.

**Problem:** There does not appear to exist an objective test that would determine if any given design is the most Sustainable at the same time as determining if that alternative would allow a community to be Sustainable. The test should be objective, repeatable, universal to all disciplines of engineering, and sensitive to culture, resource and technology availability, scale of community, and an undefined future.

As a result of this lack, the obligation that engineers have to ensure that Sustainable Development is incorporated in all the work they do, is rarely met.

**Introduction:** This poster explores the definitions and descriptions developed by others and expands on them to create self-consistent and complete definitions that can be used to derive the units of measure for Sustainability Engineering, and from those units, a method can be established to compare alternative designs. In addition, it introduces a method of combining resource consumption with the time required to meet needs to produce a relationship that is unique for every community and is sensitive to the definition of ‘needs’ and cultural expectations.

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**Time/Resource Relationship**

Within any community, there is a relationship between the Resources used and the Time used to meet needs.  If T(needs)=24 h/day/ca, then the community is at subsistence. Any reduction of resource availability will force the community to require more than 24 hours per day per person to meet their needs, and they will be in a state of deprivation.  When the resources used are equal to the resources available to the community, then the community is at capacity.  At some point, additional resource consumption will make effectively no difference to the time required to meet needs.

The graph below shows Canadian data from 2005, derived from Size Matters and the GSS Cycle 19. For Canada in 2005, T=1.899\*105\*EF-4.64 + 854.2 min/d/ca. R2 of this data is better than 98%.

|  |  |
| --- | --- |
| **First Principals** | **Evolved Principals** |
| Engineering maximizes utility while minimizing cost to the client (my understanding) | Sustainability Engineering maximizes the quality of life within a community while minimizing the negative ecological impacts |
| People use their time to meet their wants and needs (Wealth of Nations) | People use their time to meet their needs and wants directly, or use their time to convert resources into the means to meet their want and needs. All activities to meet needs and wants must occur within 24 h/d/ca. |
| Development is the process of increasing the quality of life of a community between two points in time. (Measuring Sustainable Development)  | Development is the union of at least Human Development and Technological Development. |
| Human development increases the freedoms, choices, and opportunities of people. (UNDP) | Human Development removes or reduces the obstructions that prevent individuals, families, and/or communities from being able to effectively use their time to meet their needs and aspirations. |
|  | Technological Development is the creation or enhancement of systems of infrastructure with the expectation of an improvement in the Potential Quality of Life of a community |
| Engineers build the Quality of Life (poster on the wall of the Civil Club in 1st year) | Engineers build Infrastructure. Infrastructure is an investment of time and resources with an expectation of a return on that investment in the form of time and/or resources into the future |
|  | Potential Quality of Life is the time available within a community for activities other than those required to meet needs. |
| 1. We must use renewable resources slower than they renew
2. We must use non-renewable resources slower than they can be replaced with renewable alternatives
3. We must produce wastes slower than the environment can absorb them or render them harmless (Daly's Rules)
 | Daly’s rules must be expanded on any scale less than ‘Planetary’* + 1. All labour and resources used to meet needs within any community must be managed by the community
 |
| A need is something that is necessary for organisms to live a healthy life. (Wikipedia) | Needs are aspects of Human Nature. Needs are met by activities that prevent the degradation of the individual, family or community. Needs include rest, nutrition, hydration, homeostasis, fitness, understanding, love, security. The tools and infrastructure associated with needs (or wants) would be the means to meet the needs, rather than needs themselves.  |

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**Figure 1: Resource and Time Use in Canada, 2005**

**Method**

|  |  |
| --- | --- |
| Community does | Engineer does |
| Establishes their boundary of needs in conjunction with their resources demand and supply. When demand outstrips supply, must establish a co-management relationship with other communities to ensure resources are available in perpetuity | Advises community on impact of choices of needs – like a pension, if you live richly today, you’ll live poorly tomorrow. |

|  |  |
| --- | --- |
| Client does | Engineer does |
| Establishes problem definition | Establishes a physical boundary of the community that is affected by the problem |
|  | Uses a database of resource supply and demand within that boundary (including all co-management relationships) |
|  | Develops alternative designs |
|  | Determines the life cycle time used to meet needs and resources used (and saved) by each alternative design |
|  | Applies a time cost for each alternative based on over-consumed resources and the slope of the time/resource curve |
|  | Applies a time penalty for using non-renewable resources that would be exhausted within the community during the lifecycle of the project |
|  | If net time saved for any alternative >0 = SustainableGreatest net time savings = Most Sustainable alternativeMaximum time saved / cost = Highest Sustainable Value |

**Conclusion**

This poster describes the approach taken to find a method that can be used to identify the most Sustainable alternative design for any Technological Development project, process, or product. The method is objective, repeatable, sensitive, and universal to all disciplines of engineering.

The method described uses a test that is based on an evaluation of needs within a community. That evaluation can be provided by others within the community and then used wholly objectively by the engineer. The method will determine if each alternative is Sustainable, and rank the alternatives according to how Sustainable each is. By using time as the unit of measure, the conditions for Sustainability per the expanded Daly rules can be met, and it can be used for any field of engineering, anywhere in the world.

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