mosaic
Project Services Pty Ltd

Understanding Design
The challenge of informed consent

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Synopsis

How much of a design do engineering clients really understand? A simple design document for one group of design professionals can be virtually impenetrable to other professionals, and more importantly their clients.

The need to communicate effectively is vital when an engineer wants to lead a group of 'others' in developing a design solution. You cannot lead people if they don't understand you; 'blind trust' may work if the solution is straightforward. When problems arise, uninformed trust evaporates; informed consent from committed followers is more enduring, and people are likely to support any efforts to work through to a solution to the problem.

This paper will use the evolution of the design of the Sydney Opera House roof as a case study to highlight the different perspectives on design information, starting with the free-form curves envisaged by Jørn Utzon to the mathematical (and buildable) curves developed by Ove Arup as segments of a sphere (such as an orange). The metaphor of the segments of 'orange peel' that helped make the curves possible was also used to explain the concept of the sails to the public and politicians.

With the advent of integrated design and Building Information Modelling (BIM) on one side, and the emergence of social networking and 'instant protest movements' on the other, the importance of communicating complex design information to the clients and wider public will become an increasingly important component of a successful engineering project. This paper suggests that the effective use of similes and metaphors to help people understand what is really involved in a project can convert uninformed protesters (frightened by what they don't understand) into informed supporters. This applies to 'client committees' as well as to the wider public.

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1. Language differences can distort or block messages

1.1 Understanding Language

How much of the following three sentences can you understand?

1. Die Autorin ist eine radikale Vor-Denkerin auf dem Gebiet des Stakeholder Managements und der Kommunikation.
2. Автор данной статьи является радикальным мыслителем в области управления заинтересованными сторонами и коммуникациями.
3. La autora de este trabajo es una pensadora radical en el ámbito de la gestión de las partes interesadas y la comunicación.

1.2 Lost in translation

Running the three sentences through Google Translate' returns the following:

1. The author is a radical <u>pre-thinker</u> in the <u>field</u> of stakeholder management and communication.
2. Author of this article is a radical thinker in the <u>field of communications and stakeholder</u>.
3. The author of this work is a radical thinker in the <u>field</u> of stakeholder management and communication

1.3 Methodology

The starting point for the two sections above was emailing the sentence *'The author of this paper is a radical thinker in the area of stakeholder management and communication'* to colleagues in Russia, Germany and South America for translation into Russian German and Spanish respectively.

Each person translated the sentence using their construct of its meaning framed from within their culture perspectives and personal knowledge of me. This will inevitably have created different translations with subtly different meanings to a translation created by someone unaware of my work (discussed in section 4 below).

The three translations were then run through Google Translate to see what was returned. Whilst Google Translate is far from perfect, it is ubiquitous. Professional translators use a similar process to make sure important communications translate back into the source language unaltered; the underlined text shows the subtle differences in the re-translation from the original.

1.4 Engineering drawings are a stylised language

Language is more than just words and sounds. The concept of language as a communication medium extends to all forms of symbolism used to convey ideas from one person to another, including:

- Spoken words and sounds
- Writing in its different forms

| Arabic | Chinese | Sanskrit |

Figure 1. All three words have a similar meaning

- Drawings and other forms of imagery. A picture may be worth a thousand words, but are they the *'right words'* :it all depends on the perspective of the receiver.

Most people will not understand a language that they are not trained to communicate in, and language training starts at or before birth! Learning any new language later in life is difficult and what a 'novice' will understand from a communication in a *'foreign language'* can be vey different to what the *'native speakers'* mean and understand. The 'novice' has an understanding and will honestly answer 'Yes' to the question 'Do you understand?' but their understanding is different!

As George Bernard Shaw once said *"The single biggest problem in communication is the illusion that it has taken place"*.

2. Basic communication theory

To make communication effective, careful thought has to be given to the choice of media and message, how the message will be delivered (and who will deliver it) and the best writing, or presentation style to use based on the personality of the person you wish to communicate with - the receiver.

2.1 The sender-receiver model

The sender-receiver model is the simplest communication model and underpins most others. The sender has an idea or concept he/she wants the receiver to appreciate. Before any useful outcome can be achieved from the communication, the receiver has to accurately understand the sender's idea! This means the message has to be effective in the receiver's space; if the message does not engage the receiver, the sender is wasting his/her time.
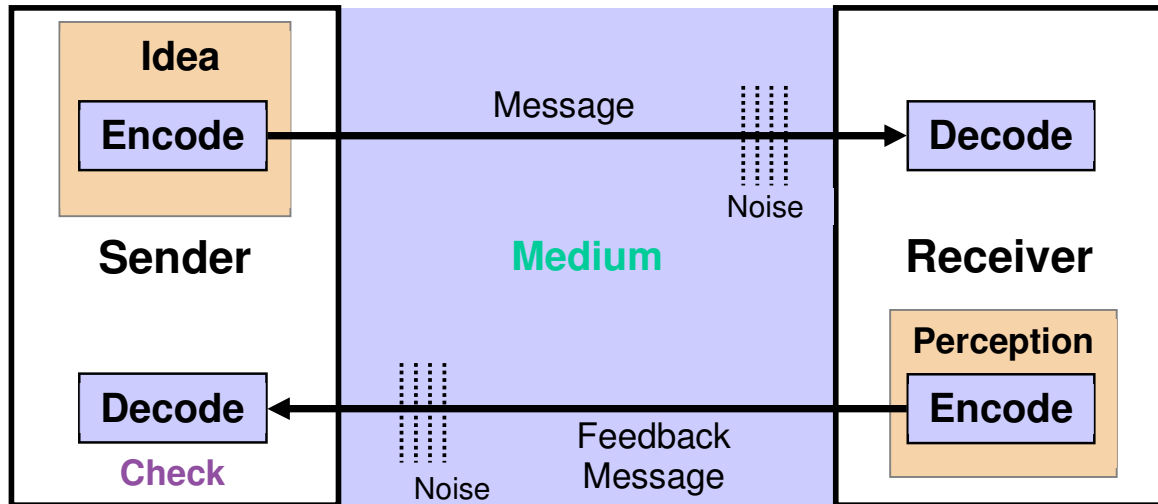

Figure 2. The basic communication model

The elements in this model are:
- **Encode:** To translate thoughts or ideas into a form of language that can be understood by the *receiver*; eg, written English, spoken French or a drawn diagram.
- **Message:** What is sent: the output of encoding
- **Medium:** The method used for sending the message (face-to-face, telephone, email)
- **Noise:** Something that interferes with the sending or understanding of the message (distance, culture, language differences)
- **Decode:** The translation of the message by the *receiver* from the medium into their thoughts.

A single communication is complete once the feedback-message has been decoded by the *sender* and checked for accuracy against the original idea. Once this loop has been closed both people have a common understanding of the idea. This does not require agreement or concurrence, but if there is to be a disagreement, it helps if everyone has the same basic understanding of the issue or idea in dispute.

Effective communication requires both the *sender* and the *receiver* to be engaged. The *sender* needs to check that the 'message' has been received and validate the feedback; the *receiver* needs to check that he/she has absorbed and understood the content of 'message'.

2.1 Communication filters and other barriers

The purpose of any communication is to create understanding leading to appropriate responses or actions by the *receiver*. However, the understanding is formed in a person's mind: and no two minds are the same. Even simple words in a language can have very different meanings to different people. The term 'plan' can have several meanings:
- A project manager will think of a schedule or if formally trained, the set of documents describing how the work of the project will be accomplished.

- Architects and engineers will think of a large 'sheet of paper' with the design for a building or similar.
- Town planners will think of the development intentions for a suburb.

Each person's brain will filter and sometimes distort information based on the connections developed over their lifetime; this can be thought of as the brain's hardwiring and affects both conscious and unconscious thought processing.

The brain is subjected to stimulation through the five senses of sight, hearing, touch, smell and taste. To manage this potential sensory overload, it classifies most of this information as unimportant at 'this-moment' and relegates it to the subconscious, where it is effectively ignored until something occurs that requires access to that information or that memory. They are then processed as efficiently as possible by pattern matching and 'packaging'.

Pattern matching allows the brain to respond quickly and simply to a stimulus based on previous similar occurrences. Subtle differences are ignored.

Similarly detail within the 'package' is ignored unless an additional stimulus makes searching within the 'package' important. An example is looking for your car in a car park; you can match the pattern of 'your car' when you see a small part projecting out from behind others….but you ignore details such as dust on the paintwork. The eye sees all of the detail all of the time, the brain filters out the extraneous information and simply deals with the 'package' of 'your car' and the process of getting from where you are to where it is, effectively and safely.

Effective communication needs both the sender and the receiver to be aware of how the brain processes information, and must work to minimize its effect. However, you can never totally remove these hard-wired processes.

How we send and receive messages is also affected by the objectives of the communication, how we feel (right now), other conscious and unconscious thoughts (our personal reality), cultural differences, personal preferences, and the personality and communication style of sender and receiver. Other potential 'barriers' to the effective receipt of the message include environmental and personal distractions, particularly lack of interest and fatigue.

For effective communication, particularly across cultures we must be aware of these potential 'barriers' and plan to reduce their effect. The 'engineering culture' is fairly similar world-wide, engineers can communicate relatively easily with other engineers, but often have difficulty communicating effectively with non-engineers (your customers).

Overcoming these barriers requires the gathering of information about each of the stakeholders you need to communicate with, including their relative importance, influence and level of support and receptiveness. From this understanding an effective communication can be designed that has the best chance of working effectively for you in the receiver's reality.

3. Ideas and understanding are framed within a language

Creating ideas and solving problems are framed by images and language. What people 'see' is literally changed by the language they use! Seeing and therefore understanding is framed in language. A well-known 1984 documentary from the BBC's Horizon series; *Do You See What I See*, provides a fascinating look at the subjectivity and divergence of how we each see the world. Including how language shapes the perception of colour in different cultures (BBC, 1984).

Most people from a Western culture will have no difficult separating the 'blue' square in the left hand image from the 'green' squares but will have more difficulty seeing the subtly different shade of green in the right hand set.
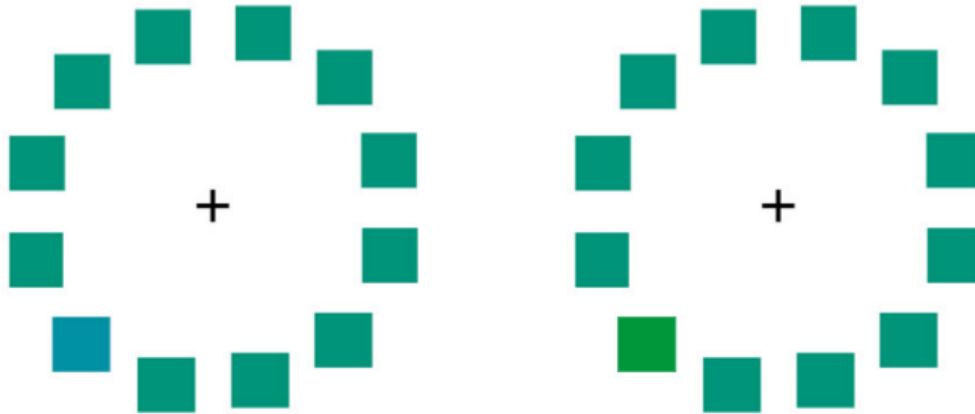
Figure 3. Colour wheels used in the Horizon program

The evidence presented by Horizon on the Himba people from Africa is that the Himba could easily pick one of the green squares as being different from the others on the right, but had difficulty with the set on the left. The Himba have different words for greens associated with fresh foliage and rainfall compared to dry foliage (a life saving difference in the semi-arid region they inhabit), but used the same work for the colours labelled 'B', 'C' and 'D' below. Whereas English speakers have different words for the colours, *blue* and *green,* creating a concept that builds a wall between them, but no real way of differentiating 'greens' in general language.
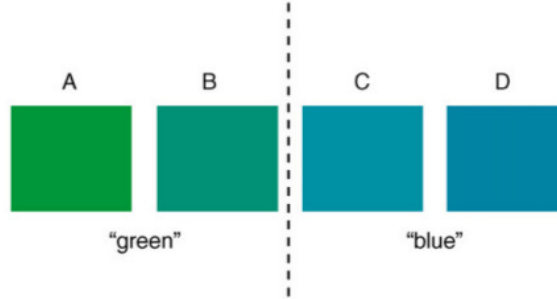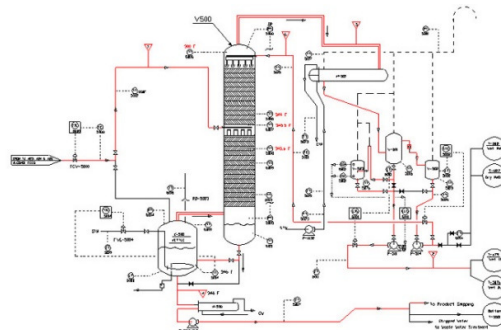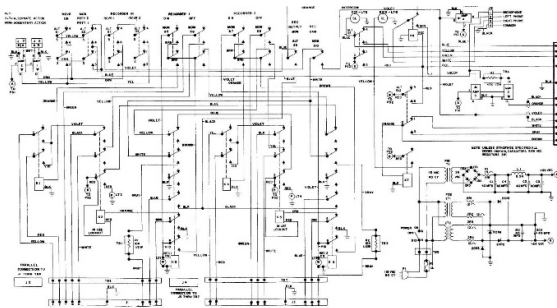

Figure 4. The colours used in the Horizon program

Your eye doesn't simply see colour[1] - your brain creates it by drawing on knowledge of what things should look like. And this 'knowledge' is framed within language. If someone does not have the same 'language' as you they will literally not see things in the same way you do.

This paper extends this concept from its scientific base (now supported by a range of studies across numerous languages) to suggest if your clients do not have the 'language of engineering design', the meaning you extract from a drawing will be very different to the meaning someone else will obtain.

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[1] For more on perceptions see: http://www.wired.com/2012/06/the-crayola-fication-of-the-world-how-we-gave-colors-names-and-it-messed-with-our-brains-part-ii/

Figure 5. Electrical and chemical engineering drawings.

Electrical engineers and electricians may understand the drawing on the left, and chemical engineers the drawing on the right; most non-engineers will simply see a mass of lines and symbols and have difficulty appreciating any meaning and differentiating either of these design drawings from the schedule below.
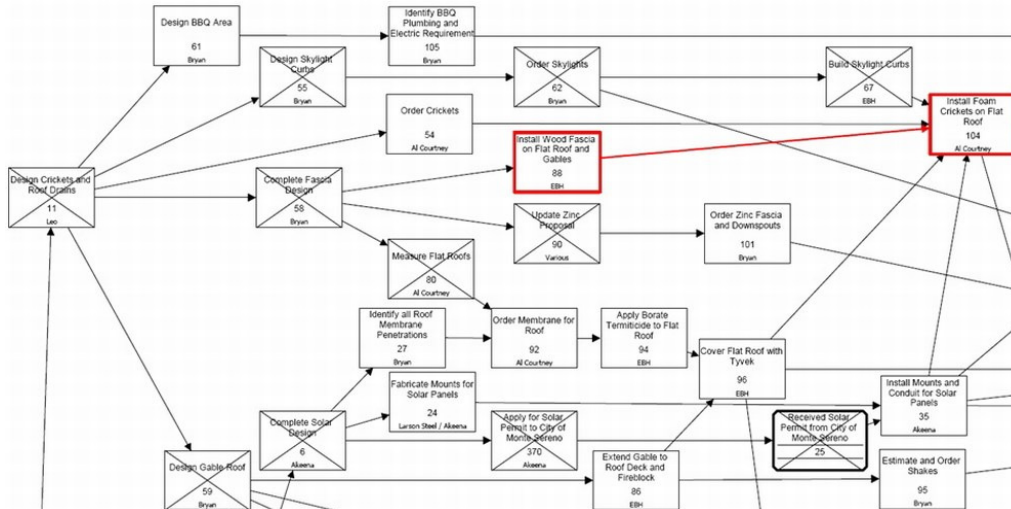

Figure 6. A CPM precedence diagram.

'Insiders' with the special technical 'language skills' needed to create and understand each of these drawings will fully appreciate their content and meaning. People with some exposure will be able to distinguish between them and know they have quite different purposes. But most of your clients will simply see an unintelligible set of lines and symbols.

3.1 Seeing the solution

At is most basic level, engineering is about solving problems and making things work through the practical application of scientific, economic, social, knowledge in order to invent, design, build, maintain, and improve structures, machines, devices, systems, materials and processes. The challenge of solving problems is firstly defining the problem to be solved, then 'seeing a solution' so that the people involved in the project can collaborate on designing and then building the 'solution'.

One of the best documented problems that required 'insight to solve' was the geometry of the sails on the Sydney Opera House – 'seeing the solution' took nearly six years of frustrating debate between Jørn Utzon and Ove Arup!

The winning concept design envisaged by Jørn Utzon used hand drawn free-form curves for the 'sails' – the design evolved over time but in the days before BIM and CAD remained 'impossible' to engineer.
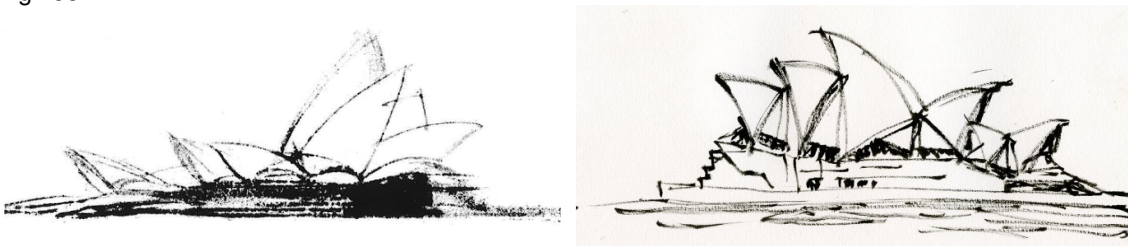

Figure 7. Original sketch designs.

The breakthrough came when Utzon 'saw' the curved surfaces of the sails as being sections cut from the surface of a sphere of uniform diameter[2]. Once the idea was 'shaped', engineering solutions and standardised precast components became possible – the Opera House was 'buildable' but not necessarily understandable!
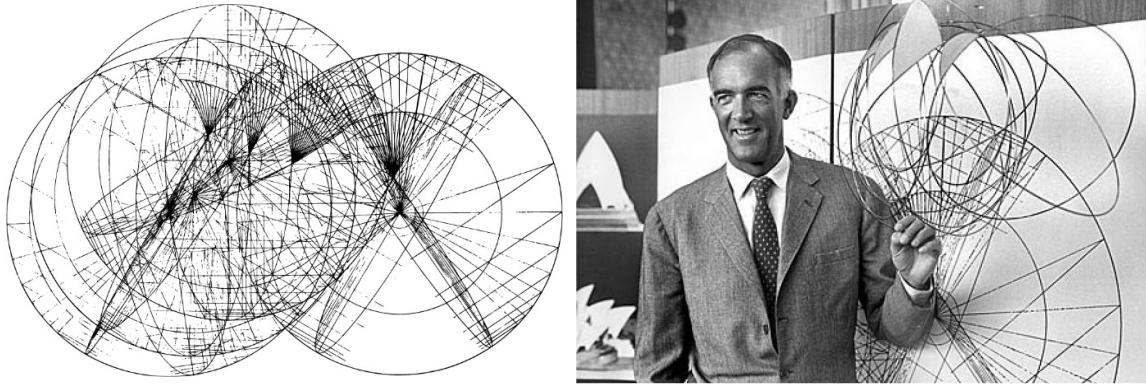

Figure 8. The geometry of the sails.

Utzon and Arup had what they needed to design and engineer the structure but the concept needed explaining to the public and politicians. The wooden model below is the representation that 'explained' the concepts above to the non-engineering people paying for the building.

Figure 9. The 'model' for the design.

And this insight is commemorated in bronze:

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[2] There is some question over who originated the idea of using segments of the surface of a sphere – Utzon, Arup or if the idea evolved between them.
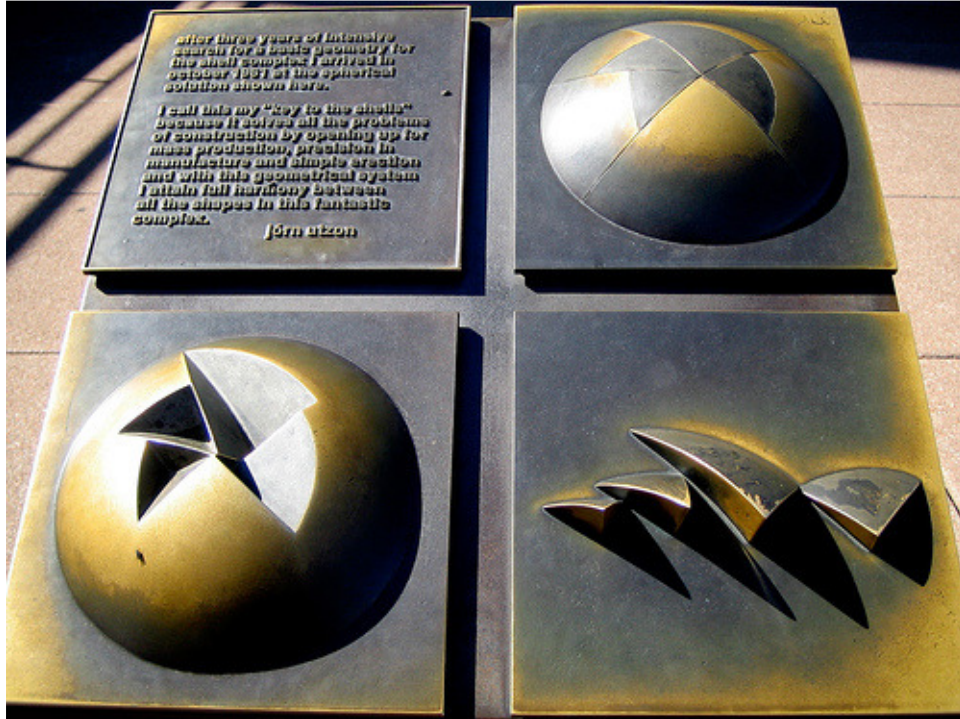
Figure 10. The plaque at the Opera House.

And concrete:

Figure 11. The sails during construction.

The challenge for any engineer is firstly defining the problem; then 'seeing' and engineering a solution; then explaining the solution to people who don't understand the 'language of engineering'.

The real problem is that most people do not like to admit 'not knowing' (particularly if they are senior managers or politicians) and are quite likely to 'nod knowingly' and appear to understand to 'save face'; they may even believe they understand based on a limited understanding of the 'language of engineering design'. But 'partial understanding', 'misunderstanding' or simply 'pretending to understand' is dangerous! *'Informed consent'* requires a reasonably full understanding on the part of the client, which requires communication in a common language both the client and engineer understand.

4. Communicating ideas effectively needs a common language

The success or failure of your projects will largely be determined by stakeholders who have little direct involvement in the engineering; clients, end users and the wider public. Their determination of success (or failure) will largely be based on how closely they perceive the finished product matches their expectations. The problem is perceptions and expectations are not 'real'; they are built inside the mind of each individual based on that person's unique view of the world. A project does not achieve a single success; it achieves 1000s of subtly different successes in the minds of 1000s of different stakeholders. Where there is broad consensus on what 'success' looks like, framed in a common language and culture this is not a major issue. However, where there are widely differing perspectives or a lack of common understanding, creating a common language where the exchange of ideas can occur without too much being 'lost in translation' is critically important.

The challenge is recognising that some concepts are easy to communicate in some communities of stakeholders, others will be more difficult; and people are frightened of things they don't understand. Effective communication builds understanding, reduces opposition based in 'fear of the unknown' and generates a framework tor success. This requires the engineers and project leaders to firstly derive a common understanding between themselves, then determine what the key stakeholders actually understand, then determine how to communicate effectively with the key stakeholders to build their understanding to the level needed for *'informed consent'*. Stakeholder agreement to proceed with a project based on a misunderstanding of the concepts involved may get the work started, but lays the foundations for failure when the stakeholder's misplaced expectations are not fulfilled.

One way to break through this communication barrier is by using the rhetorical concepts of similes and metaphors. Similes compare unrelated concepts on the basis one is *like* the other, metaphors compare two things more directly asserting one thing 'is' the other.

4.1 Similes and metaphors

One of the more endearing similes to come from the Sydney Opera House is using the peel of an orange to describe the shapes of the sails: *the sails of the Opera House are like the peels of an orange*. I do not know when this explanation surfaced within the overall challenge of seeing a solution to the problems described in 3.1 above, but it works for me:

Figure 12. An 'orange by any other name'.

Several years ago we were watching a program on the opera house and Sir Ove Arup was being interviewed. The magic of the engineering solution dawned on me when he said *'you can cut the shape of each sail from the peel of a single orange'*. A simple and dramatic explanation of a very complicated engineering solution!

Metaphors are more direct using fundamentally false statements to build a useful image. For example, if you are discussing the financial viability of a proposed new retail venture, stating *'The shop will be a little gold-mine'* creates a far more powerful image of a profitable venture in the mind of someone who is not financially literate, than saying *'The ROI of the shop is expected to be 23%'*.

Deciding which of the two statements is more valuable in creating a meaningful picture in the mind of a stakeholder depends on the person's innate knowledge:

- If the stakeholder is aware of business finance, knowing the return on investment (ROI) from the shop is around 15% better than the current bank lending rate is more precise and therefore more useful (and they would know it is also significantly better than most small gold mines). Effective communication is achieved by using financial language.

- However, if the stakeholder has no real concept of the definition of ROI or the subtle differences between ROI, BCR and IRR[3] painting a 'word picture' of a *'little gold mine'* gets the message of 'high profitability' across nicely. The communication challenge is creating an accurate impression in the mind of the stakeholder and avoiding unethically overselling the proposition.

The art of explaining a complex proposition simply and elegantly is a challenge faced by every profession. Achieving **'informed consent'** goes beyond getting the stakeholder to 'sign off' on a proposition they perfectly misunderstand (but believe they fully understand).

However, if you fail to achieve proper **informed consent**, your stakeholders will quickly start to see the project diverging from their expectations and will either demand 'unreasonable' changes to bring the project back into line with their expectations or withdraw support. No one ever believes their expectations are unreasonable! The good news is expectations are malleable and can be adjusted.

5. Project success is framed in stakeholder expectations

Fulfilled stakeholder expectations equates to a successful project; the challenge is communicating in a way that creates reasonable expectations that can be fulfilled. Unrealistic expectations are unlikely to be fulfilled!

A person's expectations are their reality, and the failure of a project to fulfil these expectations will inevitably lead to a perception of failure even if the 'unrealistic expectations' were unreasonable or simply wrong – unfortunately the customer is always correct. Perceptions of failure can change. The Sydney Opera House is a prime example: the 'unmitigated failure' and 'white elephant' of the 1970s has been transformed into a world class icon in the 1990s. This type of transition takes decades and did not help Jørn Utzon's career – he never designed another major building.

Effective stakeholder engagement creates a more immediate prospect of success, but requires building realistic expectations in the minds of key stakeholders. The final most important step is delivering on the promise by implementing good design management and good project management.

Building realistic expectations requires the stakeholder to develop an understanding of the engineering concepts in the proposed design and how these concepts will be transformed into the final product through the work of the project delivery processes. Creating this level of understanding in a person's mind requires appropriate information to be communicated in a language that is understandable to the stakeholder. In this context, 'appropriate' does not mean complete or fully detailed; communicating the *right* level of detail is an art form.

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[3] ROI = Return on investment
    BCR = Benefit Cost Ratio
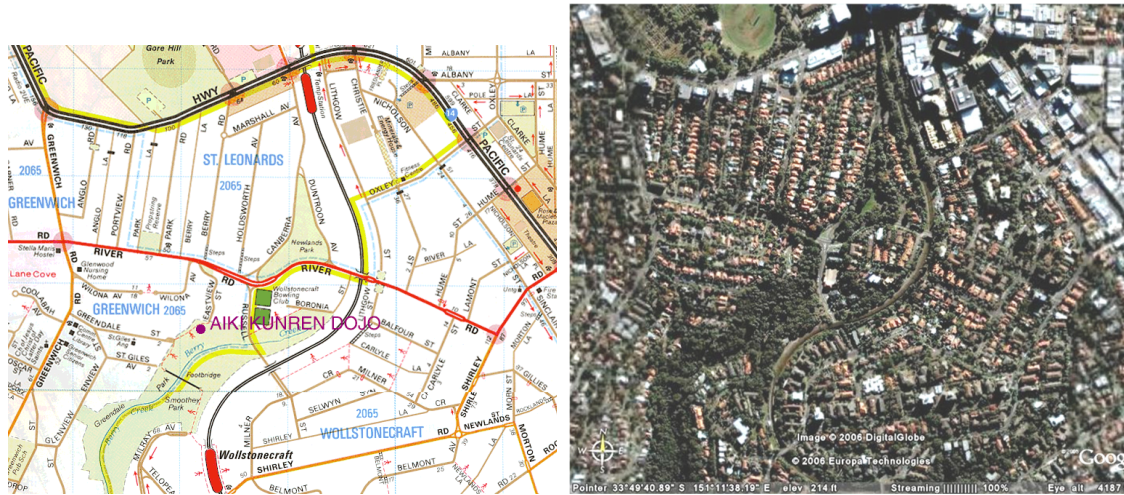   IRR = Internal Rate of Return

Figure 13. Which image of North Sydney is more useful for driving to the Dojo?
Accurate, fully detailed and useful are different concepts.

One of the reasons Architects almost always include a perspective drawing on the front of a set of 'architectural drawings' is to build this 'useful understanding' in the minds of their clients. The concept drawing has little or no value as a design document but it does give stakeholders unfamiliar with the 'language of architectural drawings' a good idea of the scale and substance of the design. The ambience is 'warm and pleasing'; the scale is derived from the people (or other familiar shapes such as cars). And the information is 'appropriate' for a stakeholder whose primary interest is focused on how the building will fit into a streetscape. Other stakeholders, such as the builders need properly dimensioned drawings and specifications.

Figure 13. An architectural perspective.

As we move into the age of BIM and 3D design, this type of static representation can be replaced by 'animated walk-throughs' generated from within the design tools. 'Walk-throughs' help the designers to literally 'see problems' and more importantly help the clients understand exactly what they are 'signing off on'. With care and time the client's expectations will align with the design intent and the project is on the way to success.

5.1 The London Underground Map

Effective communication, focused on obtaining the buy-in needed to deliver successful projects, based on a realistic appreciation of the design documentation produced by engineers requires:

- Understanding who are the key stakeholders at 'this point in time'.

- Understanding their needs and the best way to communicate with them.

- Communicating the appropriate amount of information in a way that can be understood by the stakeholder.

- Taking the time to help the person reach a proper understanding.

As suggested above, this does not need fully detailed or accurate representation. What is needed is 'useful' information that can be used! The London Underground is one of the most complicated systems in the world. By the middle of the 20th century the map was becoming too complicated for easy use.
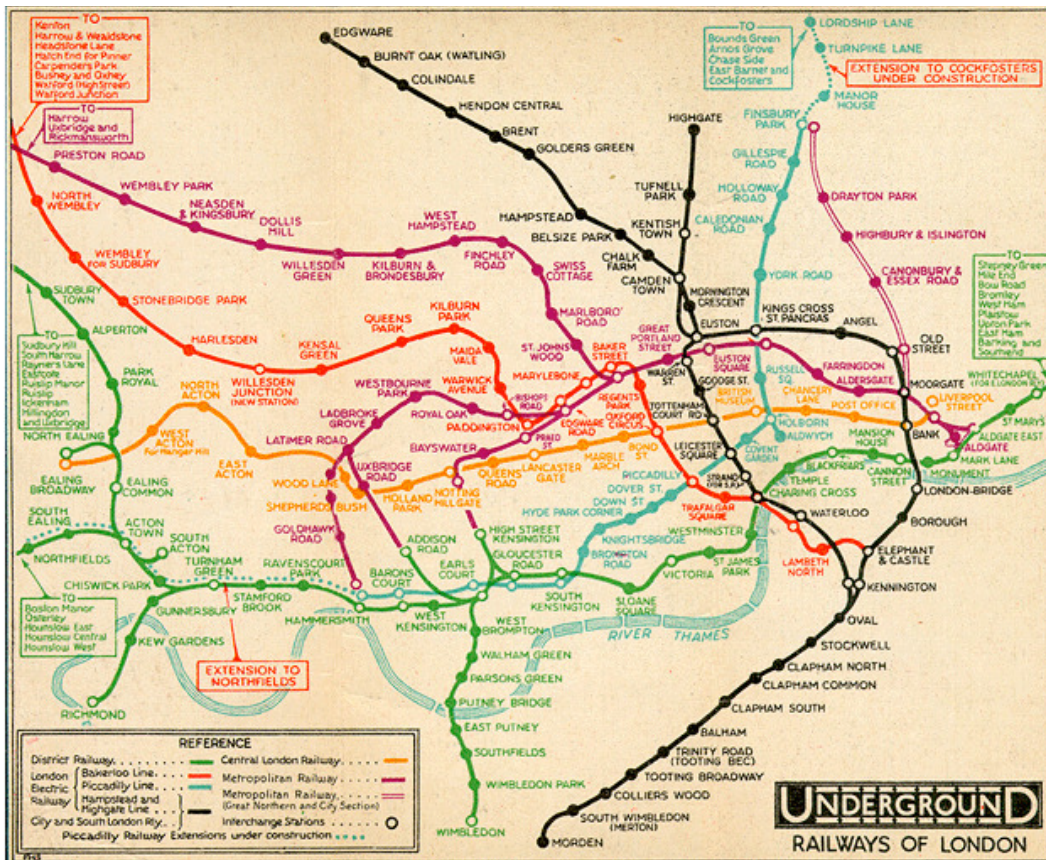

Figure 14. 1931 Underground Map.

Henry Charles Beck was an English engineering draftsman who drew up the 'modern diagram' in his spare time while working as an engineering draftsman at the London Underground Signals Office, based on an electrical wiring diagram. London Underground was initially sceptical of Beck's radical proposal and tentatively introduced to the public in a small pamphlet in 1933. It immediately became popular, and the Underground has used topological maps to illustrate the network ever since.

Figure 15. Beck's version of the 1931 Map.

This style of communication has carried through to modern times but is not without its problems – you can easily get to the station you want, but there is no indication of how close or how far apart different stations are 'on the surface' – particularly if the stations are on different lines.

Figure 16. The current London Underground Map.

Success is contagious; most transport maps world-wide follow Henry Beck's lead and a new universal language has been created. A similar convergence of communication style has occurred with in-car road maps. Most books and electronic sat-nav systems use a stylised language similar to the map in Figure 13 – another language designed for a specific purpose.
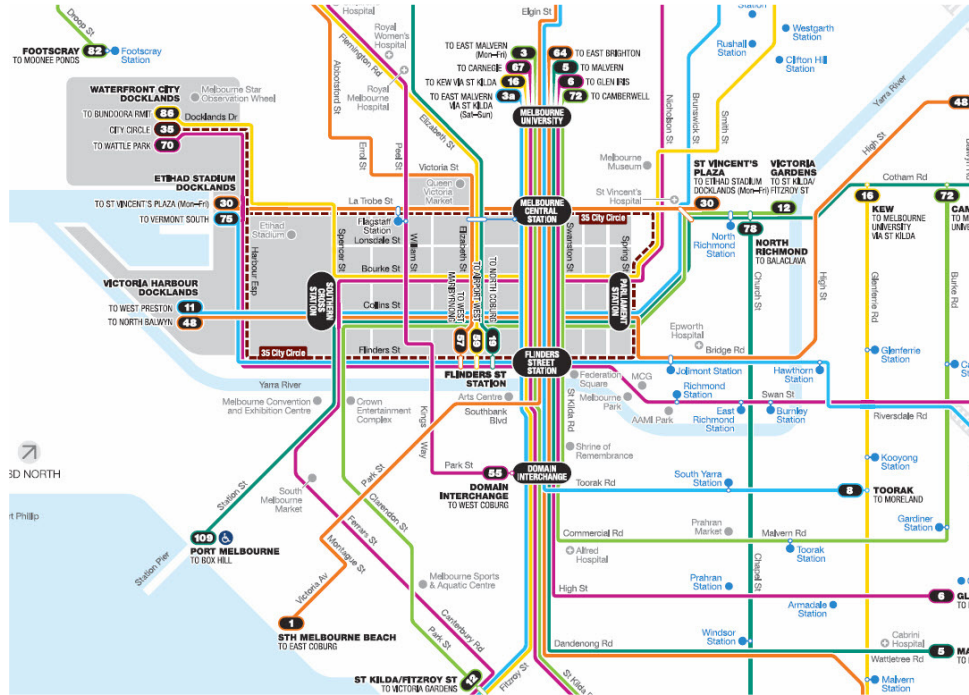

Figure 17. Part of the new Melbourne Tram Map, using a version of Beck's language.

These maps are really simple to use if you can 'read the language' and interpret them correctly. But as we all know Melbourne looks nothing like the tram map in 'real life' – we have learned how to read the 'language' and can then use that knowledge of the language to understand similar maps in different cities, even if we cannot read the Japanese text annotating the map.

The engineering challenge is to make the information a client needs to 'sign off' on a project as accurate necessary, useful, easy to appreciate and easy to understand.

6. Summary

Informed consent can only be obtained from a stakeholder, if the person's perceptions and understanding of your project appropriately reflects the way the stakeholder will experience the final outcome. The challengers are:

- Each person's perceptions and reality will be different;
- What each person needs to know is different; and
- The best way to communicate with each person is different.

Effective communication is an art form that balances form and content to appropriately meet the needs of each key stakeholder and the more general needs of the wider stakeholder community.

One of the reasons this paper has not attempted to use specific engineering concepts is the simple fact I am not an engineer. To explain a complex concept concisely and simply, while retaining the critical data the listener needs to know and understand, requires a deep appreciation of the subject being explained. As someone once said *'If you can't explain it simply, you don't understand it well*

enough[4]; the communication challenge for engineers is to first develop that level of insight to their design concepts and then know enough about stakeholders and communication to transfer enough of that understanding to their clients and other key stakeholders. The problem is there are no 'right answers' or easy options; and there is never enough time or budget to fully communicate with everyone.

However, **informed consent** is more than merely obtaining a signature – it means the stakeholder understands the project and is willing to help you make it successful. Proceeding without informed consent is dangerous!

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References

BBC Two – Horizon, 1984: *Do You See What I See?* http://www.bbc.co.uk/programmes/b013c8tb

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[4] Frequently misattributed to Einstein, this quote may be derived from Ernest Rutherford's quote "it should be possible to explain the laws of physics to a barmaid"; and the longer quote from Einstein "that all physical theories, their mathematical expressions apart, ought to lend themselves to so simple a description that even a child could understand them".