

RESOURCES FOR STUDENTS

25 Tips on Inventing and Creating Value in Science and Technology

"We are not students of some subject matter, but students of problems.
And problems may cut right across the borders of any subject matter or discipline."

Karl Popper, 1963

As explained throughout the **Atlas of Human Imagination**, appreciating the history of ideas can also be the key to understanding the future of ideas.

This document offers curious students a variety of tips for inventing – all based on the author's personal experiences of 32 patent families and 100 national patents in materials engineering and manufacturing over 20+ years. The tips below are not exclusively related to materials or engineering, and can be used in and transferred to many other disciplines including life sciences, computing and other deep-tech initiatives.

1) Understanding the problem

- Sometimes you need to identify the technical problem yourself, because people are always complaining about something, but no-one does much about it
- Sometimes the problem is provided to you by someone else e.g. a customer or colleague
- Sometimes you are solving an anticipated problem that hasn't even happened yet, but is very likely to happen in the near future
- Whichever way, it's good to have a *very clear statement of what the problem is*, when does it happen, who is affected by it, where the problem resides, why it hasn't already been solved.

2) Don't blindly accept the status quo

- It's absolutely fine to be grumpy about the status quo
- Don't always believe received wisdoms; think for yourself and believe in yourself
- Always question the engineering requirements to see if they are even required; and if they cannot be justified, see what happens when you *remove* them completely.

3) Brainstorming

- Brainstorming and creative thinking are best done in a collaborative pair or a small team, standing in front of a blank whiteboard, for example
- Sketch out the problem on the board and see it from different angles and perspectives
- Look at it from left to right, then in the other direction, or upside-down, or inside-out, or back-to-front, or with certain components removed
- Always ask, what would happen if I do the exact opposite?
- Alternatively, put yourself in the shoes of a great thinker in history. How would Da Vinci do this? What would Michael Faraday make of it all? What perspective would Marie Curie or Louis Pasteur bring?
- The key here is to see the *unseen.*

4) Keeping your options open

- Once you have the problem identified, there might be several original approaches to solving it
- Keep your options open for a while, and let them *marinate* for a few days, weeks or even months
- There's no rush, eventually you will down-select and home in on an optimal solution.

5) Occam's razor

- A good technique for inventions is to keep things simple, apply the most basic assumptions and follow the *law of parsimony* (or Occam's razor)
- Try to analyse the problem, as if you were a child asking lots and lots of why questions
- Some inventions are incredibly simple and elegant, and could be just combining two or three known things in a highly novel way.

6) Finding some quiet headspace

- Deliberately find some *quiet headspace* to mull on a problem (not always easy these days)
- Good ideas often emerge at funny times of the day, sometimes at the weekend or on holiday, sometimes completely out-of-the-blue, and sometimes even in your sleep
- Good places for invention are walking and hiking, either with another person or alone
- Staring out of the window, flying on a plane, travelling by train, or looking out to sea are all relaxing environments for creativity
- Scrolling on a smartphone, checking apps and relying on AI can crowd out your own creativity. They are best avoided during brainstorming because they won't lead to much relaxation or independent mind-wandering
- Keep in mind that AI apps are trained on lots of known facts, existing ideas and standard models – so you are very unlikely to be handed a truly novel breakthrough idea by a bot.

7) Cross-disciplinary curiosity

- Curiosity and broad interests are absolutely critical to invention, possibly *the* most important facet
- Read lots of papers and articles within your own specialised field, but also beyond
- Observe nature and get inspired by topics like botany, zoology, anatomy, microbiology, because billions of years of evolution have already provided some truly amazing solutions
- Have a good mathematical understanding of geometry, 2D and 3D shapes, polyhedra, tessellation, surfaces, topology, symmetry, packing, crystallography, branching shapes, fractals and other visual patterns to help your spatial awareness
- Art and architecture can also be very inspirational, such as the works of Da Vinci, MC Escher, Buckminster Fuller, Le Corbusier, Salvador Dalí, Anna Atkins, Damien Hirst, Antoni Gaudí, Zaha Hadid, the Alhambra, Bauhaus etc.
- See knowledge as an *interconnected tapestry*, rather than in individual subject silos
- Read novels for pleasure, because it can't all be 100% science and technology.

8) Perseverance

- Inventive ideas can come quickly, but they generally take months or even years to come to fruition
- First experiments and trials might not work perfectly; therefore, you will need a fair bit of perseverance on the practical side
- Sometimes it takes 100+ samples to get the right sample, or 10 prototypes to get the right prototype
- Patenting also takes a long time and it can be a fairly tortuous legal process, so you might need a lot of tenacity to get a patent granted, if that's the route you choose
- But…*never, never, never, never give up!*

9) First principles analysis

- Have a very good grasp of chemistry, physics, biology, computing and maths to work out if your inventive solution is even going to work
- Do a few quick *basic calculations*, check the orders-of-magnitude, verify your units, and work out the most important metrics
- Build a Matlab or Python model if you need to program something, draw it in a CAD model to visualise it better, or make a quick physical model by hand.

10) Joining the dots

- Realise that *everything connects to everything else*, somehow or other
- When your invention emerges, try to draw a sketch that connects all the relevant dots
- Visualising the connections between the different things can be quite affirmative and satisfying.

11) Scribbling things down

- Always keep a good logbook recording dates, times, sample codes, compositions, process conditions, protocols, raw data, general observations, and any other new, emerging ideas
- Write things down in such a way that you can *always repeat them later*, even years later
- Draw clear sketches, graphs, visual aids, side-notes and annotations
- When you use whiteboards for collaborative sessions, always take a photo of it afterwards
- Repeatability is critical for invention, so make sure you log all the salient details carefully.

12) Accessing the key information you need

- Fish around for the information you need in online journals and books
- Use Espacenet or other software to find older patents and prior art documents
- Visit archives or even museums if necessary
- Always have some reference books close at hand if you need basic data and properties
- Again, not everything needs to be accessed using AI tools.

13) Playing and experimenting in the lab

- The R&D lab is a *playground* to try out completely new things
- If you have some first demos, play around with them and see what happens
- Mix things, heat them up, burn them, hit them with a hammer, bend them, twist them, spin them, test them with a magnet, get them wet, throw them up in the air, try different machine settings, check them under a microscope etc.
- Don't be afraid to ruin the demo or fail in an experiment; you usually learn more from failure than you ever do from success
- And remember that many discoveries in history have been due to *trial-and-error and serendipity.*

14) Visualisation

- A picture can say a thousand words
- Science and technology are often full of complex data, so it is important to be able to visualise the information and see the *underlying structures*
- Statistical charts, diagrams, flow charts, graphs, 3D physical models, CAD drawings, X-ray images, tomographs, VR simulations are all crucial ways of seeing the unseen.

15) Zeitgeist

- The timing of an invention is quite important, too
- Sometimes an invention is many decades ahead of its time, and the market won't be interested initially, and the solution might only get picked up 20-30 years later. That's life!
- Timing is difficult to control, but certain inventions do fit the general *zeitgeist*, like energy conservation, lightweighting, climate change mitigation, national security, genomics etc.

16) Physical and mental stamina

- Invention needs a well-functioning brain, a sharp memory and some stability back home
- Make sure you get good rest, and sleep with the window open for fresh air at night
- Do regular *exercise*, yoga and sport to keep your body in good shape
- Try to do more than 10,000 steps every day, e.g. walking to school, university or work
- If you can, eat '*brainy foods*' like fish, seafood, eggs, spinach, kale, beets, mushrooms, walnuts, avocados, pistachios, blueberries, ginger, dark chocolate – and stay hydrated with water, herbal teas etc.
- Play occasional games in your downtime, like wordle, connections, sudoku, chess, crosswords, spelling bee, puzzle books – all of which will keep the mind limber.

17) Having craft hobbies

- Craft hobbies are largely forgotten these days, but they can play a vital role in invention
- Hobbies give you *manual dexterity* and a tangible understanding of the world
- Tactile skills and creativity improve enormously with hobbies like: pottery, stained glass, woodwork, wax casting, glass fusing, clay moulding, origami, bladesmithing, weaving, calligraphy, jewellery design, soap making, drawing, mineral collecting, bushcraft, beer brewing, baking, DIY, renovation, gardening, 3D printing etc.
- Have at least one handicraft hobby or creative side-project on the go
- Find your flow-state and get lost in it for hours
- These manual skills are a superpower that will always come back to help you later.

18) Keeping an eye on the economics

- Any invention needs to be rooted in reality, if you want it to be implemented in industry
- Keep things simple if you can, because that will be more cost-effective later
- The invention must be scalable, with a good yield, and based on easily available materials or processes
- It must not be toxic, polluting, unethical or downright dangerous
- Be prepared to adapt an invention, if it's not practical or it becomes far too expensive
- Model the *economic metrics* early on – especially if you want to build and develop a business case.

19) Lifelong love of learning

- Keep reading, thinking, studying and exploring new things throughout your whole life
- Talk to colleagues, friends and partners about the things they are currently reading or learning, as well as their hobbies
- Learn for the *pleasure of learning*, first and foremost
- If the knowledge comes in useful later, that's just an added bonus.

20) Conferences

- Try to attend international conferences in your field, as if they were a pilgrimage
- Read the session abstracts in advance and choose a broad variety of presentations to listen to, including a few things you don't know much about
- Make good notes, ask lots of questions and talk to people while you're there
- Read all the student posters and check out the exhibitors' hall
- Go for a long walk to think about all the information you've just absorbed
- *Sharing ideas and collaborating* are a vital part of science and technology.

21) Understanding the details of the patent process

- Inventions can be protected, if they are very good and potentially lucrative
- Bear in mind, patenting is not always required; sometimes it's simply better to have a new technology open-sourced
- Even though a patent attorney writes the formal application, you still need to know the ins and outs of patenting, novelty searches and freedom-to-operate analyses
- Pay good attention to the claim set, *claim one*, and the independent claims in particular
- Try to think how a competitor might try to bypass your invention
- Have plenty of fallback positions ready in your description text and claims
- Make clear sketches, drawings and flow diagrams for the mosaic section
- Always read the examiner's opinions carefully and respectfully, and find good counterarguments if needed.

22) Success requires a bit of silence

- *Keep quiet* initially during the patent process to make sure nothing leaks out early
- Patent first and then publish a paper in a good journal or conference proceedings later
- That way the new knowledge is shared with the community and the public.

23) Marketing the invention

- Once the invention is conceived and under way, another creative part of the whole process is: how will you *market* and sell it to potential customers?
- This is where market strategy, product names, trademarks, regional coverage, licensing and overall packaging become important, all of which require lots of imagination, too.

24) Keeping the ideas flowing

- Good inventors don't just invent one thing; they usually *keep inventing* and often generate a variety of useful products
- Consider inventing a product that complements an existing one; or find potential improvements to the initial invention and release updated versions
- Keep in mind that if you solve a major industrial problem, your customers and partners will most likely be back for more and they will want you to develop even more products
- Consistent, high-quality solutions will in turn give you a highly credible reputation.

25) Fun

- Never forget how lucky you are to be having this much fun at work
- Take a break when it gets difficult or the ideas don't flow so well, and come back to it
- Being a researcher and inventor is one of the few '*explorer*' jobs left in the world, so be very proud of what you're doing and enjoy it
- Scientific invention will literally give you *goosebumps*.

Happy inventing!

David J. Jarvis
26th October 2026
www.davidjarv.is