



How many lightbulbs does it take to change an engineer

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Here's a conundrum for those readers who are about to make a change to the way you do things in your Engineering Design department. On the one hand, engineers don't like change. On the other hand, engineers are perfectionists who are always looking for better ways of doing things. How can we plot a course between these inconsistencies?

I'll try to answer that question, and the lightbulb teaser in the title of this article, but first, let's try a test.

True or false?

1. All engineers are logical and rational.
2. Professional engineers always follow the best engineering processes.
3. If there is a flaw in their process, they are grateful when you point it out.
4. When you show them a better process, they will adopt it without question.

OK, so it wasn't that hard a test. All those statements are false. But this is the set of assumptions on which many change initiatives are predicated.

As a consulting engineer to several companies in the Rail and Aerospace sectors, I often see change plans like this:

- **Design new process**
- **Develop training course**
- **Deliver training course**
- **Write standard.**
- **Review and Approve standard.**

And the deliverables section of the plan lists these results:

- *All engineers are trained*
- *All trained engineers now follow the new process*
- *All outputs from the process satisfy the new standard.*

Q: How often does this plan work? **A:** Never.

So what goes wrong? The assertions at the top of this article are assumed to be true, or more likely, they are not even considered. The planners have no framework of ideas about the nature of change. The change manager forgets that significant new skills may be *taught* on a training course, but they are *internalised* only through practice.

So let's reconstruct the plan, taking into account these factors, and take some learning points as we go.

First, let's deal with the four assertions

All engineers are logical and rational.

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Yes, they are *most of the time* (as much as one can generalise about a wide-ranging profession). But if you provoke them by clumsy interventions, they can behave irrationally and stubbornly.

It's important to understand the group of people that you are trying to influence.

One of the most commonly used psychometrics for team-working environments is the Myers-Briggs type indicator [1]. It measures four factors, assigning to each factor one of two values. The values are: Introversion/Extroversion; Intuitive/Sensing; Thinking/Feeling; Judging/Perceiving. Of the 16 possible combinations, engineers are most commonly either ISTJ - Introvert, Sensing, Thinking, Judging; or INTJ – Introvert, iNtuitive, Thinking, Judging. [2]

Which means that they have long attention spans, need time to assimilate information before responding, make mental models in order to make sense of the world (INTJ) or rely more on data (ISTJ), make decisions by using their heads rather than their hearts, and like orderliness.

Between 10% (for Geologists) rising to 22% (Civil Engineers) are ISTJ. Between 3.2% (Civil Engineers) and 20% (Aerospace Engineers) are INTJ. The third and fourth largest groups are ESTJ and ENTJ – similar profiles, with Extroversion replacing Introversion – accounting for another 21%.

In the population at large, INTJ and ISTJ between them total a mere 7%. The implication is clear – engineers *are* different, and change facilitators need to pay attention to what's important to *them*.

All of which suggests that the best approach to change in an engineering department is:

- give them time to assimilate the reason (for the I);
- give them a model for change (for the N); and evidence, like case studies, cost savings, etc (for the S);
- give them a reason for change (addressing the T);
- give them a clear process for change (satisfying the J).

And if you're an engineer yourself, then knowing your Myers Briggs Type will help you understand your blindspots. For example, if you are an N (Intuitive) you are likely to neglect the S (Sensing) engineers' need for convincing data. A good theory is enough for you!

This paper is too short for further discussion of Myers Briggs – a web search yields thousands of references and textbooks.

So the plan should now contain these activities:

- **Formulate a model for change that you can explain to engineer and director alike.**
- **Inform the engineer cohort of your vision for change and the reasons for it.**
- **Reflection and discussion time.**
- **Publish a clear plan for change.**

This is the point at which to answer the riddle posed in the title of the article. The answer is AT LEAST ONE. Engineers are idealists at heart, they entered their profession to make the world a better place, but often find themselves beset with confusion. So striving to give them at least one “lightbulb moment”, when suddenly it all makes sense, is so important. They will follow you only if your vision shines brightly enough to show the path.

So perhaps the most important part of the plan:

- **Formulate a vision of the new process and its benefits.**

Be *passionate* about it, and communicate it. If you don't care enough to evangelise, why should anyone else care enough to listen?

Professional engineers always follow the best engineering processes.

Definitely not the case. Almost as a matter of professional pride, most engineers will know a better way of doing a task, other than the prescribed way.

The problem lies in the word “best”. Put 20 engineers in a room and you will get 21 opinions on the “best” process. But how to choose? Common methods are: a) who shouts loudest; b) the eager beaver with the M.Sc.; c) the corporate standard imported from the US; d) ask a consultant; e) what the Engineering Director saw at a conference; f) something borrowed from software engineering; g) we don't need a process, we've got a tool.

Often this is an unnecessary block to progress. Of the 21 opinions, probably 10 would fly. It takes an act of leadership to cut the Gordian knot and make a choice, preferably informed by knowledge of best practice, political acceptability, and feasibility.

Here's a hint that won't popular with my professional colleagues. Ask three sets of reliable consultants for their thoughts. They'll be keen to get some work, and will expose enough of their knowledge to enable you to get a good idea of best practice. If you like one enough, you could actually hire them to help in the implementation.

More activities for the plan:

- **Check your ideas with consultants who see more of the patch than you do.**
- **Get senior decision-making clout behind you.**

If there is a flaw in their process, they are grateful when you point it out.

No they won't be – no one likes to have their work demeaned. Ask them; don't tell them. The engineers will be very happy to tell you what they think is wrong with the way they do their work. Use a skilled facilitator to help you do this most effectively. Here's another hint: don't try to facilitate a discussion yourself in which you have an interest in the outcome. It won't work and you may only get one shot at it. If you *have* to facilitate, read a good book on it first. [4]

Add to the activity list:

- **Seek feedback on the current process.**

When you show them a better process, they will adopt it without question.

There are several models of change (see the following sections) but none of them suggests that people change their behaviour just because you ask them to.

Boiling down the theory, you need to satisfy *all* these preconditions:

- The current situation is unsustainable – “Change is my only option. I’ll sulk for a bit, but I know it’s inevitable and right.”
- There is a shared vision of the better way – “I won’t be on my own when I get there”.
- There is a step-by-step means of getting there, and the engineer can see that *the next step* is achievable – “I won’t fail and make a fool of myself”.

The nature of change

Like many engineers when faced with a problem, my first inclination is to borrow cleverer people’s ideas. This is no exception. Here are two models for change that will help you make your changes stick.

Most theorists adopt a model for change. For example, when Lewin [3] talks about change, he describes a three-step process: *unfreezing* the current state, *moving* to a new state, and *re-freezing* to stabilise the new state.

In an engineering context, I target three things for change: the engineer (his/her behaviour); the project (its activities and processes); and the organisation (its structures, policies and units).

Placed into the context of these three levels, Lewin’s three step process makes sense. For example, trying to change an engineer’s behaviour before you have established with him/her that they want and need to change (ie *unfrozen*) is worse than pointless – it’s damaging.

Beckhard and Harris [5] use the formula

$$\begin{aligned} \text{Change achievable} = & \text{[Level of dissatisfaction with the status quo X} \\ & \text{Desirability of the proposed change or end state X} \\ & \text{Practicality of the change]} \\ & > \text{“Cost” of changing} \end{aligned}$$

This formula points out that change *will not happen* unless and until you address these factors. For example, if the “level of dissatisfaction” is low, then there is little incentive to respond to exhortations to “do it the new way”. More pithily, you can take a horse to water but you can’t make it drink.

[As an aside – did you notice that the formula doesn’t follow the rules. The “greater than” sign should (more logically) be a minus sign. If it bothers you, then reflect on the impact that a large change programme would have on you, *if it didn’t make sense.*]

So here's an activity for the plan, to be slotted in at the planning stage:

- **Adopt a robust change framework.**

Last, let's look at the skill acquisition problem

Engineering skills are the pinnacle of our civilisation, built on a bedrock of maths, physics and material sciences. So *of course* they are hard to acquire. A pinnacle is hard to get onto the top of. You need a long-term supportive environment, in which mistakes are gently corrected and good work is recognised.

People who already have the skills mis-remember how hard and long they struggled to gain them. When these people plan the education of others, the results are (for example) a training courses cut from five days to three, a mentor replaced by a manual.

What gets rewarded, gets done. If it's hard and time-consuming to acquire the skills, and support is hard to find – the incentive must be strong. The organisation must show that it values the skills – through awards, professional credits, and informal recognition.

So the activities we add to the plan are:

- **Get experts to review engineers' outputs and give them feedback**
- **Regular training refreshers**
- **Put in place a means by which the new skills are recognised and rewarded**

The finished plan

The total list of activities now looks like this (in approximate order):

- **Formulate a vision of the new process and its benefits**
- **Adopt a robust change framework**
- **Formulate a model for change that you can explain to engineer and director alike**
- **Inform the engineer cohort of your vision for change and the reasons for it**
- **Publish a clear plan for change**
- **Seek feedback on the current process**
- **Reflection and discussion time**
- **Check your ideas with consultants who see more of the patch than you do**
- **Get senior decision-making clout behind you**
- **Design new process**
- **Write standard**
- **Develop training course**
- **Deliver training course**
- **Review and Approve standard**
- **Get experts to review engineers' outputs and give them feedback**
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It's a lot more work than the simpler plan that we started with. But that plan wouldn't work. This one might.

You will encounter managers and engineers who will look at a plan like this and try to trim it. There is little advice I can give, except that taking refuge in post-failure righteousness is a poor substitute for patience and dogged perseverance in getting the plan approved intact.

Stick to the vision

And finally a plea to remember the “vision thing”. There’s a large time gap between the new skills and processes being put into practice and becoming effective, and the benefit showing on the bottom line. So there will be times when it all seems too difficult, and the investment is questioned. At these times, it helps to repeat the vision, like a mantra, and hold on. But you need a vision in the first place.

Finish with a wry joke

Let me finish where I started – with a lightbulb. Q: How many Engineering Directors does it take to change a lightbulb? A: Just one. He holds the lightbulb still and expects the world to revolve around him.

Oh, and my Myers Briggs type is INTJ.

References

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4. Esther Cameron (1998), “Facilitation Made Easy”, Kogan Page, ISBN: 0-7494-2756-6
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