

Whats Unique about this Chemical Industry Digest Annual?

There is no area of our civilisation and our lives that is untouched by chemistry. And chemistry continues to break barriers and drive developments in multifarious fields. R&D and Innovation are what makes great discoveries happen. In this Annual the importance of R&D is elaborated and the intricacies of the R&D mindset.

Three scintillating new developments enabled by chemistry are covered: Graphene, Energy Storage and 3D Printing. The potential applications of these developments are nothing short of revolutionary. These and many such developments make for chemical industry's game changing role.

As people skills are what finally matters, this Annual has covered many articles on how to enable next generation engineers to communication skills such as persuasion and the power of negotiations.

This is in addition to our regular snapshot reviews on the chemical industry, energy, refineries, fertilisers etc, etc.

The CHEMICAL INDUSTRY DIGEST Annual as always is different with coverage on such unique topics.

The R&D Mindset

R&D and Innovation needs creative thinking, out of the box thinking. Solutions to the problems and challenges human kind faced from times immemorial came through the application of mind. Techniques, processes, technologies, materials, equipment & devices, ways of doing all emanated as results of thinking, from the need to create and the need to solve. This has driven all our economic systems from agriculture to industry to services.

R&D and innovation are for those with a passion, with a sense of adventure and the courage to challenge the unknown.

While all debates on R&D have been on the processes, the systems, the financial outlays and the outcomes, the most fundamental aspect of what drives some to think creatively and push or break existing frontiers in various fields has not been sufficiently debated.

What is the mental makeup of the researcher or the inventor?

CHEMICAL INDUSTRY DIGEST probes through a few questions and the views of leading researchers are presented here.

Prof Arun S. Mujumdar is a globally renowned expert on heat and mass transfer including thermal drying. He is currently Professor, Dept. of Mechanical Engineering and Director, Mineral, Metal & Materials Technology Centre (M3TC) with the National University of Singapore. He was awarded Doctor Honoris Causa from Lodz Technical



University, Poland and University of Lyon1, France. He has won major international awards and honours for his achievements in chemical engineering, particularly drying. He has authored three books on industrial drying, edited over 60 books, published over 450 refereed research papers, and presented over 350 conference papers. His research areas include drying of paper, steam drying, computational fluid dynamics, electro-osmosis dehydration, time dependent melting/freezing phenomena, novel spout/fluidized bed drying, transport processes of impinging and opposing jets, chemical heat pumps for industrial drying. He is Editor of the Handbook of Industrial Drying (now into 4th edition) and Editor-in-Chief of Drying Technology journal now in 30th year of publication. He has just been selected for Jiangsu Province, China Award for his major contribution to science and technology of the province with a GDP half of India's.

Q: What drives people to R&D/innovation?

Prof Mujumdar (M): Intellectual and/or commercial needs of individuals and/or organizations. Academics have little financial reward for innovation and yet they do strive for innovation (although not as frequently as one would expect as the incentive is often minimal).

Personally, I get “intellectual satisfaction” out of having come up with some innovative ideas that others could benefit from.

Q: What is the mental makeup of an innovator?

M: I believe that someone with both breadth of knowledge of a specific field as well as depth are more likely to be innovative. Of course, some innovations are simply serendipitous but one cannot count on such innovations by and large. Desire to make a contribution to society is also a powerful driving force. This is lacking in purely commercially driven organizations for good reason.

Q: What are some of the important requirements to encourage scientists in R&D /innovation?

M: Give free time to think (20-25% of work time) to do whatever the scientist wants to work on. Creativity or innovation cannot be regulated. If one must follow rules then by definition there can be no innovation. There should be appropriate incentives. Due credit should be given to the true innovators...it should not be diluted by distributing it to those who made peripheral or inconsequential contribution e.g. a Group Leader or Manager, when it is not appropriate.

Q: What is the environment you seek to get ideas for innovation?

M: Personally, I get new ideas when I walk in the park early morning before sunrise or when I reduce mental stress by doing some watercolors and the mind is calm and uncluttered. Often ideas emerge during discussions with students, colleagues or while listening to talks at meetings. I personally find flipping through journal pages and scanning papers in unrelated areas have given me the most ideas for innovative research. Cross-disciplinary transfer of knowledge can yield rich dividends. This is a limitation in today's tendency to only look up papers in one's area of direct interest using keywords and computer-aided literature searches.

Q: How can you create a team of innovators?

M: With great difficulty and a lot of luck! Very few are true innovators. On the other hand only incremental innovations are often used by industry. Radical ones are hard to sell due to inherent risks involved.

Giving freedom to think, to experiment, to fail and otherwise think out of the proverbial box, is the key. Multi-cultural, multi-disciplinary, multi-national teams are more likely to innovate as each member brings something different to the “Innovation Table”. If everyone thinks alike then no one is really thinking. Encourage diversity. Make small teams. Larger teams are unlikely to have a consensus and hence will be ineffective in general.



Dr Khijar Sarnaik (BSc Chemistry, Mumbai University, MSc (Analytical Science), Indian Institute of Science, Mumbai, PhD (Chemistry), BARC) hails from Ratnagiri Maharashtra. Prior to joining Nalco, he was Global Technology Director, GE Global Research, heading the Silicone and Quartz technology team at John F. Welch Technology Center in Bangalore. He had a stint of more than 19 years with Procter & Gamble where he had several successful international R&D leadership assignments across their global technical centers in India, Japan and USA.

He enjoys digital photography, digital graphic design, building computers and loves painting. He is familiar with more than seven languages.

Q: What drives people to R&D/innovation?

Dr K Sarnaik (KS): There are a number of key drivers for pursuing R&D/Innovation, could include combination of the following:

- Motivation – to make a positive impact, change the way things are done.
- Excitement – of seeing the outcome of their R&D/Innovation in the form a product/service. Thrill of exploring the unknowns.

- Association – associate with a discovery; delight the customer/consumer experience.
- Change – Changing the status quo.
- Curiosity – leverage the subject matter expertise.
- Contribute and impact our society, to a greater good.
- A rewarding and satisfying career.

Q: What is the mental makeup of an innovator?

KS: Key elements are:

- Creative and energetic – able to influence people around them.
- Ability to identify non-obvious insights and transform them into an opportunity.
- Thrive on freedom and flexibility; welcome challenges as an opportunity.
- Good at identifying opportunities by collaborating with others.
- Positive and compelling view of the future.
- Passionate about innovation.
- Realistic and informed.

Q: What are some of the important requirements to encourage scientists in R&D / innovation?

KS: ○ Engage – in organization's mission, vision and strategies, drive ownership.

- Energise – demonstrate organization's commitment to the business, produce and cultivate innovators. Keep the organization motivated.
- Enable – help manage risk taking, implement ideas quickly through rapid decision making.

Q: What is the environment you seek to get ideas for innovation like for instance in the stillness of night, early mornings or in a tranquil atmosphere – anything else which facilitates idea generation for you?

KS: Not sure any of the above environmental factors necessarily contribute to idea generation; least disturbance in a brainstorming session is helpful. Creative worrying of a given problem leads to the solution. Looking for similarities of the problem in totally unrelated areas could also lead to creative solutions.

Q: How can you create a team of innovators?

KS: ○ Leverage diversity – Technical diversity, diversity of thoughts and approaches; reach out to others, connect what's needed with what's available.

- Proactively anticipate emerging trends – consider them as opportunities vs challenges/limitations.
- Reward and recognize the innovation catalyst and team work.
- Nurture interdependencies and collaborations.



Dr S Sivaram, former Director National Chemical Laboratory (NCL), Pune and currently Shanti Swarup Bhatnagar Fellow of CSIR at NCL, Pune. Prior to this, Dr Sivaram was the Director of CSIR-NCL (2002-10). He was also the Founding Chairman of Venture Center. He is widely recognized for his contributions to polymer science, technology development, institution building and management of innovation in publicly funded organizations. An alumnus of IIT-Kanpur (M.Sc.), he received his Ph.D in Chemistry from Purdue University, W. Lafayette, Indiana, USA. He was a Research Associate at the Institute of Polymer Science, the University of Akron, Akron, Ohio. Prior to joining CSIR-NCL in 1988, he was associated with the Research Center of the Indian Petrochemicals Corporation Limited, Vadodara for about 15 years in various capacities.

Q: What drives people to R&D/innovation?

Dr S Sivaram (SS):

- To be famous and to be known
- To create wealth for the society through science and, in turn, create wealth for oneself
- To invent and create new products and processes useful to consumers
- To create new knowledge, disseminate, teach, inspire and communicate science

- Altruism; creating public good using science and technology as a tool; improve the life of the less privileged through application of science
- Self actualization; highest value in the "hierarchy of human needs"

Q: What is the mental makeup of an innovator?

- SS:** (a) Prepared mind
(b) Independent thinking

- (c) Courage, perseverance and passion
- (d) Ability to tolerate ambiguity and to connect the seemingly unconnected
- (e) Ability to look at "outliers"
- (f) Curiosity and a keen eye
- (g) Courage to ask stupid questions
- (h) Sense of imagination and "whole brain" thinking
- (i) Uncomfortable with routines and rules
- (j) High appetite for risk taking

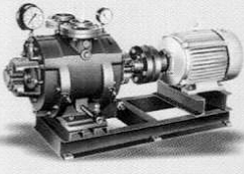


Q: What are some of the important requirements to encourage scientists in R&D/innovation?

- SS:**
- (a) Setting "impossible" goals
 - (b) Asking the right questions
 - (c) Learn to challenge assumptions
 - (d) Connect people who think differently – Focus on divergence of thoughts
 - (e) Build diversity in teams
 - (f) Promote cross – functional interactions
 - (g) Balance breadth with depth
 - (h) Focus on problems that "need" to be solved, not that "can" be solved
 - (i) Close monitoring of activity is a powerful motivator for enhancing innovation

Q: What is the environment you seek to get ideas for innovation?

SS: New Ideas emerge under many different environments. These are,

- (a) During periods of indolence
- (b) During interactions with people coming from completely different disciplines, cultures and fields (educational as well as social)
- (c) Interacting with individuals working in industries/government/societal interface
- (d) Learn to listen to the depths of your mind; intuition and imagination is sometime more powerful than facts and observations
- (e) During a period of exercise or physical work-out
- (f) By cultivating a wide reading habit – of scientific literature and books, across disciplines; breadth of interests is a key determinant to cultivate the habit of innovative thinking

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Q: How can you create a team of innovators?

- SS:**
- (a) Identify the champion; the leader should be a champion
 - (b) Leadership who is collaborative, failure tolerant open, transparent, less evaluative and is passionate about success
 - (c) Build a balanced team of problem seekers, problem solvers, integrator and implementers
 - (d) Teach the team to walk the last mile – the toughest in any innovation
 - (e) Define the ground rules; the team takes the credit for the success; the leader takes the blame for failures.



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