Imperial College London

vitae
realising the potential of researchers

Encouraging creativity in PhD and postdoc researchers

A guide for supervisors and principal investigators

Funded by Vitae Innovate 2009

About Vitae

Vitae is supported by Research Councils UK (RCUK) and managed by CRAC: The Careers Development Organisation. Vitae's vision is for the UK to be world class in supporting the personal, professional and career development of researchers.

To achieve our vision we have four aims:

- Building human capital by influencing the development and implementation of effective policy relating to researcher development
- Enhancing higher education provision to train and develop researchers
- Empowering researchers to make an impact in their careers
- Evidencing the impact of professional and career development support for researchers

Vitae's work with higher education institutions

Vitae works with UK higher education institutions (HEIs) to embed professional and career development in the research environment. Vitae plays a major role in innovating, sharing practice and enhancing the capability of the higher education sector to provide world-class professional development and training of researchers. We do this both through national projects and Hub activities.

The programme develops resources for use by trainers and others working with researchers, and provides opportunities for HEIs to share information and practice; develop ideas and approaches; and work collaboratively.

This guide was written by Katie Anders (project researcher) and Elaine Walsh (Graduate School)

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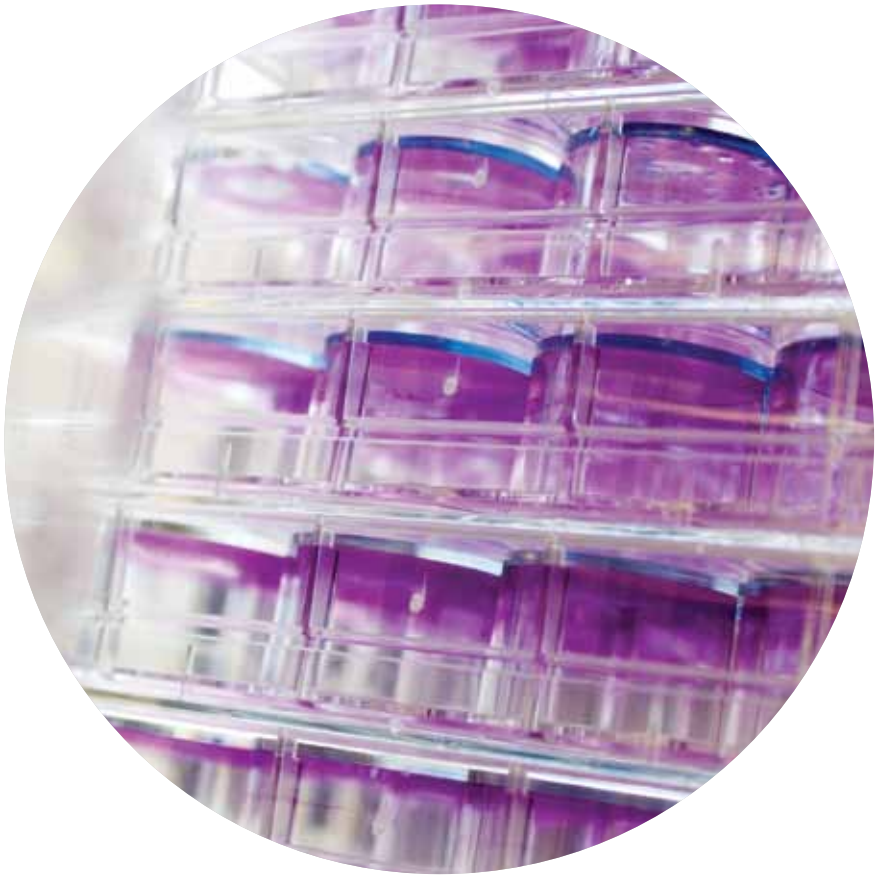


Introduction

Developing creativity is an important aspect of the training and progression of PhD students and postdocs in the STEM disciplines (science, technology, engineering and mathematics). This is because:

- Encouraging creativity can lead to unexpected and exciting research findings
- Creativity underpins the original contribution that all PhD candidates are required to make in their field
- The ability to generate new ideas, processes and products gives your postdocs a competitive edge
- Creativity enhances all of the other skills that researchers develop during the early years of their career

As a supervisor or principal investigator (PI), you are in a strong position to facilitate creativity in your research environment. However, there is very little information available to researchers about what creativity is and how to facilitate it. This is why the Graduate School at Imperial College London carried out this project looking at how PhD and postdoc researchers can develop and use creativity in their work, and how their supervisors and PIs can help facilitate this.

The aim of this guide is to communicate the key findings of the project, and to provide you with up to date information, tools and techniques on how to help the researchers you supervise and manage to develop and use creativity in their research. Its findings are applicable across the full spectrum of STEM disciplines.

PART ONE

Creativity

What is creativity?

People tend to associate creativity primarily with the arts, but it is also core to scientific and technological endeavour. So what is creativity?

There is no single, all-encompassing definition. It's understood and described differently, depending on the context in which it's being used. In the STEM research environment, creativity is usually defined as:

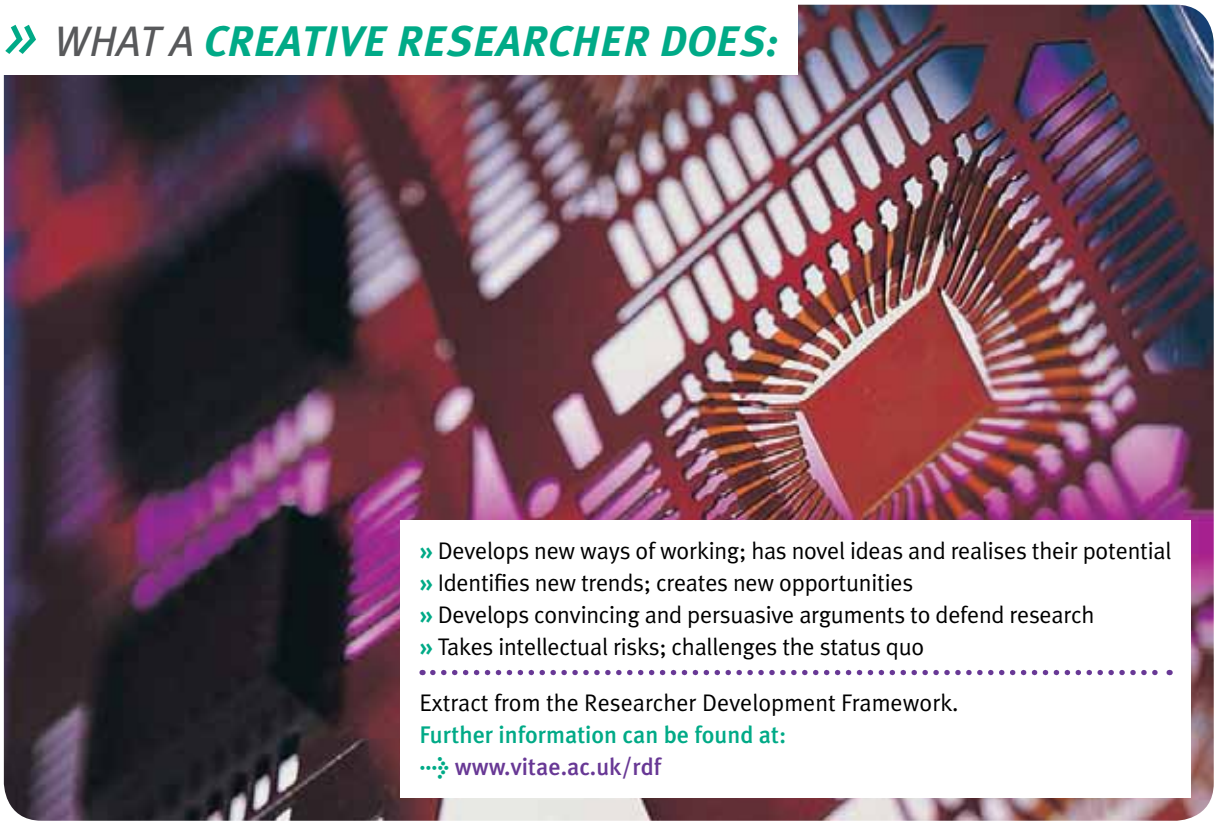
- The development of ideas and products that are original and useful
- The examination and/or combination of existing facts, ideas and theories in original and useful ways

STEM researchers use creativity to develop and explore new problems and re-examine, re-articulate or solve existing ones in novel ways.

However, deciding what is and isn't creative is not at all straightforward in practice. Who chooses whether an idea is useful, or who it might be useful to? How can we know that an idea, invention or discovery might not be useful in future? Creativity is a nebulous concept, and any definition (including ours) is best viewed as contingent.

Despite being tricky to pin down, it's often argued that 'you know creativity when you see it.' The box outlines the behaviours demonstrated by creative researchers.

» *WHAT A **CREATIVE RESEARCHER DOES:***



» Develops new ways of working; has novel ideas and realises their potential
» Identifies new trends; creates new opportunities
» Develops convincing and persuasive arguments to defend research
» Takes intellectual risks; challenges the status quo

Extract from the Researcher Development Framework.
Further information can be found at:
www.vitae.ac.uk/rdf

Who is creative?

Until recently, creativity was seen as a rare talent which a person either possessed or they didn't. Creative scientists were identified by their contributions, which were thought to be exceptionally novel and significant, and people tried to discover the characteristics that set these creative scientists apart from other, less creative people.

Today, it is widely understood that every researcher has the potential to develop and use creativity, although an individual's skills, knowledge and abilities will influence the ways in which creativity is expressed and the results of their creative endeavour will vary.

In the world of science and technology, creativity is no longer simply a matter of individual geniuses making paradigm shifting discoveries. It also encompasses the types of creativity that can lead to everyday breakthroughs and recognises the enormous potential for creativity in collaborative enterprise.

Whilst 'Eureka!' moments still occur, it's rarely an individual or a single breakthrough that pioneers development. Our knowledge is more often enhanced by the incremental progress that comes about through collectively reconfiguring problems, domains and situations.

Creativity and the research environment

As our understanding of creativity develops, so does our appreciation that the physical, social and cognitive (or intellectual) environments in which researchers work have a real impact on their creativity. Some of these environmental factors can stimulate creativity. Others can inhibit it.

We found that research environments most conducive to creativity are characterised by:

- A working culture that balances structure and support with freedom
- Frequent and constructive communication between colleagues
- Time, space and encouragement to be creative

Part two of this booklet outlines three core principles – each based on one of the characteristics outlined above – for improving your research environment. The principles are outlined in turn, accompanied by practical guidance on how to effect positive change in that area.

PART TWO

Encouraging creativity

As a supervisor and/or PI, you are in a uniquely influential position to improve your research environment and facilitate a more creative research culture for the PhD students and postdocs you work with. Even small changes can make a big difference in helping to enhance the personal and professional development of your staff and students. This, in turn, can lead to unforeseen and astonishing research findings.

"To be creative you've got to fail a lot. You've got to have stupid ideas that would never work and then you've got to figure out why. And that only happens in an environment where you feel confident and that it's not going to be the end of the world if you cock up an experiment or suggest something stupid in a group meeting. And I'd say that's it. It's not even facilities; it's not even money, because whatever circumstance you're in, you can be creative, but only if you feel comfortable. And that's what I've learned from this group – if you feel that you're in an environment where you're enjoying what you do and you can fail and it's not going to be the end of the world, then you will learn and progress".

Postdoc, Natural Sciences

Principle one: Contributing to a positive research culture

Research environments consist of the physical spaces where research takes place and the people who inhabit these spaces. A research culture can be thought of as 'how things are usually done' by the people in research environments. Our study suggests that for PhD and postdoc researchers working in STEM disciplines, creativity is most likely to flourish in academic cultures that balance support and freedom.

What is a supportive research environment?

IT'S STRUCTURED

Doing creative research involves having the time and space to think of – and try out – new ideas. Whilst this requires a degree of autonomy, it is vitally important for PhD and postdoc researchers that this autonomy be developed within a structured environment. Research cultures where project objectives, timetables and deadlines are clearly communicated and researchers are effectively managed can be particularly productive environments for creative research.

IT'S SAFE

Doing creative research requires the confidence to try things out, take risks and make mistakes. It also requires the confidence to ask questions and voice ideas. This means working in a culture where 'silly' questions are positively welcomed and nobody is afraid of being ridiculed for having an imaginative idea. Facilitating a 'safe' research environment can lead to tremendously creative and productive communication between colleagues – particularly in the form of group brainstorming or problem solving exercises.

IT'S COMMUNICATIVE

Communication is a shortcut to creativity, but it needn't involve formal collaboration. Encouraging PhD students and postdocs to spend time chatting with their colleagues can help them to generate, explore, critique and refine new and innovative ideas. Principle three explores the creative value of communication in more detail.

What is a free research environment?

IT FACILITATES AUTONOMY

Making the transition from undergrad to postgrad, and from postgrad to postdoc research involves developing greater autonomy as a researcher. The pace at which a student or postdoc develops autonomy will depend on their individual skills and requirements, the degree of research experience that they have and the environment they are researching in. A comfortable degree of autonomy gives students and postdocs some responsibility for the research processes and decisions which influence their work, whilst providing access to constructive and supportive feedback, guidance and advice when required.

IT'S INFORMAL

Working in a relaxed and informal environment can really boost creativity. Informal working cultures prioritise quality (for example, achievement) over quantity (for example, number of hours worked). They also facilitate open and productive relations between departmental staff and the postdocs and students working there. Finally, they are democratic. So every member of the department is approachable, and everyone's ideas are valued.

> *"My supervisor always says 'there's no stupid questions'. He definitely creates a completely open environment for me to talk about anything and be creative and at first it's difficult because it's your supervisor, so there's only so many times you want to go all the way up to his office to say something really stupid. But with time if you do push it and you're willing to be creative, obviously it becomes comfortable. You have to like decide in your mind not to be worried or insecure about being creative. You really just need to open the floodgates and let yourself be creative. But it's really hard to get to that stage".*
>
> PhD student, Natural Sciences

IT ENCOURAGES INTELLECTUAL ADVENTUROUSNESS

The amount of creativity a student or postdoc brings to their research will be influenced by the amount of support and encouragement they receive to pursue interesting leads, try things out and test original new ideas. In order to do these things, they need to develop the confidence to take some calculated risks – when to pursue a new or interesting piece of data, how long to deviate from their original timetable, what types of resources to invest.

It is also important that students and postdocs learn to accept that sometimes they will make mistakes and sometimes they will fail. Working in an environment where they are actively encouraged to try things out can help them develop the confidence they need to work creatively.

Managing the support/ freedom balance

One of your greatest responsibilities as a supervisor and PI is to help your researchers to find and sustain a balance of support and freedom – or structure and autonomy – that helps them maximise their personal and professional development. The balance of support and freedom that works best for a researcher will depend on their individual skills, attributes and needs and is likely to fluctuate as they develop confidence and independence

WHAT YOU CAN DO

- Invite researchers to take ownership of their professional development by actively negotiating their support/freedom balance with you. This can be discussed during supervisions and appraisals, and should be revisited periodically.
- Help facilitate a structured environment by providing clear project outlines, objectives and deadlines to everyone involved.
- Actively facilitate a 'no silly questions or comments' policy that applies to all group members and all types of group interaction – particularly meetings. Developing a research culture where everyone feels safe and confident to contribute their ideas will take time, but with continued and proactive encouragement, it can be achieved.
- Encourage students and postdocs to feel that they are part of a democratic working culture by consulting and including researchers in decisions that affect their research when possible. This will help to facilitate feelings of ownership and investment.
- Help engender an open working culture by developing a policy of approachability. Making yourself available – as far as is practicable – to students and postdocs, will help them to feel that they can discuss problems, issues and ideas with you and other members of academic staff.
- Facilitate an informal working culture by prioritising quality over quantity. Let members of your research group know that hard work, commitment and results are more important than the hours that researchers keep or what (within reason!) they choose to wear to work.
- Help encourage researchers' intellectual adventurousness by normalising their mistakes and failures. Reminding students and postdocs that making mistakes and getting things wrong are natural and expected aspects of STEM research which every researcher experiences.

Principle two: Facilitating communication

Two types of communication have been shown to be particularly useful in stimulating creativity amongst PhD and postdoc researchers: these are constructive informal and constructive formal communication.

Why it matters

CONSTRUCTIVE INFORMAL COMMUNICATION

This can take place when researchers chat with their colleagues at their workspace, over a coffee or at lunch. Informal conversations between colleagues become constructive – from a research point of view – when they offer the following:

- A chance to share cognitive resources – important information about what's going on in the field – such as new journal articles or upcoming conferences. Encouraging researchers to share information can save time too.
- An opportunity to build social and professional networks which can help researchers, and their research.
- Time and space to generate, share, explore and critique new ideas. Bouncing ideas between colleagues in informal conversations also helps to clarify and refine ideas, so researchers can enhance their capacity for thinking creatively and speed up their working processes simultaneously.

CONSTRUCTIVE FORMAL COMMUNICATION

Most research groups organise regular meetings. These meetings can take the form of progress report sessions, discussion groups or seminars, but all represent some form of structured, formal communication. But not all of these are constructive.

The most creative types of formal communication are constructive. They are:

- **Open:** they take place in an environment where everyone feels safe to share their ideas, ask questions, discuss problems and elicit help and advice
- **Safe:** they create a space where people are encouraged to feel that there are no silly questions or stupid comments, just ideas
- **Democratic:** where knowledge is exchanged horizontally across all participants rather than being dispensed by senior group members
- **Supportive and encouraging:** where every member of the group can give and receive constructive critique without fear of rebuke or ridicule
- **Intellectually adventurous:** where all group members are encouraged to think big

What you can do

CONSTRUCTIVE INFORMAL COMMUNICATION

- Let researchers know it's okay to chat. Many PhD students and postdocs think that conversations with colleagues in the lab or office, popping out for a coffee, or even taking lunch away from their desk might be frowned upon by their supervisor or PI as time wasting. Make it clear that it is an important – and expected – part of their job.
- Encourage researcher led initiatives such as the establishment of weekly journal clubs, poster days or even departmental picnics. If researchers know that suggestions will be met with enthusiasm, they are more likely to take the initiative.

> *"The problem sessions that we have – we have cakes and pastry and coffee and stuff and it's just a really relaxed sort of attitude – we have a laugh if someone makes a mistake and it's a very relaxed environment where you're allowed to fail basically! Then that fosters your creativity because you don' t hold back and you start to just get better at it".*
>
> Postdoc, Natural Sciences

CONSTRUCTIVE FORMAL COMMUNICATION

» **Group meetings**: To facilitate meetings that are open, safe, democratic, supportive and that encourage intellectual adventurousness focus on these practical techniques:

- **No silly questions:** Doing creative research requires the confidence to ask questions and voice ideas. As experts in your field, it's unlikely that any contribution is completely silly. More importantly, even if it doesn't solve the problem on the table, it could be the catalyst for the idea or solution that does.
- **Rotate the chair:** This helps establish the principle that everyone can contribute ideas on an equal footing, regardless of their position, and widens participation.
- **Arrange tea and biscuits (this too, can be rotated):** Not all meetings are tea and cake appropriate. But a cup of tea and a biscuit can help create an environment where researchers feel more comfortable sharing ideas and discussing problems.

» **Departmental seminars or talks:** These are an important opportunity for researchers to meet and exchange ideas with one another and with the experts in their discipline. Whilst you can delegate the admin, students or postdocs may not have the seniority to draw the key thinkers in their field. Taking ownership of the speaker list for an academic year will boost both the profile of the seminar series and the experience of those who attend.

» **External events:** Encourage PhDs and postdocs to attend relevant events taking place outside of their department. Attending and, where appropriate, presenting at seminars and conferences in other departments, faculties and universities can be inspiring and useful, and can generate enthusiasm and ideas which are then fed back into their research.

Whilst chatting with colleagues might not appear productive, PhD and postdoc researchers report a real benefit from such exchanges, which enable them to cultivate invaluable resources.

Principle three:
Providing time, space and encouragement for creativity

Developing and using creativity in today's results driven research environment isn't straightforward. Pressure to win funding, complete projects to deadline and on budget, then publish the results in high ranking journals can leave little room for pursuing interesting leads or trying out new and exciting ideas. But these things are vital to the professional development of PhD and postdoc researchers, and they require your support. They can also lead to exciting and unanticipated findings.

Why it matters

TIME AND SPACE TO THINK

» As creative ideas and solutions rarely occur as soon as a problem or issue has been identified, it's important that PhD and postdoc researchers are given adequate time and space to think them over. This can mean being encouraged to spend some time focussing on a particular issue, or to let ideas and problems develop over time rather than being rushed. Thinking problems, issues and questions over outside of the workspace can also be beneficial to PhD and postdoc researchers' creativity. Engaging in a non-work related activity or even 'switching off' from a problem altogether have both been reported to be conducive to the development of original and imaginative ideas and solutions.

TIME AND SPACE TO LEARN BY TRIAL AND ERROR

» Having room to find out how things work by experimenting with them is also vital to the development of a researcher's creativity. If some time and space for 'trying things out' is factored into a researcher's schedule, it might be accepted as part of the learning process rather than perceived as time wasting.

» Learning by experimentation requires confidence as researchers will spend time experimenting with ideas and solutions that won't always generate the results they anticipate or hope for. If researchers feel they are working in an environment where it's ok to take calculated risks with time and resources and make some mistakes in the pursuit of new ideas and solutions, they are more likely to develop the confidence and autonomy to try things out. In addition, discovering where an idea or experiment went wrong can be as instructive (particularly for PhD students) as getting it right.

> *"I really encourage my people to be innovative, to try and come up with new ideas, to not feel restrained by the project brief; to, if they come across something interesting, to go and follow it up".*
>
> Supervisor and PI, Engineering

TIME AND SPACE TO PURSUE INTERESTING LEADS

» Researching creatively involves being attentive to interesting and unexpected findings which can emerge during experimentation or data analysis. These might be overlooked by PhD and postdoc researchers, particularly if they do not relate directly to the project they are working on. Encouraging them to look out for interesting results and leads can help researchers to feel less constrained by their project brief. If they do come across something they think might be worth pursuing, ask them to raise it with you. You might sometimes decide that the potential rewards – exiting and unexpected research findings – are worth the calculated risk of deviating from budget and deadline.

What you can do

As a supervisor and/or PI, you have a significant influence over the amount of time and space your students and postdocs are able to dedicate to doing creative research. If you are open to the pursuit of new findings and ideas, it's likely that they will see this as a fundamental part of the research process and build this into their research practices.

» Encourage students and postdocs to make some time for thinking – inside and outside the workspace. Encourage them to feel there is time for this, and that it's valuable work.

» Encourage researchers – particularly students – to try things out for themselves. As well as being an effective learning tool, experimenting also helps students and postdocs to build the confidence and develop the autonomy they will need to conduct independent research in the future.

» Normalise failure. Getting things wrong, making mistakes and failing is an unavoidable aspect of creative research. Encourage students and postdocs to view their mistakes and failures as a normal and unavoidable aspect of STEM research and a valuable learning opportunity, as opposed to a disaster.

» Encourage students and postdocs to share the exciting aspects of their research with you as well as the frustrating or problematic parts.

» Ask your students and postdocs to actively look for interesting new leads or findings as they research. If they do discover something original or exciting, ask them to discuss it with you. Together you can explore the relative merits of further investigation and decide on a course of action.

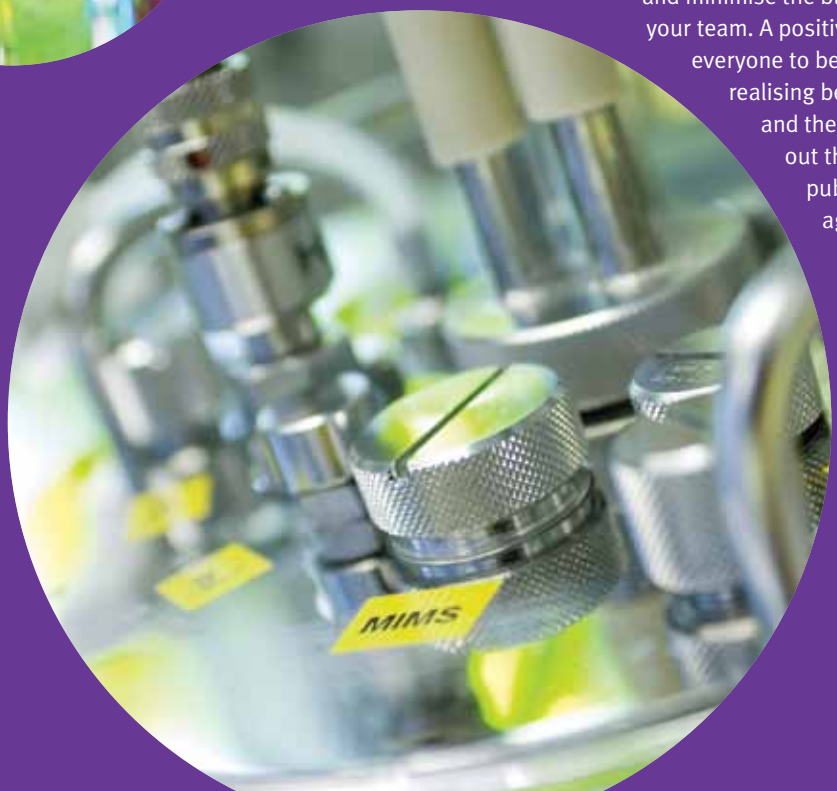
» Try to be as flexible as possible if you are approached with a proposal to pursue an interesting finding. Is there scope to deviate from the time table for a set period of time? If not, might there be an opportunity for students or postdocs to pursue this thread later on? Alternatively, might they be able to conduct an investigation in their own time?

» Try, wherever possible, to build a degree of flexibility into the research grants that you oversee. Although this is far from straightforward, it is necessary to enable the pursuit of interesting findings that may arise during a project.

Conclusion

Make the difference

It is important to recognise the power that supervisors and PIs have and that small changes in the research environment can make a big difference to results. PhD students and postdocs may have good ideas for how things could work better, but without encouragement from you, they may never share them.



Every academic department, lab and research centre constitutes a unique research environment, with its own individual culture. Some aspects of this research culture will help researchers to work creatively. Others will make it more difficult. A PhD or postdoc's experience of their research environment will also be influenced by the qualities and abilities that they, themselves, bring to the environment. These are likely to change over time, as they learn new skills and techniques, grow in confidence, adopt more responsibility and attain greater independence.

Because of this, there is no algorithm for facilitating and managing consistently creative research projects. Making space for creativity is itself a creative task, one that is often achieved by striking a balance – sometimes known as a creative tension – between too little of a given factor and too much. As we have suggested, the freedom to pursue ideas needs to be balanced by the structure of reasonable and clearly communicated project targets and deadlines. Similarly, having unlimited time and space to try out new ideas would soon become as unproductive as working with insufficient resources.

Nevertheless, it is worthwhile using your influence to ensure you maximise the flow and minimise the blocks of creativity in your team. A positive environment helps everyone to be more productive, realising benefits for individuals and the whole team. In carrying out the research for this publication, time and again we observed that people who worked in creative environments were more likely to be motivated, enjoy their work, be invested in it, get on with their colleagues and feel good about their results than those who didn't. Use your influence to make the difference.

Other good practice guides are available in this series:

Doing creative research
A good practice guide for postgraduate researchers in STEM disciplines

Doing creative research
A good practice guide for postdocs in STEM disciplines

These resources may also be downloaded from:
www.vitae.ac.uk/database-of-resources