



Intuitive and analytical thinking in technology management



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Headlines

- ★ The essence of business growth is technological innovation. Objective, skilful and strategic allocation of resources is needed to bring about this growth through the right technologies
- ★ Good technology management is key to this growth and can be viewed in two parts: strategic (what to do) and operational (how to do it). This process requires a mix of creativity, objectivity and analysis
- ★ If this work is carried out by an aligned team it helps to map the competitive battlefield and select the strategic technology areas. Thinking hard about the future is not easy, mainly because we are glued to the present, but this exercise forces the team to look to the future and outside technologies
- ★ Both analytical and intuitive thinking styles need to be included in a team when carrying out a technology management exercise; however extreme thinkers can derail the process
- ★ Once the technology management team is in place, the process needs to be facilitated effectively to accommodate both intuitive and analytical thinking styles
- ★ Whilst R&D staff are trained to be analytical it is surprising how easily they are led astray by gut feeling, especially when working on problems outside their 'discipline'; this can be catastrophic for technology strategy development
- ★ To achieve effective alignment and good outcomes from both intuitive and analytical thinking, technology management workshop facilitation is usually designed in three parts: set-up, operate and set-down
- ★ The more preparation you do before a workshop or meeting the better the outcomes will be. There are guidelines and tools to manage intuitive or analytical dominance and these facilitate smoother meetings and generate higher quality strategy

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Case Study

Thinking styles can improve or destroy a technology management project



It was while facilitating a technology strategy process for a global cosmetics company that I most acutely observed how an extreme thinking style could disrupt the process.

The workshop was evaluating new technologies, and the objective was to create a new independent technology strategy that would lead to a step-change in development that would in turn reinvigorate the brand.

However, two of the ten participants suddenly stopped coming to the workshops. Some detective work revealed that the gang of two were creating their own separate presentation to the CTO and Main Board. It was based on their personal view of a specific formulation containing binding, thickening and stabilizing properties.

A lot of good scientific evidence had been presented and the other members of the team were puzzled by the desertion. Everyone believed that it was unfortunate as the outputs of the technology strategy were well-articulated, based on good assessment and subject to peer review by external experts. Also, the emerging technologies superseded those favoured by the two.

It was later found that the two had been involved in signing a large contract with an external supplier for most of the older set of technologies. Both were intuitive thinkers and both had previous careers with the same large company that had a culture that didn't tolerate external experts and didn't utilise structured approaches to strategy management¹.

This experience made me consider other occasions where a particular thinking style had been incompatible with the objectivity required to develop a strategic direction.

During my thirty years working in Research and Development (R&D) environments, as a scientist, an R&D manager and then advising global companies on R&D strategy and organization, I have observed how there are two required thinking styles – analytical and intuitive – and blends between them. Most people involved in innovation management are able to adopt one or other as the process evolves, but some remain on one pole, and these extreme thinkers often distort technology and R&D strategies with catastrophic end results.

Technology management

Successful technology management combines a view of the strategic direction of the organisation (what to do) with operational (how to do it). Technology strategy is the front-end and describes the 'what'.

Technology comes from the Greek techne (meaning art) and logos (logic or science) and so technology management has both analytical processes (inductive methods, tools and techniques) and arts (creativity, experience, lateral thinking). So analytical thinkers see it as a science and intuitive thinkers an art. Both are right in my view.

Technology strategy creation is an objective team exercise to decide on what technologies to focus on and then how to access and integrate them either inside (R&D) or outside the organisation.

If this work is carried out by an aligned team it helps to map the competitive battlefield and select the strategic technology areas. Thinking hard about the future is not easy, mainly because we are glued to the present, but this exercise forces the team to look to the future and outside technologies. If done well and objectively this will protect the competitiveness of the company.

What technologies?	How to access?
Technologies to develop further	Leader or follower positioning
Technologies to hold down or phase out	Make - collaborate - buy choices
New technologies to acquire or grow	Strategic alliances retained or developed
New technologies to monitor or explore	Technology plan - internal/external

Gut reaction can be positive

For years I have tried to understand the wide range of opinions and beliefs structures in different types of industry sectors, locations and levels within a company.

According to Canadian psychologist Gordon Pennycook, all of us are to some extent intuitive thinkersⁱⁱ.

As we solve problems and make decisions in our lives, we let our emotions guide us. And that's a good thing, because often our "gut feelings" have been honed over evolutionary history to help us quickly and effortlessly achieve good enough outcomes.

However intuitive thinking alone can create 'conformational bias' (picking information that fits your world view)ⁱⁱⁱ and within R&D this can send you down the wrong technology track or miss technologies outside your own experience (e.g. from another industry sector).

In some disciplines, intuitive decision-making can be marvellously effective when the person has a large amount of experience in precisely the type of problem needing to be solved. Doctors and art experts are good examples.

But for R&D management this can be disastrous; R&D outputs are long term and poor decisions made now by gut feeling may not show up for years, by which time it's too late to change direction.

This is discussed extensively by the book 'Thinking, Fast and Slow' by Nobel Memorial Prize in Economics laureate Daniel Kahneman^{iv}. The central thesis is the dichotomy between two modes of thought: System 1 is fast, instinctive and emotional and System 2 is slower, more deliberative, and more logical. The book delineates cognitive biases associated with each type of thinking.

Analytical thinking removes bias

At the other extreme, analytical thinking is focused, sharp, linear, deals with one thing at a time, ignores time constraints, is deconstructive and contains no opinion or bias.

Analytical thinking is a recent phenomenon and began when humans started to investigate how the world is put together and how it functions. Intuitive thinking has been mankind's chief possession since the dawn of time.

At one extreme, the intuitive thinkers seemed to totally dismiss any type of good practice management process, framework or techniques, relying on gut feeling and experience, while the other, analytical thinkers, needed methodologies, analysis and logic before making even the smallest decision. These more analytical people work as though down a tunnel, blind to the big picture and the softer needs of the people working for them.

Observations

The problem with extremes

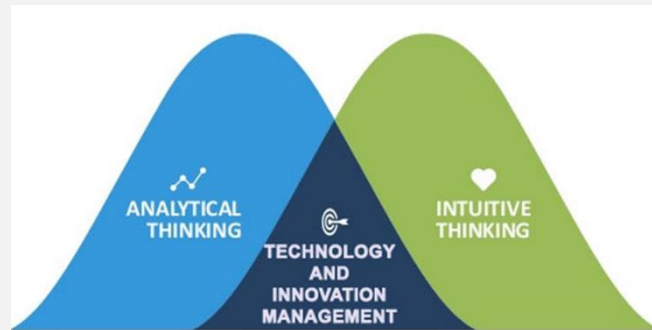


The VP of R&D for a global advanced materials company commented:

"I can remember very similar cases when I was running an R&D planning exercise as part of the '5 years forward' horizon scan. Making the obvious change in thinking from traditional materials and coatings was made more difficult because of extreme intuitive behaviours. Most of the group were thinking about additive manufacture, nano-scale coatings etc. and three individuals didn't believe this would happen, even though there was a body of evidence to suggest it would. Their world view was closed to what they were developing now.

"We were once talking to suppliers about new adhesives but two product developers were discounting new smart adhesives that did not use chemistry but a physical effect. I had to stop the conversations and do some more desk research. The problem was that analytical thinking focused the product developers and stopped them thinking out of the box."

Both thinking styles are required



It's important not to think of intuitive and analytical thinkers as two different types of people, since all of us are capable of both modes of reasoning. Some people are more in the habit of thinking analytically, others not.

In the Star Trek universe, the Vulcans have no emotions and are totally analytical creatures. Yet if this were truly the case, Mr. Spock wouldn't be able to order lunch in the ship's galley, let alone

interact successfully with his crewmates, because our day-to-day social decisions have no rational solution and we have only our intuitions to guide us.

Intuitive thinking alongside analytical thinking is very important for strategy development. It provides the 'big picture' and the important softer 'touchy feely' inputs to technology strategy and planning.

"Once I had to let a senior person go because they were so analytical things were taking much too long – there was too much desk work before development started. They were also very verbal and distorting a number of marketing/R&D joint strategy groups."

Former CTO of a consumer goods company

Balancing the seesaw

A blend of analytical and intuitive thinking is needed within a team carrying out a technology management project as the exercise requires a mix of creativity, objectivity and structure.

As shown in Figure 1 there are 'Pros' and 'Cons' to both extremes. Trying to keep the seesaw level is

tricky because of the complex nature of technology, the mix of people in R&D and the opinions that they may have.

It often surprises me that senior R&D management don't intervene more to facilitate objective strategy outcomes that use both styles of thinking.

Cognitive biases

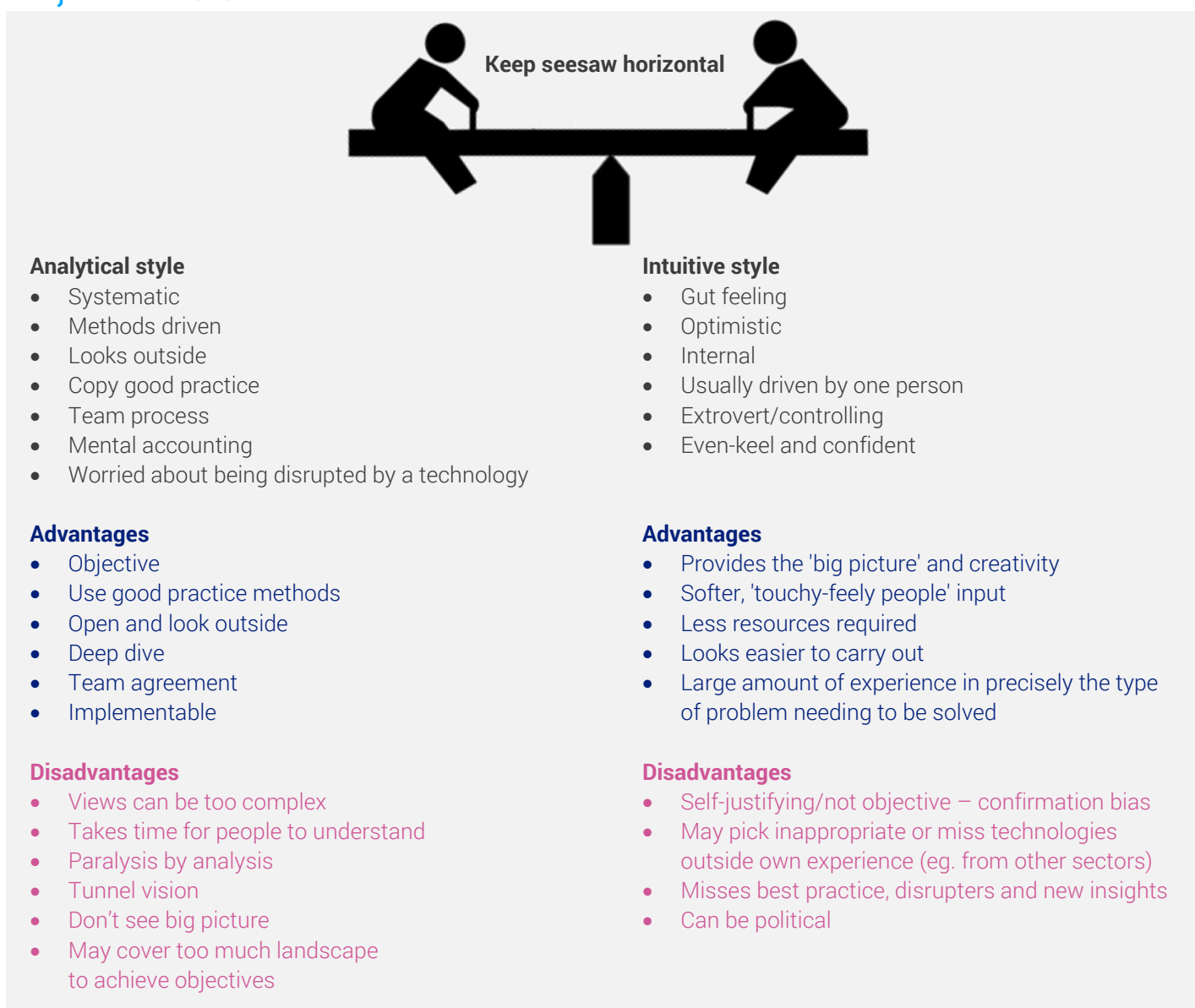


Figure 1: Analytical vs. Intuitive thinking in technology management^v

Observations

Technology strategy workshops



The VP of Global Product and Applications Development for a world leading supplier of speciality chemicals and ingredients comments that she has seen how the dynamics in a workshop can be impacted by personality type:

"Emerging technologies can be seen as a threat so it is not uncommon for experts to try and stay in their comfort zone using older technologies rather than learn something new.

"This can result in analytical people getting 'analysis paralysis' and will push the case for more information.

"Belief, motivation and vision are of course key aspects for project teams driving R&D projects. But those same factors can lead to protectionism if it is feared their project would be regarded as under threat from any new strategic direction. This can lead to people manipulating things (working backwards) to ensure that the outcome includes their project area.

"Communication style of the extreme can be influential. Those with a stronger voice will bias the group more, especially if they are held in high regard.

"We have had board members in some of the workshops and I agree that senior management involvement can change the dynamics as they carry weight and often use intuitive gut feeling alone.

"It depends a bit on the personality as normally they would have the power of rank but in a workshop this is not the case. They may lack the skill of persuasion or feel powerless and that can lead to disruption or rejection of the whole process if not handled carefully."

Managing different thinking styles in the R&D environment

Working outside the comfort zone

An important element of technology management is the objectivity gained from looking outside of the organisation.

When carrying out a technology strategy exercise, nu Angle has always enlisted an international group of extremely experienced external technology, business and market experts.

These experts add new insights and challenge our work – we don't discourage this as we could also become biased during assignments. To assess the technologies, we have developed a structured process using well tried tools and techniques. To ensure objectivity software is deployed to help score and rank technologies against business and technology criteria such as: strategic fit, market attractiveness, cost, risk, maturity etc.

People in R&D usually have a mix of science, technology, engineering, and mathematics training and this requires structured analytical thinking. What is interesting to me is that many of these people are easily led astray by their intuitions, especially when working on problems outside their 'discipline' such as technology management^{vi,vii}.

Many R&D staff don't realize that technology and innovation management is a discipline^{viii} and without this understanding they can't acknowledge that it's outside of their discipline area.

This brings with it a variety of issues that must be resolved prior to implementing any technology management thinking.

The legendary educator and author Peter Drucker argued that technology management was a branch of science^{ix} over 40 years ago, but even in 2017 we see intuitive thinkers in senior R&D positions ignoring best practice and going with gut feeling and their own narrow industry sector experiences.

Within companies we work to gain agreement, with scores used to rank technologies against corporate objectives. This is achieved with most of the participants but sometimes we get a few members of the team who strongly disagree with all the evidence.

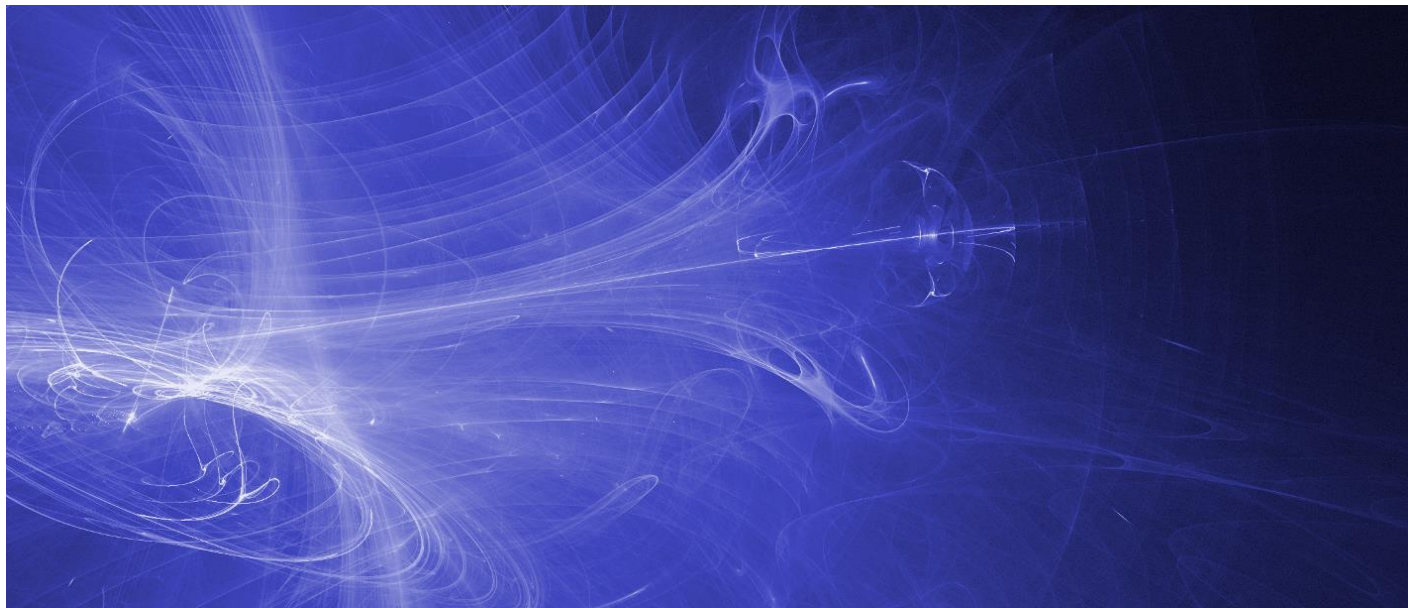
They may blame the structured process, a particular technique, the external experts or just 'Fake News'. We often find these strong views are due to intuitive thinking with sometimes conformational bias.

There may also be a political agenda, they may think an R&D program that they have been running will be less important or they simply don't like change. In extreme cases, we have seen some leave the project team and instead create a process that they are more comfortable with by DIY but without including any learning or good practice, such as in the cosmetics company discussed earlier.

"One strategy team had to disband because they were focused on the wrong direction. This was due to one strong intuitive thinking person who recently came from another large company and wanted to do exactly what they had done in the other company. No one could change their mind"

Former CTO of a consumer goods company

Successful facilitation of technology management projects



When putting together a team for a technology management project it is important to include a mix of thinking styles and also to consider how to facilitate the project to accommodate this diversity.

We have tried different types of psychometric tests from Belbin Team Roles^x to Myers Briggs^{xi} to assess team members' skills and aptitudes; they are good, but often too detailed and involved for our purposes. Most people don't want to be tested or participate in such an exercise for one project. We find it more effective to talk to the HR department and other team members. With experience and tenacity, we can usually generate a good profile for the group quickly.

Once the team is in place there will be several workshops and meetings. At these sessions avoiding the extremes of intuitive and analytical domination will be difficult.

There are many guidelines for workshop facilitation, and those that work well for technology management type workshops are discussed below, including some ground rules and tricks to facilitation (Figure 2) that we find useful.

Workshop management is usually in three parts: set-up, operate and set-down, as shown in Figure 2 on the following page.

The more preparation you do, the smoother meetings and workshops will be and the better the outcomes (see mindtools - Planning a Workshop^{xii}).

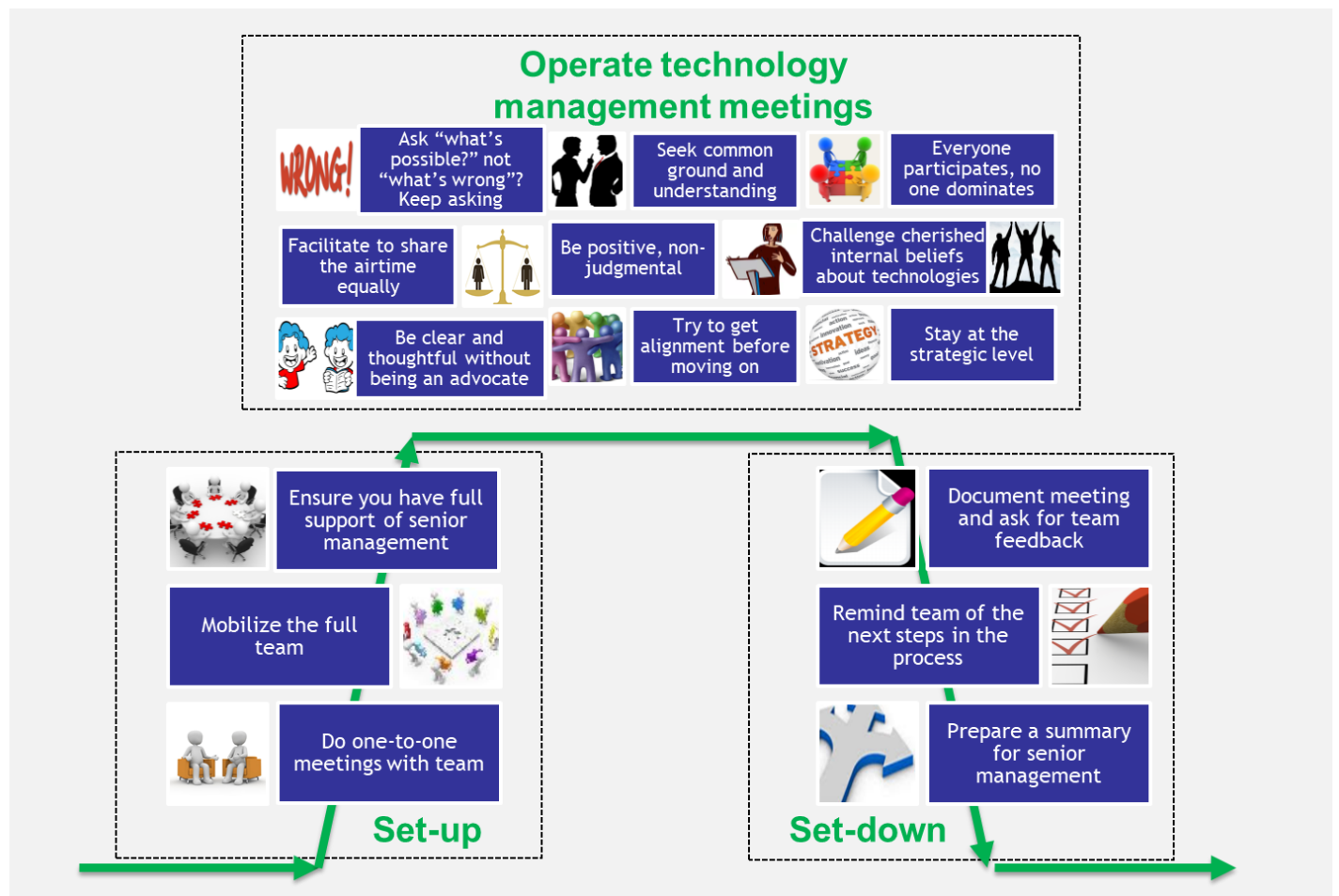


Figure 2: Facilitation of analytical and intuitive thinking in technology management

"Despite all the evidence from manufacture and marketing about the quality of a new product, one of the senior R&D managers totally ignored it. They were very intuitive, didn't easily work in a team and had their own view – 'my way is the only way'.

"It was a very difficult situation eventually solved by an effective team facilitator I bought into the Company. The facilitator was external so had no vested interest and was not influenced by internal politics or the strong character intuitive thinker."

Former CTO of a consumer goods company

Effective workshop management



Our learning points

Before you start (set-up)

★ Full support

Ensure you have full support of senior management and manage their individual and combined expectations. Make any discussions top-level, strategic and commercial and anticipate any questions before dialogue takes place

★ Participation

Senior management participation in team meetings can be very disruptive. Most recognize this so ensure good, accurate executive summaries are sent to them on a very regular basis

★ Context

Mobilize the full team, explaining the project and inputs required and what they think outputs should look like

★ Prepare

Do one-to-one meetings with all participants before any team meetings. Find out worries about the process, important technology inputs and gauge any political issues that may get in the way of objectivity. This helps the facilitator understand and manage the landscape. The facilitator must manage these meetings, they should not be delegated

Operation (doing)

★ Attention

Get full participation and engagement before you say anything. A good trick is to stand up and look around at all participants to get eye contact with all before speaking. When all is quiet give it a few seconds and then start the meeting

★ Inquiry

Be clear and thoughtful without being an advocate, maintain an atmosphere of inquiry until you are summarizing the end of the meeting

★ Sharing

Facilitate to share the airtime equally. For those that continually dominate say "That's a good point – what do others think?" or "Time is moving on – what does XXX think?" or "I think you have some useful insights – can anyone else contribute?"

★ Listen

The facilitator must be able to listen to understand in order to manage technology and commercial points. Research the area before any workshop to gain understanding and credibility. Don't use a facilitator who has no technology knowledge or experience

★ Speak

Speak honestly about points and give all external technology experts time for input, especially when one person dominates

★ Open

Be positive, non-judgmental and open to new ideas, technologies and product concepts

★ Strategic

Stay at the strategic level (out of the operational and internal politics)

★ Focus

Be aware of meaningless abstraction about how technologies can make a difference as these take time away and misdirect the meeting and allow politics to creep in

★ Challenge

Challenge cherished internal beliefs about technologies and open this up to the rest of the group and especially the external experts who hopefully will agree with you

★ Explore

Be intrigued by the difference you hear about new technologies from other industry sectors and then park for more assessment if required

★ Ask

Ask "what's possible?" about a technology embodied in a product rather than "what's wrong?" – and keep asking

★ Solutions

Seek common ground and understanding about solutions to engineering and technology problems (not problems and conflict)

★ Summarize

Summarize at the end of the meeting and ensure both intuitive and analytical thinking styles are covered. If there has been any scoring or analysis carried out during the meeting try to feed back using visualization while it's fresh in participants' minds. Ask for comments. Summarizing can't be done without content so the facilitator, whilst not being a deep expert, needs to understand the science and technology

After meetings (set-down)

- ★ Document
Document meetings and send out to participants. If there is analysis afterwards (such as technology assessment, commercial studies, technology portfolios and ranking) include this
- ★ Feedback
Ask for feedback within seven days
- ★ Next steps
Include a reminder of the next steps in the process with dates, location and times for the next meeting.
- ★ Summary
Prepare a summary of this document for senior management as soon as you can

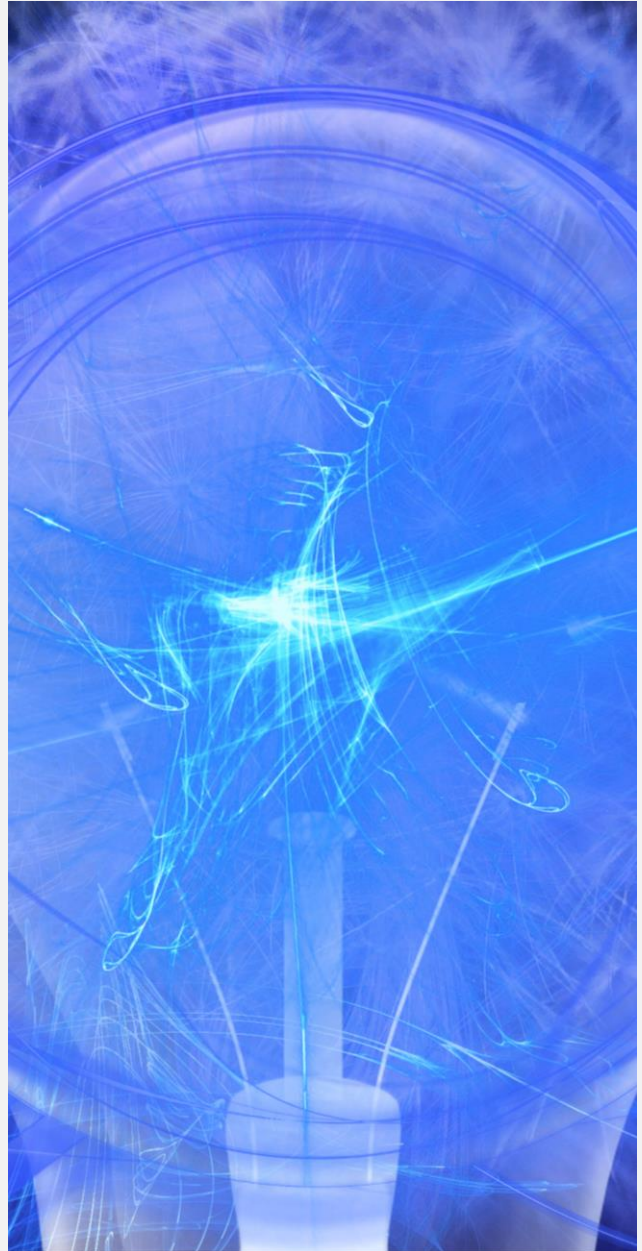


Summary

The essence of business growth is technological innovation, and successful technology and R&D management lies in the objective, skilful and strategic allocation of resources to bring about growth through the right technologies.

To achieve this requires a balance between both analytical and intuitive thinking when carrying out a technology management exercise as this needs a mix of creativity, objectivity and analysis. Ideally the team should be equally balanced.

The successful management and workshop facilitator needs a mix of good science, technology, strategy, facilitation and business experience. The facilitator also needs many years of experience of technology management in several types of companies in different industry sectors. There are many ground rules that are important to successful facilitation of both an internal group and external experts.



About us



About the author

Dr Steve Bone started his working life as an industrial chemist and materials scientist before becoming a business director for the sensor division of Thorn EMI.

For the last 25 years he has occupied leadership positions in leading technology, innovation and strategy consulting firms – namely PA Consulting Group, Arthur D Little and the Monitor Group – before forming nu Angle with Dr Peter Allen, a physicist with a similar background to Steve's.

Steve has helped clients grow their businesses through innovation and technology management in a wide range of sectors – chemicals, pharmaceuticals, consumer electronics, biotechnology, and fast moving consumer goods. He is also a recognized thought leader, having written papers on trends towards virtual R&D (before 'open innovation'), technology strategy and applying core competency thinking to R&D. He has worked on developing the approaches and thinking to technology strategy, growth platforms and technology business incubation whilst working at nu Angle and is now applying them to very successful assignments in Europe, USA and China.

About nu Angle

nu Angle helps clients capture real value from innovation. Since it was founded by Dr Steve Bone and Dr Peter Allen, nu Angle has established an enviable international reputation for excellence.

A core team of experienced consultants is supported by a virtual network of technology specialists. This offers the agility to create a bespoke team of industry experts for each client, reducing overheads and giving clients access to the insights of international experts. This includes access to relevant technology as part of an open innovation program.

It is the most experienced single group of technology and innovation management specialists in Europe, bringing together over 150 years of accumulated experience in helping clients grow through innovation.

nu Angle believes in creating lasting value. Its passion to share capability and transfer it to client teams means that clients continue to enjoy transformative success far beyond initial engagements.

nu Angle specializes in helping clients to:

- Connect brand direction, ideas, and technology for sustainable innovation
- Decide technology direction aligned with commercial priorities
- Implement processes and systems that help deliver on choices
- Create value from ideas and innovation
- Build client capability around technology
- Innovation management
- R&D strategy – analysis and design
- Innovation and technology management
- Innovation growth platforms
- Technology road mapping
- Innovation audit
- Foresight and technology watch

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ⁱ Details of client confidential

ⁱⁱ Trippas, D., Pennycook, G., Verde, M.F., & Handley, S.J. (2015). Better but still biased: Analytic cognitive style and belief bias. *Thinking & Reasoning*, 21, 431-445

ⁱⁱⁱ Confirmation bias: refers to a type of selective thinking whereby one tends to notice and to look for what confirms one's beliefs, and to ignore, not look for, or undervalue the relevance of what contradicts one's beliefs. Nickerson, Raymond S. (1998), "Confirmation Bias; A Ubiquitous Phenomenon in Many Guises", *Review of General Psychology*, Educational Publishing Foundation, pp. 192–194

^{iv} Daniel Kahneman (25 October 2011). *Thinking, Fast and Slow*. Macmillan. ISBN 978-1-4299-6935-2. Retrieved 8 April 2012

^v Ideas taken from *Intuition in Organizations: Implications for Strategic Management*, Gerard P.Hodgkinson, Eugene, Sadler-Smith, Lisa A.Burke, GuyClaxton, Paul R.Sparrow, *Long Range Planning*, Volume 42, Issue 3, June 2009, Pages 277-297 and *Exploring Intuition and its Role in Managerial Decision Making*, Erik Dane and Michael G. Pratt, *Academy of Management Review* 2007, Vol. 32, No. 1, 33–54

^{vi} Technology management represents the set of policies and practices that leverage technologies to build, maintain, and enhance the competitive advantage of the firm on the basis of proprietary knowledge and know-how. Burgelman, Robert A., Clayton M. Christensen, and Steven C. Wheelwright. *Strategic Management of Technology and Innovation*. McGraw-Hill/Irwin, 2003.

^{vii} Strategic and Operational Technology Management is a set of management techniques that allow organizations to direct their current and future technological fundamentals to create competitive advantage. Typical concepts used in technology management are: technology strategy (a logic or role of technology in organization), technology forecasting (identification of possible relevant future technologies for the organization that could either disrupt or be an opportunity), technology scouting, assessment and integration (structured search for new technologies, possibly in adjacent industry sectors), technology roadmapping (mapping technologies to business and market needs), and technology project portfolio (a set of projects under development) and technology portfolio (a set of technologies in use). Taken from nu Angle's works and <http://www.referenceforbusiness.com/management/Str-Ti/Technology-Management.html>

^{viii} *Technology Management: Activities and Tools*, January 2016, Dilek Cetindamar, Robert Phaal, David Probert

^{ix} *Technology, management & society: essays* / by Peter F. Drucker. New York : Harper & Row, [1970]

^x <http://www.belbin.com/>

^{xi} <http://www.myersbriggs.org>

^{xii} <https://www.mindtools.com/pages/article/PlanningAWorkshop.htm>



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