How to motivate, control and keep good engineers

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***Abstract*-This paper looks at how to lead engineers so that they produce excellent and relevant work for the business while at the same time giving them an environment where they grow and thrive. The specific area looked at is the role of the technical management in producing this environment. The findings are based on a combination of practical knowledge gained while managing engineers backed up with information from management and leadership research.**

I. Introduction

Most companies have problems managing engineers; maybe they cannot get the engineers to understand that the business needs an answer now – not nine months later, or maybe they think the engineers speak an alien language that they can never understand. Even if you do get an engineer with all the right qualities they might leave too soon for you to benefit from their talents.

In his years of experience the author has seen some problematic engineers, but conversely has also seen senior management who fail to take time 'to bridge the gap' and communicate effectively with engineers. The thesis of this paper is that with the right leadership approach this gap can be closed. The result is that the development is business focused and the engineering team are motivated and growing personally.

A. Setting the scene

It is worth stating at the outset the background and experience of the author, as this will help you place his comments in the right context. Jon Smith has an engineering background, with many years of practical hardware and software design and development.

He migrated to full time management of engineers in 1988 and has managed development departments of up to 50 people consisting of mixed hardware and software engineers. His last full time engineering role was as Technical Director of a medium sized telecoms equipment manufacturer.

Jon Smith has now moved away from technical management and runs a management consultancy that helps companies through rapid growth events such as new business development, spinouts, mergers and acquisitions, new funding and management buy-outs.

The point is that this paper is not theoretical in nature, but is based on real world experiences. Much of what is detailed has been found out by trial and error in the workplace, backed up by management research that the author has found useful in his years of management.

B. Technical Management – the key to success

It is the contention of the author that good management of engineers is one of the keys to successful project development. This management role, which the author refers to as a 'facilitator', can make the difference between a good or bad engineering department and ultimately a good or bad company.

The aim of this paper is to open the eyes of senior management to this role and encourage latent 'facilitators' to take up the baton and make it happen where you are.

II. What Motivates an Engineer?

The title specifies three aspects that many people look at when considering any staff situation. We will consider the definition and actual practice of each one with reference to engineering staff starting with motivation.

What most senior management forget is that what motivates them is not the same as what motivates their staff. The author's experience of good engineering staff is that at the highest level they are motivated by:-

a) A desire to make something that they can be proud of.

b) Positive feedback and appreciation of their work by others.

c) A desire to be constantly learning new things and growing.

These motivations are good, but the environment shapes whether they are positive or negative to the business. Let us take these three attributes and see the effect of two environments on them. One with low levels of linkage, i.e. communication between the engineering teams and the business, and one with high levels of linkage.

TABLE I
Effects Of Good and Bad Linkage (Communication)

Motivation	Low linkage	High linkage
a) Proud of work.	High quality not balanced by business needs. **Good, but late**	High quality balanced by business timescales. **Good and on time.**
b) Have work appreciated.	Feedback is from other engineers. **Good technically.**	Feedback is from customers & sales. **Good commercially.**
c) Constant learning.	Always trying new technology. **Anarchy.**	Always looking for better solutions. **Innovation.**

We will see later in section VI Information Flow, how a facilitator can make such a difference by improving the linkages between departments.

III. How do you control engineers?

The author has purposely used the term control in the title, as it is the term that classic management would use for the directing of staff. However in today's knowledge based societies this term is not a good one. The author favours the term 'channel' rather than 'control'.

All the great management gurus such as Tom Peters, Peter Drucker and Charles Handy have written about the effect of knowledge workers, of which engineers are a particular type. In Drucker's book [1] he states 'Knowledge employees cannot, in effect, be supervised. Unless they know more about their [specialty] than anyone else in the organization, they are to all intents and purposes useless.' This may not be true of an individual engineer but is often true of a whole engineering team. This is why the author favours a more informed version of control, called channelling.

You expect your engineers to be the experts in the chosen field. However due to the limitations of time and temperament they are unlikely to know of, or possibly understand the financial, sales, marketing or other segments of the business needed to make their project successful. This is where they need help.

An analogy heard many years ago by the author is that of moving a wide load from one place in the country to another. A supervisor is sent out in front of the load to ensure that any major obstructions are known and plans developed to overcome them. Maybe obstructions need temporarily to be removed, or alternative routes avoiding the obstacles agreed.

Using a similar management approach of 'charting the route and removing roadblocks' is a powerful one as it allows the team to do their part without being blocked. It is a hard role for the technical manager to fulfil as sometimes (mostly!) the roadblocks are internal and the manager has to use his best negotiation skills to overcome them. However if done correctly it allows the team to do their job well, feel good about the product and the business goals are achieved.

In section VII Managing Innovation, the author looks in more detail at this complex area.

IV. Keeping good engineers

Studies[2] show that the difference in productivity and quality between engineers can be very large – far larger than the salary differences between these workers. Therefore if you find a good engineer then there are good economic grounds for employing them or keeping them if they are already with you. The problem is, how?

A. Keeping those that already work for you

If they are already with you then you have a distinct advantage, as the author's experience is that engineers will normally stay if the conditions are right. The 'right' conditions are maybe not what non-engineers might expect, as they often have more to do with type of work and style of management than the pay. The author has seen good engineers stay in a company facing closure because they were asked to work on a new product which had a high technical challenge and could turn round the fortunes of the company. The job security and short-term pay increases may not have been attractive, but the work was.

Maslow [3] in his work on 'hierarchy of needs' said there were five levels ranging from physical needs, i.e. food, clothing, shelter, right up to what he called 'self-actualisation needs' – see fig. 1. Maslow says that people need to feel safe at each level before the next level comes into play. For instance it is no good showing that you value someone (esteem level) if the person does not get on with the people around them (social level).

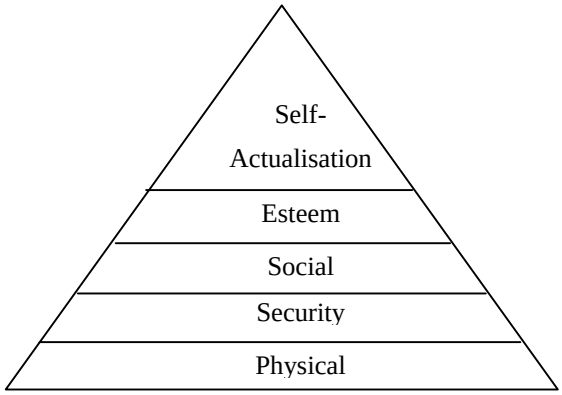

Fig. 1. Maslow's 'Hierarchy of Needs' pyramid.

However even in the turbulent times of today's business world good engineers can still get jobs – hence the example earlier where engineers stayed in a insecure job because the work was interesting. While we certainly cannot ignore pay and job security we have to understand that for engineers the emphasis will quickly move towards the top levels of Maslow's pyramid. Engineers are looking for people they respect and like working with (social), an environment which recognises their value (esteem) and finally a job where they can do something they consider challenging and 'fun' (self-actualisation).

In section VIII Team Structure, the author also looks at the role of team structures in helping to fulfil these needs.

B. Getting the good engineers to join you

At the other end of the job pipeline technical managers will have experienced the situation where they have found an excellent and gifted candidate, but cannot persuade them to join their company. The problem is that the candidate often knows they are good and has multiple offers. How can you convince the person to join you?

Firstly forgetting that you are selling as well as buying in an interview will lead to failure. It is fairly easy to get mediocre engineers, but hard to entice

good engineers that may be sitting on multiple offers. Here are some suggestions:-

1. *Understand their ideal job.* When interviewing the candidate you should find out what they like doing. This will tell you what they are looking for and more importantly what motivates them. If you can see a role inside your company for such a person then you can sell that role. If not then irrespective of their skills and talents the job is not right for the candidate and you should not offer it to them.

2. *Make sure you can deliver what they want.* Once you have understood what they like doing make sure you can provide the sort of work that will stimulate them long-term. If you cannot then say so and either consider alternatives with them or turn them down. It is better to lose a good candidate than employ someone who is not going to enjoy the job and is likely to leave quickly.

3. *Be honest about the position.* It is no good over-selling a job, as good candidates will quickly see through this. Better to discuss openly the pros and cons of the position. This shows a professional awareness of the job role and an open management style that is ready to discuss things. People will respect that.

4. *Introduce them to their prospective work colleagues.* Most candidates want to look round the work environment, as it is a key part of the job. If at the same time they have an opportunity to talk to other staff in an open way then this acts as a double benefit – it helps the candidate check on what has been said at the interview and also allows your staff to comment on a prospective colleague's approach and attitude.

Interviews are best carried out by a technical person with good communication skills backed up with HR support as appropriate. The reader will see that the technical manager is ideally suited to carry out interviews due to their overall grasp of the department's needs and the existing dynamics of their department or group.

V. The Facilitator In Action

All of the above sections point to a role for a technical manager who in the author's terms is a facilitator. That is someone who can translate and communicate between upper management's business goals and the technical world of the engineer. If you like a 'Dr Doolittle[1]' of the technology company.

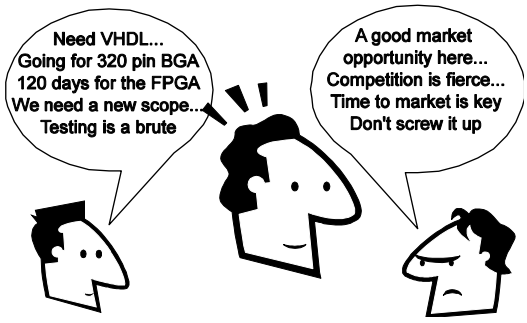

Fig. 2. The Facilitator as a translator.

It is the author's experience that few people capable of facilitating exist, but they can be grown internally or sometimes recruited. The point of this paper is to show the massive leverage such a person can make to the work of an engineering department.

The size, constitution and geography of the company and the development team will obviously have a big impact on the facilitator role. In large, bureaucratic organisations the facilitator's job is very important, but might be impossible to carry out. In small or mixed team projects, i.e. marketing, production, sales and engineering working together, then the facilitator role might be shared across a few people who communicate well.

Much has been written about cross-functional development teams and also organisational structures that aid team working [4][5]. The author agrees with these views of mixed teams, but for brevity this paper concentrates on the key role of the technical manager, or facilitator.

In the following three sections - Information Flow, Managing Innovation and Team Structure – the author looks how the facilitator can provide the required environment that both engages engineering staff and achieves the required business goals.

VI. Information Flow

Thomas Gilbert [6] expounded the view that information was the first key to motivating people. In this case the information he was referring to was "guidance and feedback". However with engineering projects guidance and feedback alone is often not enough because no one person has access to the whole project parameters.

The 'information flow' referred to in this paper is used to mean the providing of relevant and timely facts about the project to all the interested parties. Examples are:-

- Information on project progress and risks to marketing, production and senior management.
- Marketing intelligence and business goals to engineering.
- Quality issues to production, engineering and quality staff.

C. Why is it so important?

It may not be obvious that information on areas not directly relevant to the engineer can have a great impact on the quality and applicability of the produced product. However if we consider complex developments and the skill of modern engineers then the extra information can be vital to a good product and engaged engineering effort.

This can be information like customer feedback, market surveys, the executive decision process around

[1] Dr Doolittle is a fictitious person who could talk to both humans and animals.

the specific project, long-term business goals of the company, production or product constraints etc.

This information has a number of effects:

- It helps the engineer ensure that their solution solves the problem properly.
- The wider contextual view allows the engineer to make better decisions in areas of the product that are not fully specified.
- It stops the job from being a purely technical one and widens the engineer's view of the project.

Many of these results are highly beneficial to the company – a better product and less likelihood of ill-fitting parts of the product. However if we limit ourselves to the specific area of an engineer's motivation we also see benefits. The engineer is able to do a good job that others respect and they can feel good about the outcome.

D. How the facilitator uses this information

The real skill of the facilitator is to 'tie together' the information coming from each group. For instance if marketing talk about 'a window of opportunity' they are effectively saying 'we need it by date x'. It is then the facilitator's job to understand why the window is there, whether it is real and what shape it is before discussing the effects with the engineers.

The engineers can then understand the 'we need it by date x' in context and can maybe recommend a early release with limited features, or technical reasons why the window is not real, or even ways to combat the threat by pointing out technical weaknesses in say the competition's product. The facilitator must similarly help 'test and translate' this feedback to help the marketing department.

The point of this example is that each side has information that the other side does not have. The facilitator can tie these together to produce a reasonable discussion on the issues. The facilitator must be able to test and challenge the information, but respect each party for their knowledge.

The end result is that each side feels that their input is valued and, assuming an amicable outcome can be achieved, then a better business solution has been realized.

It may now be obvious why the author says that the technical manager role has to be the facilitator. If someone is going to test and translate this information in a meaningful way then they need to a) be senior enough to challenge the information, b) be insightful enough to understand both perspectives and c) be diplomatic enough to let both sides come out of any such discussion without feeling they lost or were railroaded.

It should also become obvious what a difference that such a person can make to the whole process.

VII. MANAGING INNOVATION

Innovation comes in many forms within a project. The author has classified innovation into macro-innovation and micro-innovation. Macro-innovation is where a major new step forward is required to make the product or project work. This could be some new patentable technique or the combining of existing processes in a new way.

While macro-innovation is very exciting the idea is understood and much has been written about encouraging it [7]. The author has therefore avoided macro-innovation and for this paper has concentrated on what he terms micro-innovation.

Micro-innovation is where people use their knowledge and skills to come up with creative approaches or techniques to solve a particular problem or facet of a project. The problem might be a good clocking design, a clever approach to marketing a product or simply a nice data structure. A good product is made up of hundreds and thousands of micro-innovation steps.

It is the author's premise that for systems other than those rigorously specified, these micro innovation steps are vital to make a product/solution successful. Most specifications are not detailed and there is normally a need for clear thinking on the part of all involved to make the project successful. In actual fact the art of a good functional specification is to clearly spell out what is required without saying how this should be achieved. This gives room to the individual experts to define the best way to achieve it, i.e. it encourages micro-innovation.

At the same time the creative act of producing these micro-innovations is both pleasing and motivating to the individuals involved. The trick is to encourage them without losing control of the process.

A. What enables Micro-Innovation?

The simple answer is information in the right form and the opportunity for staff to respond to it. Information in the right form means not overburdening the engineers with needless detail while still recognising that the functional specification is insufficient for the production of an applicable solution.

Overviews and open discussions with marketing or senior management can be very helpful, but there is real power in the facilitator's role of communication conduit. This also needs the facilitator to have the time and desire to find, sift and share this information.

The ability of the staff to respond to this information is more a company structure issue. If the engineering staff are simply measured by the time to first beta version of a product then this can endanger the quality and applicability of the solution. Having a management which recognises the need for applicable products can make a big difference to the space given for engineers to undertake micro-innovation.

B. The dangers of Micro-Innovation

It is important to list the dangers of encouraging micro-innovation. A lot of this has to do with the way in which the engineers have been channelled, but can also be a character trait of the individual engineers. Here are some problem areas that the author has seen.

- Engineers that try to be too clever and leave 'hooks' in their product for every possibility.

- Engineers that cannot consider a solution that is not technically perfect.
- Engineers that just enjoy playing with technology rather than making a business solution.
- Overloading the engineers with irrelevant information that distracts them from the job.

VIII. TEAM STRUCTURE

The final area that we wish to consider is the character and 'style' of each engineer on an engineering team. We are not going to deal with team structure as this is well covered in other literature [4][5][8]. What we are going to consider is the particular 'style' of an individual and how the engineering management might arrange work to best fit the team's particular mix of talents.

A. Forming a perfect team

The choice of people for a project is often based on individuals' technical abilities, such as knowledge of the particular tools or technology to be used. Most good technical managers also try to balance the character traits of the individuals concerned. This can be just as important to a project as the technical side.

There are literally hundreds of psychometric tests and reviews looking at people's attitude, approach, learning ability etc etc. Over time the author has found Meredith Belbin's work on team structures [9] a useful way of considering staff style and approach. This paper will not detail Belbin's work, but his main premise is that we have certain strengths and weaknesses which, when balanced in a team, can produce a powerful collaboration. The good aspect of Belbin's approach is that no one is a failure - we are just different.

To explain the idea let us consider three simple cases.

- If a job requires creative, blue-sky work then you would be ill advised to use someone who is more inclined to low-level details work.
- If a job requires contact with the customer then you would be unwise to choose a shy person.
- If you need someone for testing and quality issues then a good choice would be someone who is painstaking and pedantic.

B. Getting a perfect team is hard

This may seem blindingly obvious that we need to get this balance, but is it really possible to achieve? Life is often not perfect and management has to deal with the cards it has been dealt, especially when working with small teams.

Dealing with less than perfect teams is part of the key jobs of the technical manager. The author has found a number of techniques useful in team structures. Here are some ideas to consider.

1. *Understand the weaknesses in a team.* Firstly an important point for management is to understand the weaknesses inside a team. By knowing these then the risks inherent in the team structure can be identified and compensated for in some way.

Does the team lack someone who will drive the project forward? Then watch out for late timescales. Are there too many creative people on the project? Then watch out for an ivory-tower technical excellence. The facilitator must compensate in some way for this. Maybe they need to spend more time with this team, or draft in a technical or business mentor for regular meetings. In the extreme the facilitator might need to alert senior management to the possible risks due to the team makeup so that they can plan accordingly. (Although the author has never succeeded well with this last option!)

2. *Look to improve things long-term.* It might not be possible to get today's team perfect, but in the longer term you might consider encouraging those aspects of an individuals character that would 'round' the person out. While Belbin does not state this, the author's experience is that people can change over time and more importantly can become more flexible, i.e. they can take on roles that are missing from the team.

This takes time, but can be encouraged by a good facilitator and an enlightened management style.

3. *Try to recruit different, not similar people.* Finally when recruiting look at people's style as well as technical ability. If you are short of solid workers then favour them over creative types. Over the medium term you can change the style of a department markedly by dropping in a few new people who balance up the current staff.

Most people have a tendency to recruit 'clones' of themselves, i.e. people with a similar style to the interviewer. This is understandable because most people warm to people like themselves. However a balanced approach will provide a better department over time.

C. Better teams encourages stability in staff

One further benefit of building team roles that fit an individual's style is that it recognises that particular person's value and allows them to work in their most productive zone. As well as the productivity gains it also helps the individual increase his or her personal esteem and do work that they really enjoy. These are the top two parts of Maslow's pyramid – esteem and self-actualisation.

The net result of this is that staff are happier and see a clear role for themselves in the company. This can, over time, produce a highly stable workforce. At Quantel, where the author worked for 17 years, they had a track record of highly innovative work and strong teams (plus good pay!). The net result was an average length of service in the R&D lab of 11 years across all 50 staff even during a sustained period of recruiting new engineers.

The other element of keeping staff long term is recruiting the right people in the first place. As explained earlier making sure you can see a way of fulfilling their short and medium term ambitions is an important one. No one can guarantee a progression, but knowing from the outset that you cannot provide what the candidate is looking for should stop you recruiting him or her, as they are unlikely to stay long term.

IX. Conclusions

In this paper the author has attempted to show what motivates, controls and keeps good engineers. He also shows that the right type of technical management can be a key provider of the environment needed to achieve these goals.

It is the hope of the author that this will highlight the value to senior executives of a facilitative style of technical management. It may also encourage existing engineers or existing technical managers to take up this style of management.

Acknowledgment

The author wishes to acknowledge the many great engineers that he has had the privilege of working with over the years.

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