Real Time Modelling: Life, Light, Architecture and Energy

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Is the art and science of light being reduced to an accounting exercise to meet a target in watts? Usually when reference is made to energy saving the focus is on tonnes of CO^2. What is a tonne of CO^2? At 25 degrees C and 1 atmosphere it is 556.2m^3. What is that visually? Actually (the room for this presentation), Parkside 110B is equivalent in volume to 2 tonne of CO^2. What does it mean in terms of light: it varies around Australia? A 100W incandescent lamp switched on in:

- NSW will contribute 1 tonne of CO^2 to the atmosphere from electricity generation in 3.1 months,
- VIC will contribute 1 tonne of CO^2 to the atmosphere from electricity generation in 2.5 months,
- TAS will contribute 1 tonne of CO^2 to the atmosphere from electricity generation in 2 years 1.6 months.

Same lamp used in each instance but different energy source for electricity generation. If the energy consumed by the air conditioning system is also taken into account the time period is reduced by 25 percent.

Are these references just theoretical numbers or do we have a sense of the meaning? What is the sense of the meaning of 10 or 3w/m^2 with respect to the appearance of an interior space?

Light *per se* cannot be seen: sunlight travels through space yet space is pitch black. Light must strike something; dust particle, water molecule, a surface etc so that the light is reflected and/or refracted toward our retina and received on our optic nerve for us to see. Humans 'see' wavelengths of energy photopically in the range 380nm (deep blue) through to 700nm (red) with a peak of efficiency at 555nm following the standard CIE curve that represents the average eye.

Light is essential to most forms of life, providing health and a sense of well-being. Our understanding of light and human behaviour is constantly under investigation as the demands for greater human performance is required whilst people work in man-made environments. Recent research would indicate that it is not just a matter of rods and cones in the retina and the state of adaptation of the visual system that affects visual perception of the environment but our pineal gland also influences our total experience. Stimulation of the pineal gland can suppress the production of melatonin within our bodies so that we feel more alert and this stimulation can be produced by exposure to high colour temperature light (similar to daylight approaching midday – bluish white light 6500 to 8000 kelvin or higher) for a short period of time when our circadian rhythm would normally be decreasing.

Light *per se* cannot be seen. Understanding how and why we see is important. Architecture and interior finish may vibrate with life when designed integrally with light. Surface hue, tone, texture and position within the volume are just as vital as knowing the intended ambience or emotion to be evoked by the experience of the space. What happened to the watts?

Lighting is neither about achieving 320 lux average maintained on a desk top or achieving 10 or 6w/m^2, they are simply numbers that also need to be achieved. Computer modelling is a useful tool to assist in calculating the quantity of light at a location and more frequently a tool to visualise the lit three dimensional spaces. Some architectural graphics packages can provide photographic quality simulations down to the glint and reflection of light in glass, however, a tool is only an aide and needs to be used with wisdom so that it does not mislead in the enthusiasm to impress.

Computer simulation of lighting can be achieved in a number of ways:

- If an architectural rendered image exists or a project exists and a photograph can be taken, the simplest technique is to use Photoshop. A skilled software technician and a light-wise designer can create a visual impression using that image or series of images. Energy consumption would be a collation of manual calculations of total installed wattage.
- If plans and/or elevations exist, a three dimensional model can be constructed within a computer program, the degree of sophistication depending on how much time a client is prepared to pay for on that project. There are a number of lighting programs that can be used. Commonly in Australia DIALUX is one option, AGI32 is another option and RADIANCE another.

DIALUX is freeware that is supported in Europe by many of the major lighting companies. DIALUX will produce moderately complex three dimensional spaces and lights can be grouped together, such as wall washers, and switched on or off in the program to provide an image of how the scene appears with or without that group of lights. With a number of groups of lights in the one space, a dynamic impression of the change can be provided by loading the static images into a Power Point presentation sequence. Power consumption is a manual collection of data of total installed wattage. To make a change and view the result requires reiteration of the process.

AGI32 in Australia has become an industry standard licensed software package. This package allows a more complex modelling of three dimensional spaces with more sophistication of surface treatments. The package also produces rendered images and it is possible to sequence a number of images together to create a dynamic scene. The software will show the total installed wattage. To make a change and view the result requires reiteration of the process.

RADIANCE is a much less common licensed software package primarily used in ESD modelling and heat transfer and fluid dynamics but also has the capability to include lighting. The package can provide rendered images and it is possible to sequence a number of images together to create a dynamic scene. To make a change and view the result requires reiteration of the process.

The process of modelling is time consuming and therefore expensive. A three dimensional model built in AutoCAD or DIALUX or AGI32 or RADIANCE will only work in the program within which it has been constructed; it is not transferable. None of the programs are conducive to demonstrating in front of a client the changes resulting from switching and/or dimming any or all groups of lights within a space in real time. None of the above programs show in real time the energy consumed as a result of those choices or that critical areas of illuminance or luminance are maintained as a result of those choices.

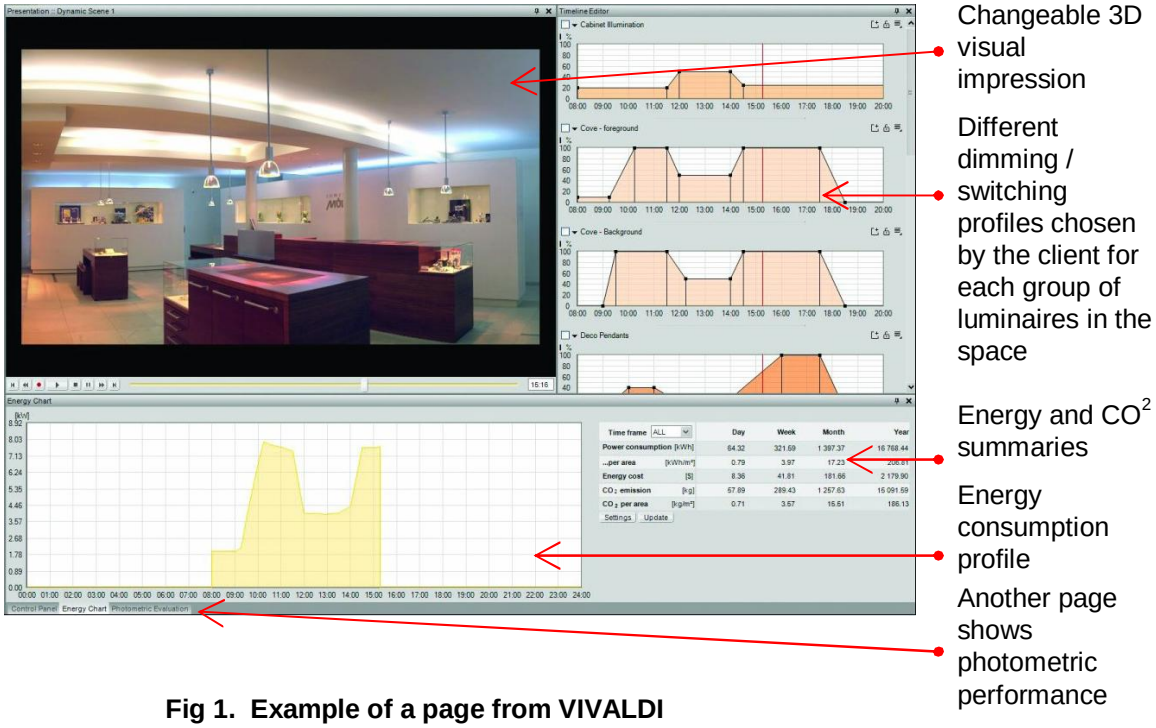

Fig 1. Example of a page from VIVALDI

An exciting new software package VIVALDI by Zumtobel provides this capability. It is combining together the theory of light, a visualisation of the space, a monitoring of critical illuminance or luminance targets and monitoring of energy consumption as a result of those choices. Watt a useful design tool! It is now much easier to have a sense of the watts in terms of lighting within a space in the one place at the one time and in real time.

The combination of experience, knowledge and modern lighting technology with software such as VIVALDI should enable the possibility of much greener solutions to architectural spaces.