difficulty of using and interpreting detailed life cycle inventory results. The six summary measures include:

- Aggregate ecologically weighted resource requirements;
- Embodied energy inputs by type;
- Global warming potential;
- An index of water pollution effects;
- An index of air pollution effects; and
- Solid wastes.

The interpretation of the results is directly linked to the purpose for which the study was originally undertaken, such that users will interpret the output information differently. For example, certain impact categories may be of interest to different groups in different regions.

3.3.1 Modifications to standard Athena method for this study

There were two main modifications made to the Athena method in this study.

Modification 1: The first modification in this study was to the way entries were made into the Athena software. The standard use of the software entails entering the required information by individual assembly which requires technical knowledge and familiarity with building systems. As the author does not have this background, and it would have been much more expensive to UBC for CAGP or another consultant to purchase, learn, and run the software, an alternative method was developed. CAGP was able to quickly generate a quantity survey with the Autodesk Revit software and pass the information on. The Athena Institute actually does allow for buildings to be entered in this way, but stresses that the environmental impacts will be underestimated, by up to 30% (see next section):

> "In fact, if a design has been previously broken down into a basic bill of materials, then it can be entered by simply entering basic materials without reference to the predetermined assemblies, but with the following limitation caveat: when using the "Extra Basic Materials" input dialogue the environmental implications of associated on-site construction activity and final transportation to the site are not calculated for the selected materials. Hence, you will underestimate the total environmental load."[5]

Modification 2: The second modification is with regards to the total environmental impacts that are avoided when a building is retained, namely the effects of demolishing building assemblies, *plus* the effects of rebuilding replacement assemblies. The method described in the Athena Institute's research paper entitled *Renovating vs. Building New: The*

[5] *Introduction,* Athena Environmental Impact Estimator User's Manual: http://www.athenasmi.ca/

Environmental Merits[6] entails the estimation of both sets of impacts. As detailed drawings of a replacement structure have not yet been made, it is not possible to use the same method that was used to model the assemblies that are retained in the renovation (i.e. using similar quantity survey data for the new construction.) As per very rough estimates by CAGP, it is assumed that approximately the same amount of concrete would be used in the new construction, though of course it would be arranged completely differently, stretched over three floors, and built with either 25% or 35% flyash concrete.

3.3.2 Accuracy of Athena Results

The bulk entry method, a combination of quantity survey information with the Extra Basic Materials entry option, was the quickest way to use the Athena software for this study. In personal communication with technical support at the Athena Institute, however, the author learned that construction effects in a concrete building such as building 481 can account for up to 30% of the total life cycle impacts. As the Extra Basic Materials entry option does not allow construction effects to be captured, the environmental effects may be *substantially underestimated*.

The accuracy of the Athena results is also affected by the accuracy of the quantity survey. As discussed previously, the reinforcing steel rebar content information provided in the survey was based on CAGP estimates. The margin of error is not known for the steel rebar content, though CAGP has indicated that the estimates may be on the high side.

3.3.3 Data Inputs

Table 1 provides a summary of the total quantities that were entered in to the software, broken down by assembly type. Tables in Appendix A provide a more detailed breakdown. As all of the information was kept separate, the environmental effects of removing individual assemblies in different parts of the building could be estimated. In order to model the effects of replacing the building with roughly the same amount of concrete but a different flyash content, two additional scenarios were entered (rebuild with 25% flyash, or rebuild with 35% flyash.) The psi value was kept the same for these additional entries (4000 psi).

Table 1: Summary of Inputs Into Athena Software

Assembly	Extra Basic Materials Entry					
	Concrete		Steel			Extra Envelope Materials
	4000 psi, average flyash (y^3)	Masonry Blocks (#of Units)	Rebar Rod Light Sections (Tons)	Galvanized Decking (Tons)	Galvanized Studs (Tons)	5/8" Regular Gypsum Board (ft^2)
Foundations	393.52		132.82			
Columns	149.54		30.14			
Floor Slabs	2098.22		424.95			

[6] Trusty, Wayne B. *Renovating vs. Building New: The Environmental Merits*. 2004. Presentation to the OECD/IEA Workshop on Sustainable Building, Tokyo Japan. From Athena SMI website: http://www.athenasmi.ca/publications/docs/OECD_paper.pdf

Stairs	51.44		10.4			
Roofs—Concrete	953.29		318.32			
Roof—Steel Deck				3.65		
Exterior Walls—Cast in Place	1220.67		287.65			
Interior Walls—Cast in Place Partitions	675.3		150.97			
Interior Walls—CMU Partitions		324				
Interior Walls— Stud and Drywall					2.96	25355
Totals	**5541.98**	**324**	**1355.25**	**3.65**	**2.96**	**25355**

3.3.4 Data Outputs

The results are presented here in tabular form, by summary measure. Alternatively, the absolute value tables could be used to present the raw data. Raw data allows for more detailed study, but is more difficult to interpret at the 'big picture' level.

The manufacturing and construction data for average flyash content in Table 2A (next page) represents the embodied effects that have already occurred in sourcing and constructing the assemblies in building 481. The end-of-life data indicates the demolition impacts that would occur if the assemblies were demolished. Table 2B indicates the impacts that would occur if building 481 was rebuilt with 25% flyash concrete, while 2C indicates the impacts of rebuilding with 35% flyash.

While renovation also involves impacts, this study focussed in on determining the differences between the renovation and new construction options. To reiterate, it is the difference between the two scenarios that was estimated in this study. Compared to renovation, demolition and rebuilding with 35% concrete would result in the following additional impacts:

- 37,088,704 *additional* MJ of Primary Energy Consumption
- 448,033 *additional* kg of Solid Waste
- 198,556 *additional* Air Pollution Index Points
- 1,820 *additional* Water Pollution Index Points
- 1,792,193 *additional* kg of Emissions with Global Warming Potential (Carbon Dioxide Equivalents)
- 13,605,304 *additional* kg of Resources Used

Rebuilding with 25% flyash concrete instead of 35% flyash concrete would result in slightly higher impacts across most of the categories. (The values from the "total embodied" column in Table 2B can be substituted for the values pertaining to 35% concrete in the above summary.)

Tables 2 A, B and C: Outputs from Athena Software: Summary measures by Life Cycle Stages for Average, 25% and 35% Flyash Content

- Note: The **solid rectangle** includes all the embodied effects (environmental impacts that have already occurred) in sourcing materials to construct the major assemblies in building 481. The **dashed rectangles** include the impacts that would occur if demolition and new construction were to take place.

Table 2A: Actual Assemblies, Building 481: Assumed to be "Average Flyash Content"

	Manufacturing	Construction	Operations and Maintenance*	End of Life	Total Embodied
Primary Energy Consumption (MJ)	36318468	2265786	0	285418	38869672
Solid Waste (kg)	462512	20	0	3	462535
Air Pollution Index	232850	686	0	113	233649
Water Pollution Index	1820	0	0	0	1820
Global Warming Potential (kg)	2039736	3851	0	583	2044170
Weighted Resource Use (kg)	13897045	51415	0	6477	13954937

Table 2B: Rebuild assemblies with 25% Flyash Content

	Manufacturing	Construction	Operations and Maintenance*	End of Life	Total Embodied
Primary Energy Consumption (MJ)	35169567	2265786	0	285418	37720771
Solid Waste (kg)	453264	20	0	3	453287
Air Pollution Index	210472	686	0	113	211271
Water Pollution Index	1820	0	0	0	1820
Global Warming Potential (kg)	1879049	3851	0	583	1883483
Weighted Resource Use (kg)	13588132	51415	0	6477	13646024

Table 2C: Rebuild assemblies with 35% Flyash Content

	Manufacturing	Construction	Operations and Maintenance*	End of Life	Total Embodied
Primary Energy Consumption (MJ)	34537500	2265786	0	285418	37088704
Solid Waste (kg)	448010	20	0	3	448033
Air Pollution Index	197757	686	0	113	198556
Water Pollution Index	1820	0	0	0	1820
Global Warming Potential (kg)	1787759	3851	0	583	1792193
Weighted Resource Use (kg)	13547412	51415	0	6477	13605304

*** The operations and maintenance phase of the building life cycle accrued none of the impacts in each case because operating energy consumption was not entered for this study.**

4.Conclusion

The purpose of this report was to provide a Triple Bottom Line perspective to the renovation feasibility study for the 1973 addition to the G.F. Curtis Building. In addition, an environmental impact assessment of the additional impacts that would occur in the case of demolition and new construction was undertaken.

The results of this TBL Assessment suggest that the 1973 addition to the G.F. Curtis building should be retained and renovated. In this study, the building has been deemed an important heritage building with architectural merit; it has been shown to be successfully amenable to various renovation scenarios for different user groups; it is the option with the lowest first costs; and it is the option with the lowest environmental impacts.

The two dominant concerns in the study relate to the costs of renovation when compared to new construction, and the possible dissatisfaction of the Law Faculty with occupying the renovated building. Both of these concerns have been shown to be resolvable in this study. In the costing sections of the study, it has been found that renovation costs could be brought within the 67% range required by UBC Renew (or, alternatively, UBC could make a case of challenging AVED on the use of this cut-off figure.) There is adequate room on the site for new construction in which to house the Law Faculty, such that the renovated building could provide badly need Swing Space.

As the benefits of retaining the G.F. Curtis addition outweigh the costs (across the Triple Bottom Line) and the problems with renovation can be resolved, renovation is the preferred option.

4.1 Recommendations

The two recommendations that flow from this assessment are as follows:

1. The addition to the G.F. Curtis building should be retained and renovated;

2. Further study could be done to formalize the results for inclusion in the business case or other communication with the Ministry of Advanced Education, taking the form of a Multiple Accounts Evaluation. This could help to support the case that the building is an asset.

4.2 Next Steps…

If decision-makers at UBC decide to integrate the TBL Assessment format into communications with AVED regarding the G.F. Curtis addition renovation, a formalized TBL assessment will likely be required. It is recommended that the Multiple Accounts Evaluation format be used.

The Multiple Accounts Evaluation format that is the subject matter of the author's SEEDS project is intended to provide the framework and method UBC can use to formalize the inclusion of the TBL perspective into decision practice. The project will soon be finalized and presented to Land and Building Services.

APPENDIX A: Total Inputs for Athena Software

Structural Foundations

- Entered as *Extra Basic Materials:* Cubic Yards of '4000 psi Concrete, Average Flyash' and Tons of 'Rebar Rod Light Sections'

Classification	Description (inches)	Count	Concrete Volume		Reinforcing Steel (25 pounds/ft3)
			Cubic Feet	Cubic Yards	Tons
Spread Footings	Continuous Footing 36x12	100	5116	189.48	63.95
Footings and Pile Caps	Pile Cap – 81x81x36	11	3007	111.37	37.59
Footings and Pile Caps	Pile Cap – Column Pad	45	2502	92.67	31.28
Totals				393.52	132.82

Superstructure; Structural Columns

- Entered as *Extra Basic Materials:* Cubic Yards of '4000 psi Concrete, Average Flyash' and Tons of 'Rebar Rod Light Sections'

Location/Level	Description (inches)	Count	Concrete Volume		Reinforcing Steel (50pounds/ft3)
			Cubic feet	Cubic Yards	Tons
Basement	Library Slab Edge– 24x24	5	140	5.19	3.5
Basement	Rectangular – 12x24	2	56	2.07	1.4
Basement	Square - 24x24	11	616	22.81	15.4
Level 1 (Library)	Library Slab Edge – 24x24	6	169	6.26	4.23
Level 1 (Library)	Rectangular – 12x18	4	66	2.44	1.65
Level 1 (Library)	Rectangular – 12x24	14	308	11.41	7.7
Level 1 (Library)	Rectangular – 12x30	3	83	3.07	2.08
Level 1 (Library)	Rectangular – 15x18	23	561	20.78	14.03
Level 1 (Library)	Square – 12x12	1	11	0.41	0.28
Level 1 (Library)	Square – 24x24	11	616	22.81	15.4
Level 2 (Faculty)	Rectangular – 12x18	8	124	4.59	3.1
Level 2 (Faculty)	Rectangular – 15x18	21	408	15.11	10.2
Level 2	Library Slab Edge – 24x24	7	264	9.78	6.6
Level 2	Square – 24x24	11	616	22.81	15.4
Totals				149.54	30.14

Floor Construction; Concrete Floor Slabs

- Entered as *Extra Basic Materials:* Cubic Yards of '4000 psi Concrete, Average Flyash' and Tons of 'Rebar Rod Light Sections'

Location	Level	Description	Concrete Volume		Reinforcing Steel (15 pounds/ft3)
			Cubic feet	Cubic yards	Tons
Building Services/Circulation	Basement	6" Concrete Slab	849	31.44	6.38
Building Services/Circulation	Level 1 (Library)	6" Concrete Slab	1226	45.41	9.20
Courtyard	Level 1	6" Concrete Slab	1360	50.37	10.20
Faculty	Basement	6" Concrete Slab	573	21.22	4.30
Faculty	Basement (Faculty)	6" Concrete Slab	233	8.63	1.75
Faculty	Level 1 (Library)	6" Concrete Slab	4250	157.41	31.88
Faculty	Level 2 (Faculty)	6" Concrete Slab	5631	208.56	42.23
Lecture Theatre	Level 1 (Library)	5" Concrete Slab	1584	58.67	11.88
Lecture Theatre	Level 2 (Faculty)	Concrete on Deck	704	26.07	5.28
Lecture Theatre (Ramp)	Level 1 (Library)	6" Concrete Slab	192	7.11	1.44
Library	Basement	6" Concrete Slab	6486	240.22	48.65
Library	Level 1 (Library)	15" Concrete Slab	15646	579.48	117.35
Library	Level 2	15" Concrete Slab	16590	614.44	124.43
Stair 2	Level 1 (Library)	6" Concrete Slab	10	0.37	0.08
Stair 2	Stair 2 Landing	6" Concrete Slab	41	1.52	0.31
Stair 5	Level 1 (Library)	6" Concrete Slab	14	0.52	0.11
Stair 5	Level 2 (Landing)	6" Concrete Slab	14	0.52	0.11
Stair 7	Basement	6" Concrete Slab	21	0.78	0.16
Students	Level 1 (Student)	6" Concrete Slab	1228	45.48	9.21
Totals				2098.22	424.95

Stair Construction

- Entered as *Extra Basic Materials:* Cubic Yards of '4000 psi Concrete, Average Flyash' and Tons of 'Rebar Rod Light Sections'
- All Concrete is Cast-in-Place

Location	Base Level	Top Level	Concrete Volume		Reinforcing Steel (15 pounds/ft^3)
			Cubic feet	**Cubic yards**	**Tons**
Stair No. 1	Level 1 (Library)	Level 2 (Faculty)	71	2.63	0.53
Stair No. 1	Basement (Faculty)	Level 1 (Library)	71	2.63	0.53
Stair No. 1	Level 2 (Faculty)	Roof (Faculty)	71	2.63	0.53
Stair No. 2	Basement (Faculty)	Basement (Faculty)	28	1.04	0.21
Stair No. 2	Stair 2 landing	Level 1 (Library)	28	1.04	0.21
Stair No. 2	Basement	Basement (Faculty)	17	0.63	0.13
Stair No. 2	Level 1 (Library)	Level 2 (Faculty)	51	1.89	0.38
Stair No. 2	Stair 2 landing	Level 1 (Library)	28	1.04	0.21
Stair No. 2	Level 2 (Faculty)	Level 2	21	0.78	0.16
Stair No. 3	Basement	Level 1 (Library)	124	4.59	0.93
Stair No. 3	Level 1 (Library)	Level 2	124	4.59	0.93
Stair No. 4	Basement	Level 1 (Library)	160	5.93	1.2
Stair No. 4	Level 1 (Library)	Level 2	160	5.93	1.2
Stair No. 5	Basement	Basement	55	2.04	0.41
Stair No. 5	Level 1 (Library)	Level 1 (Library)	55	2.04	0.41
Stair No. 5	Level 2	Level 2	55	2.04	0.41
Stair No. 6	Level 1 (Library)	Level 2 (Faculty)	62	2.3	0.47
Stair No. 7	Basement	Level 1 (Library)	61	2.26	0.46
Stair No. 7	Basement	Basement	47	1.74	0.35
Stair No. 7	Level 1 (Library)	Level 2 (Faculty)	99	3.67	0.74
Totals				51.44	10.4

Concrete Roofs

- Entered as *Extra Basic Materials:* Cubic Yards of '4000 psi Concrete, Average Flyash' and Tons of 'Rebar Rod Light Sections'

Roof Type	Location	Base Level	Area (ft^2)	Concrete Volume		Reinforcing Steel (All 25 pounds/ft3)
				Cubic feet	**Cubic yards**	**Tons**
15" Concrete Deck – EPDM (Waffle Slab)	Library	Roof	13113	16665	617.22	208.31
Concrete Deck – EPDM	Faculty Block	Roof	11999	6250	231.48	78.13
Concrete Deck – EPDM	Student Block	Level 2	2655	1383	51.22	17.29
Concrete Deck – EPDM	Stair 1		174	91	3.37	1.14
Sloped Concrete	Theatre (North end)	Level 1 (Library)	456	304	11.26	3.8
Sloped Concrete	Stair 7	Level 2 (Faculty)	85	57	2.11	0.71
Totals					953.29	318.32

Steel Deck Roof

- Entered as *Extra Basic Materials:* Tons of Galvanized Decking
- EPDM not included because it would be removed in renovation as well

Roof Type	Location	Base Level	Area (ft^2)	Galvanized Decking (Tons)
Steel Deck - EPDM	Theatre	Roof	3653	3.65

Exterior Walls, Cast in Place

- Entered as *Extra Basic Materials:* Cubic Yards of '4000 psi Concrete, Average Flyash' and Tons of 'Rebar Rod Light Sections'

Wall Type and Width (inches)	Area (ft^2)	Width (inches)	Assumed Dimensions		Concrete Volume		Reinforcing Steel	
			Av. Height (feet)	Length (feet)	Cubic Feet	Cubic Yards	Unit Weight (pounds/ft3)	Tons
CIP, 6"	528	6	12	44	264	9.78	15	1.98
CIP, 8"	24763	8	12	2063.58	16508	611.41	15	123.81
CIP, 10"	6524	10	12	543.67	5436	201.33	20	54.36
CIP, 12"	10794	12	12	899.5	10750	398.15	20	107.5
Totals						1220.67		287.65

Interior Walls, Cast In Place Partitions

- Entered as *Extra Basic Materials:* Cubic Yards of '4000 psi Concrete, Average Flyash' and Tons of 'Rebar Rod Light Sections'

Wall Type and Description	Area (ft^2)	Width (inches)	Concrete Volume		Reinforcing Steel	
			Cubic Feet	Cubic Yards	Unit Weight (pounds/ft^3)	Tons
CMU Partition, 4.5"	1001	5	375	13.89	10	1.88
CMU Partition, 6"	1559	6	780	28.89	15	5.85
CMU Partition, 8"	16525	8	11018	408.07	15	82.64
CMU Partition, 10"	3894	10	3245	120.19	20	32.45
CMU Partition, 12"	2816	12	2815	104.26	20	28.15
Totals				675.3		150.97

Interior Walls, CMU Partitions

- Entered as *Extra Basic Materials:* Number of Concrete/Masonry Blocks (8 x 8 x 16 inch)

Wall Type and Description	Area (ft^2)	Width (inches)	Concrete Volume		Number of Blocks (Derived from Concrete Volume and Athena block dimensions)
			Cubic Feet	Cubic Yards	
CMU Partition	308	8	191	7.07	324

Interior Walls, Steel Stud and Drywall

- Entered as *Extra Basic Materials:* Square Feet of '5/8" Regular Gypsum Board' and Tons of 'Galvanized Studs'
- Colborne estimate of Steel Stud weight is based on manufacturer's specification, 0.4 pounds per LF

Wall Type	Description	Gypsum Wall Board	Steel Studs	
		Area (ft^2)	Length (Feet)	Weight (Tons)
Partitions, Steel Stud and Drywall	Interior S4-SS 3-5/8", GWB 5/8"	25355	14790.58	2.96

‘Renewing’ UBC Renew

Building Full Cost Assessment into Renovate vs. Replace Decisions at UBC

SEEDS Project Final Presentation

Alison Aloisio • July 25, 2006

Overview

1. *Aspirations:* Renewing UBC Renew

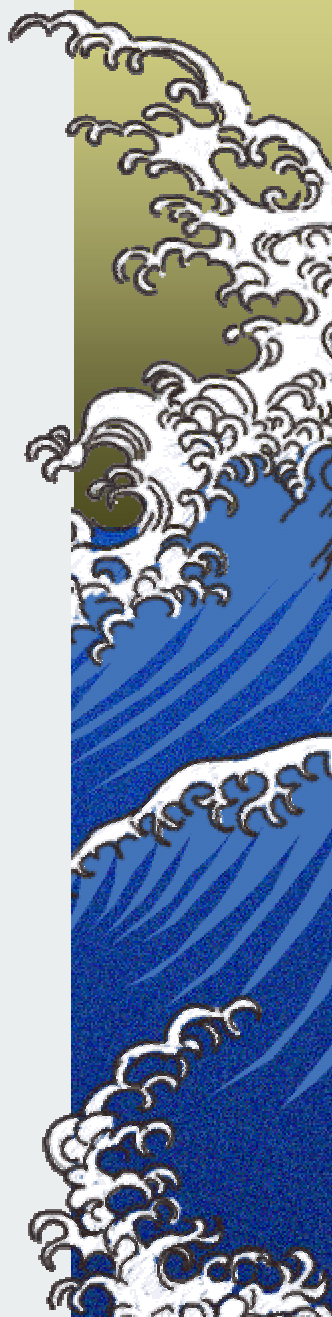
2. *Concept Foundations:* Full Cost Assessment

3. *Touchstones:* UBC and AVED

4. *Synthesis:* FCA Framework

5. *Application:* G.F. Curtis Law Building

6. *Conclusion*



SEEDS: Social, Ecological, Economic Development Studies

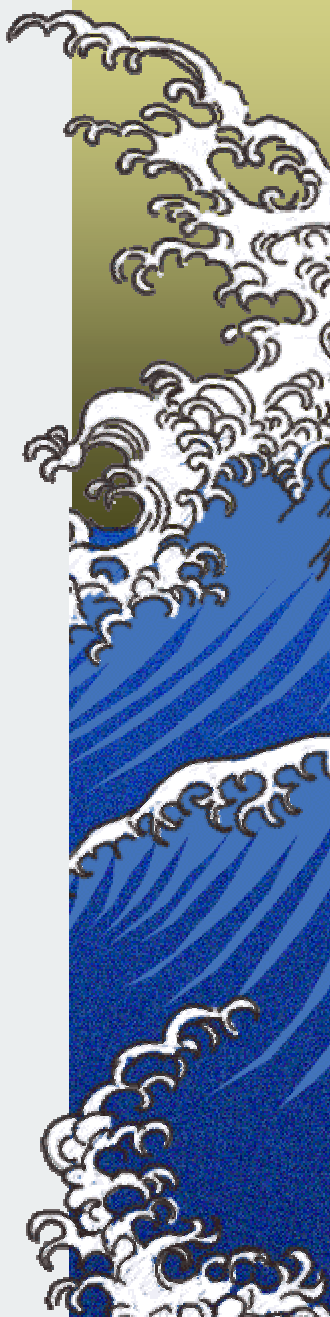
*…seeks out projects that are **implementable** and that will enable campus decision-making that integrates all three aspects of sustainability; the social, ecological and economic.*

UBC Renew

This partnership program is addressing:

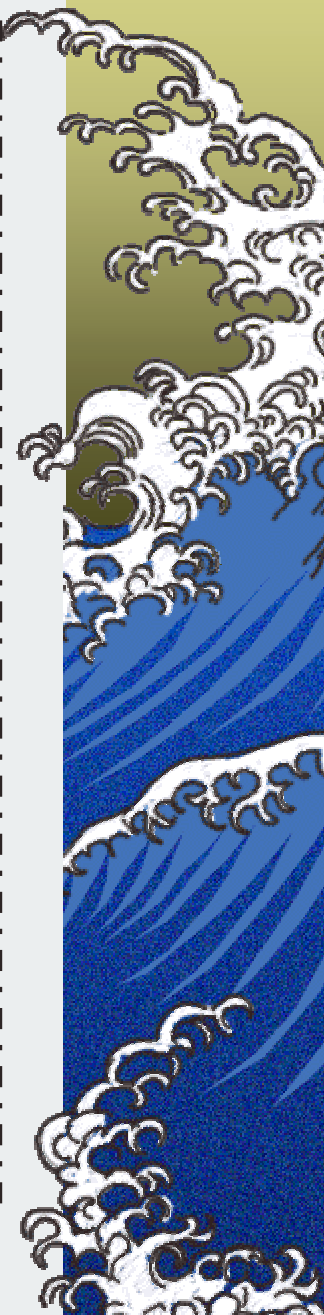
- Accumulated Deferred Maintenance debt
- Academic Improvements

Problem: The established conventions for business case contents and the 67% rule do not allow broader assessments to be incorporated into the decision process



UBC SEEDS
PROJECT REGISTRATION FORM

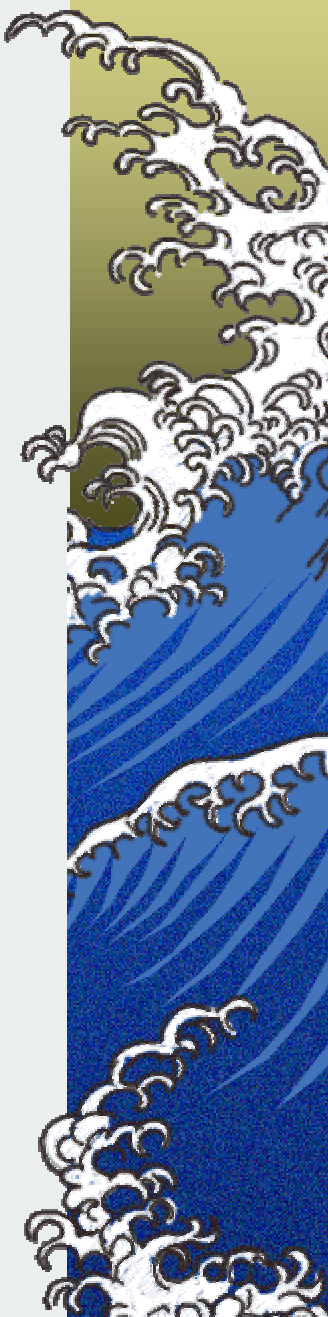
Project Information	
Working Title of Project	Total Cost Assessment of Buildings Slated for Demo or Reno at UBC
Overall Purpose of Project	This project will determine a method for evaluation of existing buildings that takes into consideration the social, ecological and economic impact of replacement vs. renovation.
Contribution to Sustainability at UBC	Social-retention of existing aesthetic and history Ecological-reduced waste, more reuse, longer lasting buildings Economic-more value for money
Outline of Project Details	At present, the decision to renovate or replace buildings on campus is based on a strict existing MAE (Ministry of Advanced Education) formula such that if the cost of renovations exceeds 67% of the cost of a new building, a new building will replace the old. **This formula considers economic cost only and does not consider the total cost assessment (environmental and social costs of rebuilding). This project will propose a method to consider all three in decision making and lay out a method for determining if a bigger economic capital investment in existing buildings is justifiable from a sustainability point of view.**



1. Aspirations

Implementing UBC's vision for Sustainable Development

- Expanding the scope of cost assessment in UBC Renew
- Providing a defensible alternative that will resonate with both UBC and AVED



2. Concept Foundations

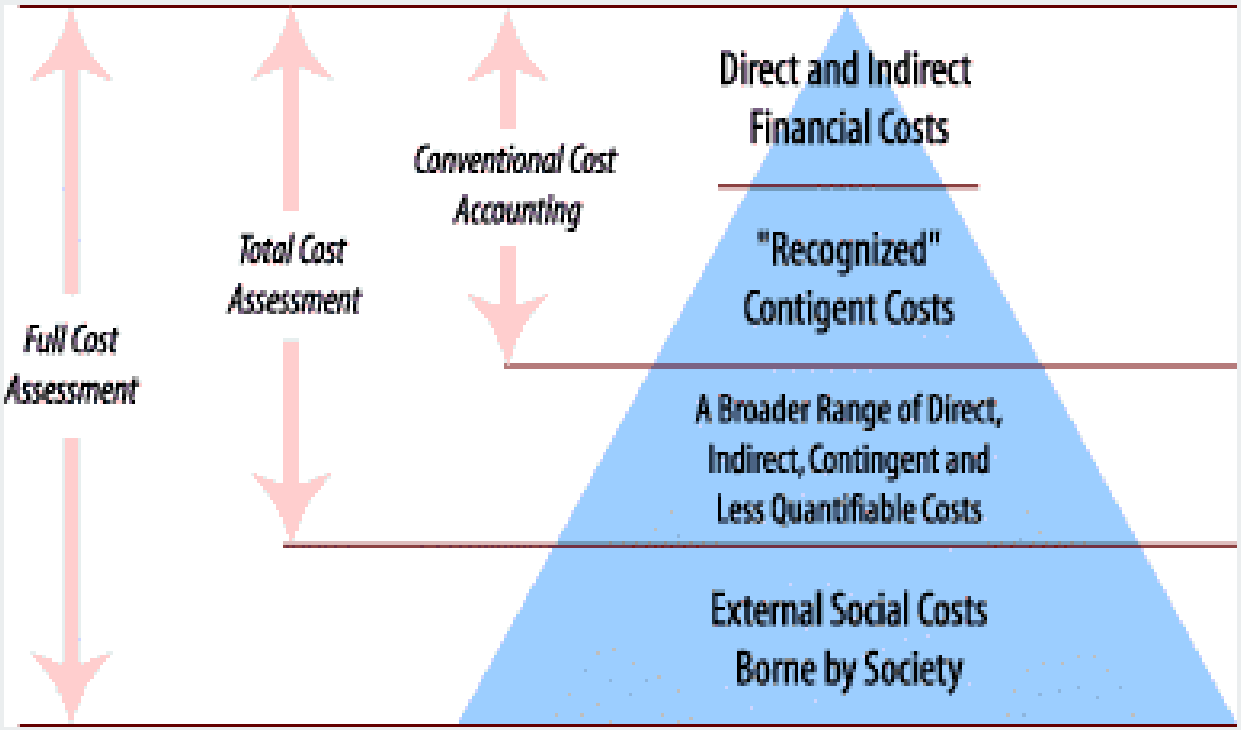


Image from http://www.bsdglobal.com/tools/systems_tca.asp

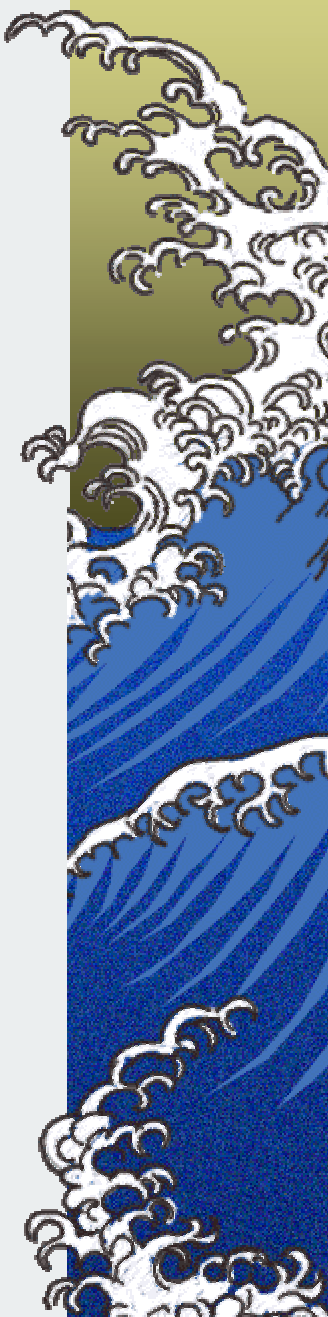
Alternative approaches to FCA

Social Benefit Cost Analysis (SBCA)

- Public sector framework intended to determine social profits from the perspective of the efficiency of the entire economy
- All values are measured in terms of dollars to allow for comparison amongst different types of costs and benefits
- Features:
  - Single objective focus: economic efficiency
  - Problems dealing with values for public goods that have no market to price them
  - Lack of consideration of winners and losers (distribution of costs and benefits)

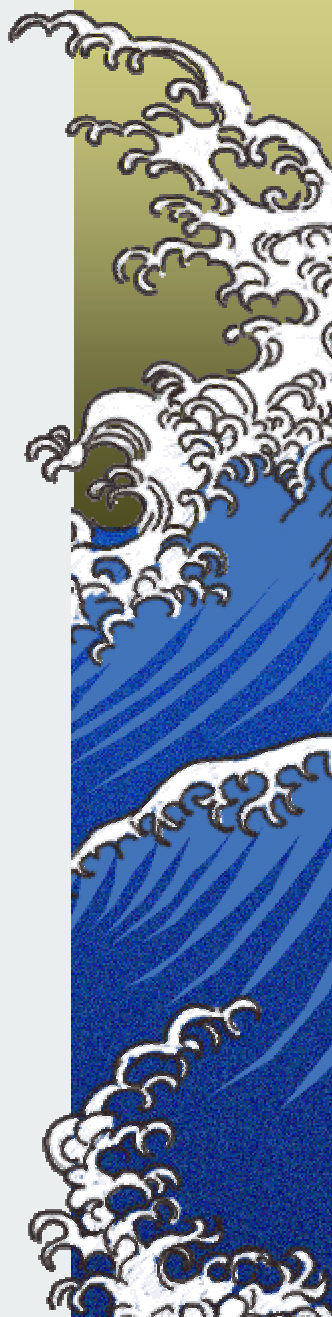
Multiple Objectives Analysis (MOA)

- More broadly based than SBCA
- Can be used in public and private sector
- Conceptual framework, set of techniques, and a process for attaining insight into complex decisions
- Features:
  - Monetization limited to certain aspects
  - Other aspects measured in ‘natural units’
  - Measures are not combined across categories
  - Not as many practitioners are as familiar with MOA as with SBCA



3. Touchstones

- UBC
  - Trek 2010
  - Policy #5: Sustainable Development
- AVED
  - Environmental Guidelines
  - Capital Asset Management Framework



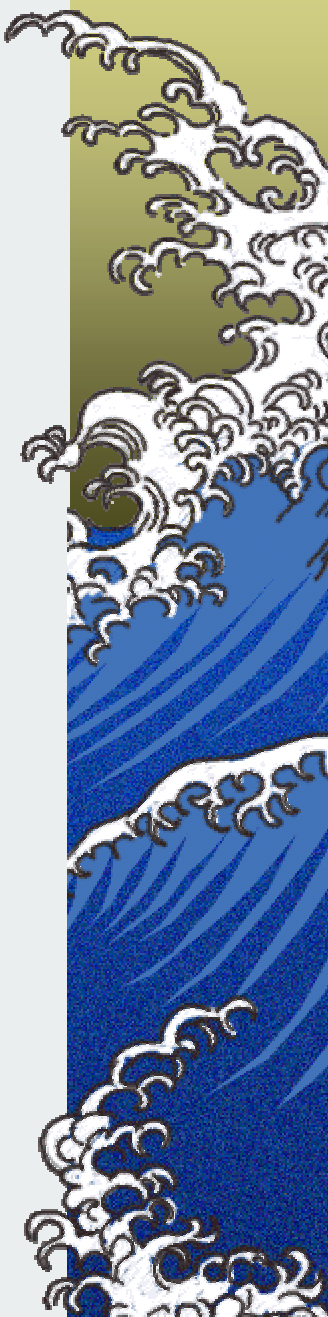
4. Synthesis

Foundations+Touchstones=Framework

- Information to be captured…
  - Effects on *Finances*
  - Effects on the *Environment*
  - Effects on *People* and *Culture*
- In a critical application….
  - Needs to be rigorous and acceptable as a basis for business cases

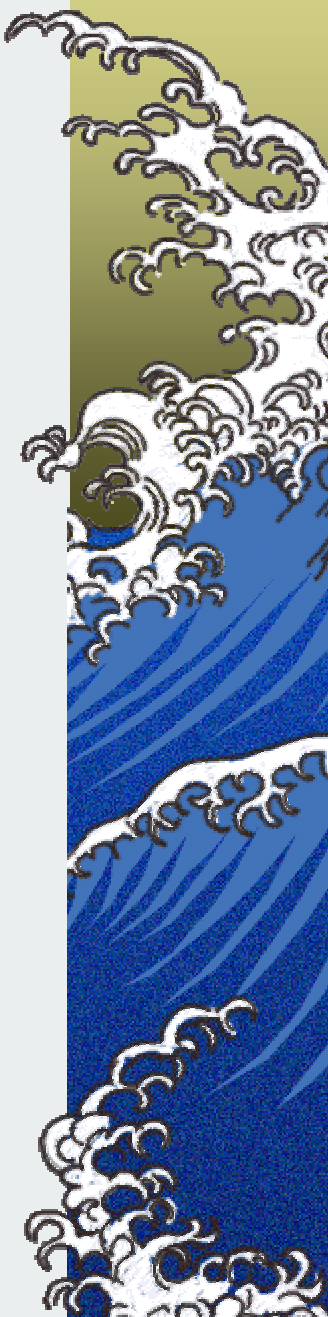
Multiple Accounts Evaluation

- Developed by Crown Corporations Secretariat in 1993 for Province of BC
  - **Purpose:** "To provide an evaluation framework to assist Crown corporation management and Boards in systematically identifying and evaluating the implications and relative merits of alternative plans and projects."
- Formal evaluation of financial, environmental, social and customer service accounts and forms basis for business cases
- Supported by AVED (see Capital Asset Management Framework)



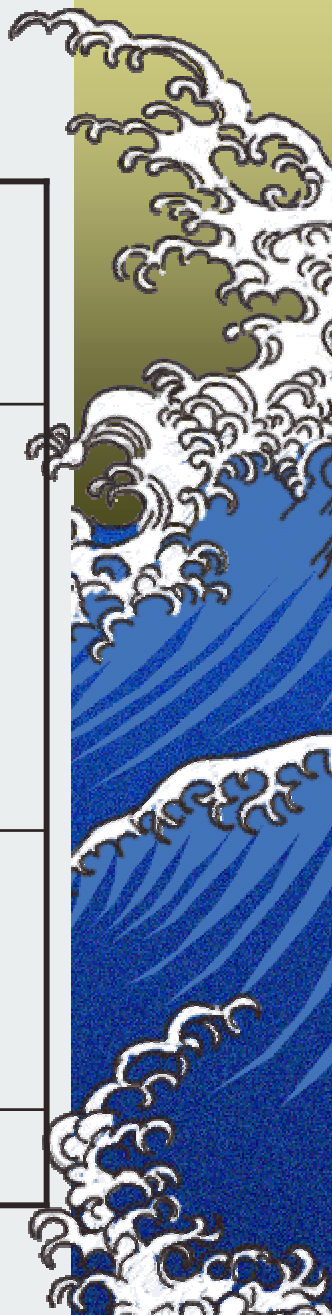
MAE Procedure

1. Problem definition and identification of alternatives
2. Specification of evaluation accounts
   - Financial Performance
   - Customer Service
   - Environment
   - Social
3. Documentation and assessment of implications under each account
4. Presentation and interpretation of results



Summary Matrix of Results

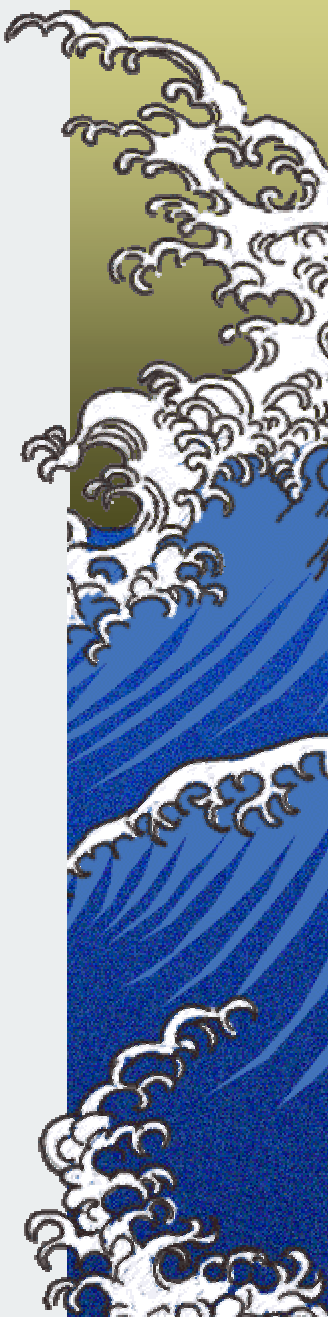
Financial	Life Cycle Cost (LCC) • Construction + Operation + Maintenance +/- End of Life (salvage and demolition cost)
Environmental	Whole Building Life Cycle Assessment (LCA) • Assesses the environmental performance of a building over its full life cycle across a wide range of potential effects • ATHENA Environmental Impact Estimator
Social	Heritage or architectural merit assessment
Customer Service	Service delivery assessment



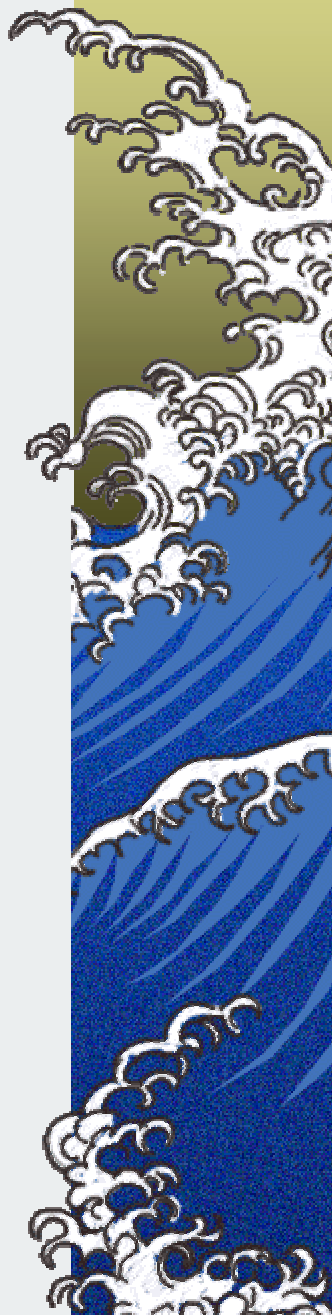
5. Application

Renovation Feasibility Study

- To renovate or rebuild the 1973 addition?
- A Triple Bottom Line Assessment Report….
  - Summarized work done by other consultants into TBL format (costing, heritage)
  - Piloted use of Athena Environmental Impact Estimator software
  - Recommended linking TBL with MAE for business case to AVED



Financial Performance ‘Global’ Project Costs (Cost consultant’s assessment)	**Bottom Line:** Renovation would be 77% of the cost of new construction
Environmental Impacts Impacts avoided by retaining the building (Estimated with Athena software)	**Bottom Line:** Demolition and new construction would result in significantly higher impacts
Social Impacts Occupant Satisfaction (Informal assessment) Cultural Relevance (Heritage consultant’s assessment)	**Bottom Line:** Occupant comfort would be addressed Renovation would retain an important architectural asset



6. Conclusions

- Acknowledge ‘Renewing’ UBC Renew includes a number of challenges:
  - Technical Issues (Life cycle costing, life cycle environmental impact assessment)
  - Value-Based Issues (identifying priorities, changing criteria for assessing public value in existing buildings)
- Full Cost Assessment using Multiple Accounts Evaluation will ‘Renew’ UBC Renew
  - supported by existing UBC and AVED policy
- TBL assessment can help to get the process started. Assessment can then be formalized into MAE to challenge the 67% rule.