

# **A Look at Professor Arun S. Mujumdar from Different Angles: A TRIBUTE**

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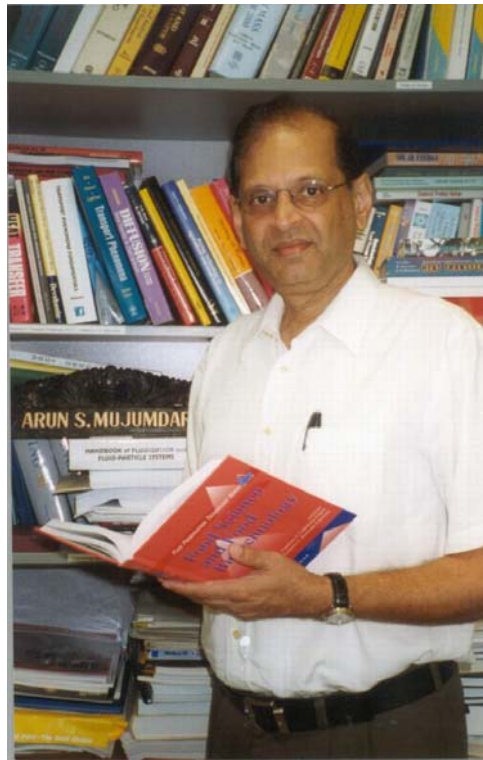
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## **INTRODUCTION**

Frequently we are asked various questions regarding Professor Mujumdar by friends, colleagues, students or new participants in drying conferences because people are curious and wish to know more about the personal side of the “drying guru” that is not obvious from his published work. IWSID is the first meeting of its kind in India and has the honor of holding it under the sponsorship of the esteemed University of Mumbai Institute of Chemical Technology (MUICT), the alma mater of Prof. Mujumdar. We think we owe the participants and also our new colleagues a personal introduction of Prof. Mujumdar as we have had the privilege of interacting over a long period with him as students, colleagues, friends and admirers.

At the inception of this idea, it seemed quite easy to write an essay on Prof. Mujumdar because there are so many published materials on him out there as a quick check to Google will confirm. When we started this work, we felt precisely the lack of ability to assess the materials and yet to come up with a concise article. Prof. Mujumdar is a philosopher, a mentor, an organizer, a leader, a research engineer, a husband, a father, etc., etc., to name a few hats he wears at all times. After debating and discussion amongst us, we come up with the present form of this manuscript. We try here to look again at Prof. Mujumdar from different angles and summarize our observations and feelings. Different sections are not necessarily mutually exclusive on specific topics. In fact, most are intertwined inseparably as will become obvious upon reading this article.

## A PHILOSOPHER AND A PRACTITIONER



India is a great country that has produced many philosophers. For Prof. Mujumdar, we have not really summarized his philosophical contributions. In this section, we would like to note down his philosophical beliefs to share with others and witness how he practices his own beliefs.

When asked about his philosophical belief, this is his answer “I do not really have any lofty philosophy as such. My mission has always been to be helpful and productive in some way in every aspect of life - in personal dealings as well as work. I believe ethics takes precedence over every other aspect of life. For professionals ethical behavior is even more critical as consequences of unethical behavior can be dangerous and even catastrophic. In the face of severe and relentless competition around the world in every aspect of life, unfortunately, ethics seems to take a back seat these days.” He believes this is knee-jerk reaction. Indeed, truly ethical behavior in the long run always prevails. He tries to inculcate ethical behavior in his students at every opportunity. His power point presentations on many topics that are freely available on his Website ([www.geocities.com/as\\_mujumdar](http://www.geocities.com/as_mujumdar)) clearly indicate the high value he gives to ethics. He feels that ethics should be taught right from the primary school; starting to teach ethics at the university level is probably already too late to make a difference!

Instead of competing, it is a better policy to collaborate. In research it is best to form networks and freely exchange ideas and information. Knowledge grows by giving it away (unlike most other things). From his web-page the viewer can tell immediately that he has a large international network of collaborations covering USA, Japan, Canada, UK, Thailand, Hong Kong, Greece, Malaysia, Poland, China, Norway, Finland, Poland, India, etc. He also strongly feels that we need wisdom-based economies since purely knowledge-based economy can actually worsen matters globally. To use the transport phenomena analogy, he believes that gradients in economic standards around the globe must decrease in order to bring

stability, peace and prosperity to all. The selection of quotes on his Website gives a glimpse on this. The following are just a few examples (often attached to his signature on e-mail messages: *Great beauty, great strength, and great riches are really and truly of no great use; a right heart exceeds all* (Benjamin Franklin); *Knowledge is a process of piling up facts; wisdom lies in their simplification* (Martin Fischer); *It is, in fact, nothing short of a miracle that the modern methods of instruction have not entirely strangled the holy curiosity of inquiry* (Albert Einstein). Finally, *Knowledge is proud it knows so much; wisdom is humble it knows no more*. These quotes are not taken randomly; they are foundations of his personal philosophy.

Another important part of his personal philosophy is his personal trait of being respectful to all, regardless of age, race, nationality, religion, sex, position, etc. He is always respectful of his students, colleagues, relatives and friends. He believes in the old adage: *First deserve then desire*. For those that have worked with him from around the world, we must remember the addresses “3795 Navarre, Brossard” and more recently “113 Clementi Road, Kent Vale BLK D-05-03” where we had parties now and then. The joys we had are forever in our sweet memories. He also likes to cook and is proud of his cooking skills; he thinks a good chemical engineer must, by definition, be a good cook.

As a teacher his philosophy is to motivate students to learn and develop a fundamental understanding rather than building up an impressive super-structure of fancy passing applications with no foundation. Applications come and go but the fundamental science stays firm. He also feels lecturing is not the best way to teach engineering subjects; students must “do” things actively and not try to “absorb” things passively. They must be taught and encouraged to “produce” not just “reproduce” what they learn from books and lectures. The emphasis should be on “innovation” and not “renovation” which is a superficial activity with a very short half-life, according to him.

He is fond of giving an analogy, again based on, what else, transport phenomena! In Prof. Mujumdar’s opinion the rate at which students actually absorb (and retain!) what is “taught” depends on the magnitudes of two resistances: resistance to teaching (on the side of the lecturer) and the resistance to learning (on the side of the student). By effective teaching the former resistance can be minimized. However, what is actually learnt also depends on the other resistance; that can be reduced only by hard, proactive effort by the student. This is why with the same teacher and teaching methods we have a wide assortment of distribution in the academic performance of students in a given class. Perhaps a mathematical model could be developed based on this basic idea for future use!

On engineering education his views are expressed in several of his editorials in *Drying Technology* with a brief summary available in *Mujumdar’s Practical Guide to Industrial Drying*. He believes in the importance of academic and industrial cooperation. He also encourages such a model for engineering research. Engineering research in academia, for and by academics is a poor model. He keeps close ties with industries by giving seminars or providing consultancies. He believes that the primary product of a university is “researcher” with good, useful research as an important by-product. Hence he stresses more on the training of the student as an ethical person and an engineer. Out of his busy schedule, he sets up regular meetings with his students discussing about research progress as well as daily life. For example, one female student once was very much stressful regarding her family life. He and his wife were there as friends to cheer her up. One male student just arrived McGill expressed very much of missing his home. Prof. Mujumdar offered his phone for the student to call home. His students’ productivity is also quite impressive with 10 publications from one Ph.D. student is not uncommon in his research group.

He believes that it is very important to broaden the knowledge base of engineering in humanities and sciences. He notes that to create true wealth we need good engineers - not

jack-of-all-trade types that more and more academic institutions are competing to produce internationally. Unfortunately, students joining such programs often have no clue where they will be led to. As the boundaries of knowledge are dynamic and expanding at exponential rate all the time and frequently in an unpredictable manner, it is increasingly important to be able to work in multi-disciplinary teams. One individual cannot know all disciplines to depths necessary to accomplish complex tasks. With globalization, respect for and ability to work with other nationalities, races and cultures are even more important today. Nations around the world will find their pecking order in a state of constant flux. Yesterday's emerging nations will become tomorrow's economic powerhouses. Nothing can be taken for granted any longer. At one casual meeting of McGill alumni, his former students noted that Prof. Mujumdar is the person that can talk to the person that sweeps the floor or the waiters that serve the food, he could also talk comfortably with the Queen of England. For the former, we were witnesses. Many times as fresh students we knew literally nothing about research and enjoyed his conversations. For the latter, we have yet to receive the invitation! However, a friend of us who is an influential investment banker noted that Prof. Mujumdar's comments and observations on global investment as well as economic issues are very much impressive and professional. This banker was very much enjoyed the time with Prof. Mujumdar. Clearly, this is a result of Prof. Mujumdar's regular reading of the London Economist, Fortune and other economic magazines.

### A MENTOR



Among the several possible titles for Prof. Mujumdar to choose, probably he is most happy and comfortable to be called a mentor. This is not only because he is a dedicated educator but also because he knows the importance of mentoring in engineering and research. He believes that creative thinking is the key to all breakthrough research in sciences, engineering as well as in the liberal arts and business. He even proposes that the training of researchers (master's or Ph.D.) should not even be bound with a specific research project. Depth must go hand-in-hand with breadth of knowledge. Knowledge of hard subjects must be coupled with soft knowledge of the humanities, arts, communication skills, etc. Knowledge of world economics, world history and world geography is especially critical in this new age of globalization.

When asked about why his students are so productive, his answer was quite philosophical: "I treat each of my students as a family member. I give them my trust and support them with advice and financial resources as needed. I make sure they feel that I am

there to assist and guide them, and I am happy and truly proud of their achievements.” Meanwhile, he seldom uses pressure to force progress. This is rare for most other professors. In fact, he treats even the IDS events held biennially in various continents as “global family re-unions” wherein the families are expanding all the time. Anyone who has attended IDS conferences can feel the family atmosphere even when everyone is discussing truly “dry” topics all the time!

One of his former Ph.D. students indeed recalls the good experience of working with him as follows: “I understood very early in my Ph.D. work the concept of an earned Ph.D. Prof. Mujumdar’s philosophy is that to be awarded a Ph.D. a student must not only have demonstrated the mastery of the thesis subject but most importantly also, the capability to perform independent research worthy of a Ph.D. Therefore, not only did he encourage independence he demanded it of every one of his students. Though painful at the time, this policy helped to build confidence and prepare us in no small measure for our future professional career, be it in the industry or academics. It was a privilege to be under the tutelage of such an exceptional and outstanding research advisor.”

The same student continued with the story, “A remarkable experience occurred just a few months before my graduation. As part of the final validation exercise of the CFD code that I had spent years developing, I had chosen the classical Graetz problem in the entrance region. To my dismay, there was an unacceptably high discrepancy between the analytical solutions and my numerical results. I was panic stricken, for obvious reasons, one of which was a possible delay in my graduation. On alerting Prof. Mujumdar about this potentially devastating discovery, to my utter surprise, his reaction was calming and very re-assuring, reminiscent of that of a war-general. Upon further investigation, we discovered that the comparison exercise we had undertaken was a land mine, which most researchers in the field had cleverly and deliberately avoided. On his suggestion, the problem was assigned as a term project to two graduate students in his ‘heat and mass transfer’ class, and was jointly supervised. The problem was quickly resolved, and arising from that near-fatal experience at least for me, were two journal publications, which are still referenced till today.”

For fresh research students, he would first talk to them regarding his vision on how to become a successful researcher; his advice in the form of Power Point slides are now available on his Website for anyone anywhere to use. He would point out his views on different research areas along with necessary updated literature. Yet, he never forces his ideas or thinking on the student. He would leave the final decision to the students to make regarding the selection of a specific topic, way to approach the problem, etc. This may explain in part why his research covers many subjects ranging from heat and mass transfer in general, drying and dewatering of different materials, to dryer designs, process innovation, etc. He is a professor who has patience and also trust in his students. If a student needs extra help he can see it and then provide the necessary backup. According to him, during the conduct of research he would encourage and wait for the students to give him the answers even though he already knew them. When the answers are there, he is equally happy and cheers the students for their accomplishments. He encourages students to write good papers to disseminate their findings first by following the format of excellent papers in the area and then develop their own styles in scientific writing. He would spend a significant amount of his time revising the drafts of the manuscripts before sending them out for peer review. Since he needs to go on business trip quite often, there are more often than not that some papers and thesis drafts to be revised are packed in his luggage. He uses his time in airplane rides, airports, during the wait for visitors, or after meals to write down his comments and suggestions in the margin or between lines. He believes knowledge is valuable if it is shared, whenever he finds something interesting and useful, he would send them out to his students or colleagues via e-mail, thanks to the Internet.

At the time of graduation, the students would find that Prof. Mujumdar is equally concerned about the job hunt for his students as well as others who interact with him. He would make photocopies of job ads and place them in the mailboxes of his students. He also voluntarily writes to his contacts seeking opportunities for his students and even for those who are not supervised by him. Once he is convinced about the ability of his students or associates, he always goes beyond the call of duty to assist them in finding a suitable position in industry or academia. For his Ph.D. graduates he would advise if an academic or industrial career would suit them better. Readers may find his Power Point presentation on his Website about the traits of an academic. This is a useful starting point for someone thinking of an academic career. He is always there for his students when advice is required. Frequently, we hear his students or researchers say that Prof. Mujumdar was instrumental in finding his/her job. Such help is not a simple favor; it would mean a totally different career or life for most of them, especially for those from the developing countries. While we cheer Enrico Fermi as a great mentor because six of his students won Nobel Prizes, we proudly find that nearly a dozen of Prof. Mujumdar's students are engaged in forefront research related to drying or heat and mass transfer.

In spite of the competing demands for Prof. Mujumdar's time, he has continued to take keen interest in the professional and career growth of his numerous students, and associates all over the world. He has always found the time to be supportive of their career aspirations and goals. He sets a good example to live a happy and fruitful life. He would hold parties at his home to show his students and colleagues his way of living and provide advice on various issues regarding how to deal with different people, cultures or societies. He often cooked full meals for his students and colleagues to display his culinary skills; at last report everyone who consumed his meals is still doing fine!

## AN ORGANIZER



Ever since the successful hosting of the First Drying Symposium at McGill University in August 1978, there is no doubt among the drying related researchers that Prof. Mujumdar is an efficient and effective organizer. We try to tell some inside stories so that people can understand better how he can manage the seemingly impossible task so well. Being an excellent organizer, he must first be a visionary. A quarter of century ago, the energy crisis inspired many new research fields such as biological production of chemicals using natural produces, solar energy utilization, etc. Conservation of energy cannot solve the energy problem but remains a tangible technique to win precious time to find solutions for the crisis. Prof. Mujumdar must have visualized this impact on one of the old unit operations – drying – the most energy intensive process in many fields. This was at a time when even some senior drying researchers of the time did not think there was need to pursue drying in a big way. He promoted drying R&D with an almost missionary zeal, and almost single-handedly until he convinced a critical mass of academics and industry people that it was a truly worthwhile and challenging activity for both academic research and industrial R&D. Today, many research students, academics and even industry persons attribute some of their professional success to what Prof. Mujumdar did, but he is often not even aware of such impact of his work.

Convinced by this visionary thinking, he needed to mobilize support, both human and financial, to realize it. To this end, he found a reliable and capable assistant, Purnima Mujumdar, his better-half in more ways than one, who volunteered cheerfully to assist Prof. Mujumdar in the mammoth effort right from the days of the electric typewriter with no fax and certainly no e-mail capabilities. It is hard to imagine today how the monumental work was actually accomplished in those “pre-historic, pre-internet, ancient” days! Purnima has been working tirelessly with Prof. Mujumdar on many administrative issues such as compiling databases of international experts, taking care of international correspondence (using typewriter and snail mail), preparing manuscripts of many of Prof. Mujumdar’s lectures, and typing or even editing and typing manuscripts of serious authors from countries like the former USSR and East European Countries based on handwritten drafts. She has been doing this for IDS, for Drying Technology Journal, and also for many volumes of books on drying. Clearly, she must share some of the credit for the prolific output of valuable books that came from the desk of Prof. Mujumdar. Academic institutions rarely have resources to support such effort and even more rarely the needed vision to foresee its impact globally.



Now the International Drying Symposium has become one of the most significant and successful events of its kind. There are an ever increasing number of participants and the number of papers presented during the conferences. For the drying symposium to become a truly international platform, Prof. Mujumdar traveled around the globe to promote drying and IDS. Now, competing to be the host of IDS is one of the agenda items during each IDS. We are happy to see that IDS has been successfully hosted by Canada (3 times), UK, Japan, USA, France, Czech Republic, Australia, Poland, Greece, The Netherlands, China and Brazil. Besides, Prof. Mujumdar also helped and participated in many regional drying conferences such as Nordic, Australasian, Chinese drying symposia and this very new Symposium in India. In addition, Prof. Mujumdar is also actively involved in related international conferences such as AIChE, ASME, etc. He is pleased to see activities in drying R&D rise nearly exponentially over the past decade. At least 8 regular drying conferences are held around the world now.

When we look at Prof. Mujumdar's CV, we are impressed by his so many significant and impactful activities and yet so many high quality original publications. Moreover, he has been the Editor-in-Chief of the only journal devoted to drying – Drying Technology. Some of the secrets probably derive from his brain capacity in storing, classifying, processing and retrieving information, and his ability in identifying the strong points of his collaborators so that their potentials can be maximized. For those associated with him, we are accustomed to receive e-mails from him on a daily basis (very often written and sent during the early hours of the day). We are sure that ours are only a small part of his communication list. On delegating duties, one frequent question is about the quality and credits. He stated that he would trust the ability of his delegates and give full credit to them. Of course, sometimes the outcome may be only 70-80% of his expectation but that is sufficient to make him happy since the original bar is perhaps set too high.

### **A LEADER**



For a philosopher, a mentor and an organizer to be embodied in one person, one has to be an effective leader. Prof. Mujumdar is a true leader in the drying field. He is the guru sitting at the very top of the high mountain, who can envision the clear trends of the flow of rivers near and far through the fogs and clouds, and tells his followers the location of the “promised” lands. It has become customary to have one of his plenary lectures at IDS on the development and future trends in drying. As the editor of IDS proceedings for many years

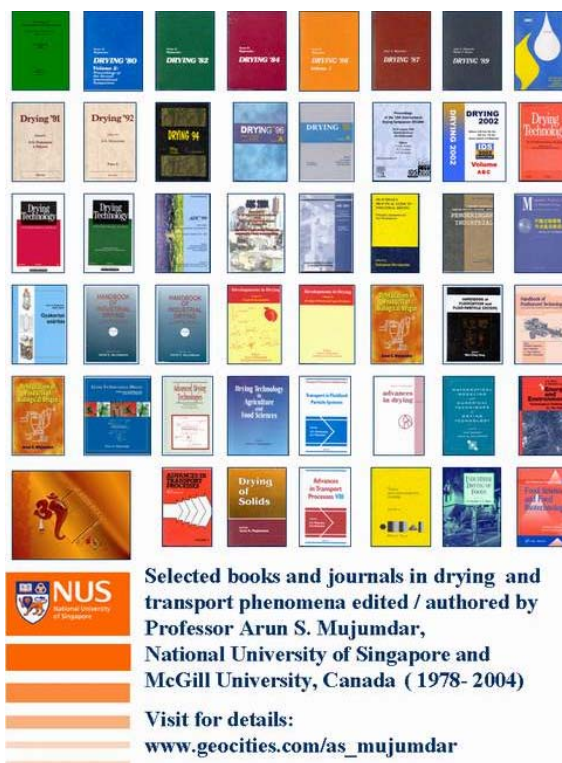


and editor of the journal he is familiar with R&D trends. As consultant to numerous companies, both small and Fortune 50, he is also aware of industrial needs although often he cannot work on truly realistic problems for reasons of confidentiality. In addition to a summary of recent developments, he would point out the short and long term impact of some new research areas. Of course, out of all the materials he has given, it is only those who have the necessary ability and aptitude can access and benefit from it.

Prof. Mujumdar attributes at least a part of his training in “leadership and organizational skills” to his stint back in 1966-67 as President of Indian Students Association at McGill, then a small but very active group of graduate students at McGill. He says he had the good fortune of interacting personally with the then Principal of McGill University, Dr. Roche Robertson, the then Indian High Commissioner to Canada Gen. Chaudhuri, and many prominent leaders of various communities in Montreal that gave him the confidence to undertake major events and bring them to successful conclusion. In fact, he was personally responsible for organizing a major reception to the then President of India, Dr. Zakir Hussein, who visited Montreal to inaugurate the Indian pavilion at Expo’67. Little did he know that this experience would come in handy later on when he undertook IDS even as a junior faculty member with no experience and, more importantly, no financial or other resources!

From his many editorials in *Drying Technology*, he points out the importance of creative thinking and innovation; the impact of “Extreme Engineering” on drying, drying and environment; the meaning, use, misuse and abuse as well as impact of the ISI “impact factor” of journals; significance, price and value of R&D; multi-disciplinary nature of drying, etc. He advocates more research on superheated steam drying, heat pump dryers, intermittent drying, spouted bed drying, vibrated fluidized beds, etc. He also emphasizes the importance of drying in the development of new materials such as nano-particles, nano-tubes, nano-fibres, aerogels, etc. His 300+ journal papers, 50 books including the widely acclaimed *Handbook of Industrial Drying*, and chapters including one to be released in *Albright’s Chemical Engineers’ Handbook* (Taylor and Francis, PA) have placed him unarguably as the top leader in drying. As a successful leader, he not only gives away his ideas freely but also donates many books and journals, all in all worth tens of thousands of dollars, to researchers, universities or research institutes in countries around the world. At the time he moved from McGill to NUS he donated, at one time, more than 200 books to the Physical Science and Engineering Library (or the Schulich Science and Engineering Library as it is now known) at McGill; the action he had indeed continued for more than 20 years while at McGill.

## A RESEARCHER



It should be noted at the outset that Prof. Mujumdar's own Master's or Ph.D. theses at McGill had nothing to do with drying, although the late Dr. W.H. Gauvin, who was already world-renowned in the sixties for his original work on spray drying was indeed at McGill at the time Prof. Mujumdar joined its chemical engineering department in 1965. It is noteworthy, that the late Professor T.K. Sherwood (of the Sherwood number fame), who made significant original contributions to drying theory in the thirties while at MIT, was a chemical engineering alumnus of McGill University. So, McGill's connection to drying now spans over 75 years!

Prof. Mujumdar worked in fluid mechanics and heat transfer for his two theses at McGill with Prof. W.J.M. Douglas as his thesis supervisor. He was fascinated by the mathematical complexities of turbulence and the measurement of its statistical properties and relating them to heat transfer from blunt bodies such as cylinders. Later he went on to work as a Mechanical Engineer with the Aerodynamics Division of Carrier Corporation in Syracuse, N.Y., USA. That was where he, as part of his job, studied computational fluid dynamics on his own, referring to research papers in aerospace, aeronautical and nuclear engineering journals. There were no textbooks and the field was just evolving and expanding to other than aerospace and nuclear engineering applications. When he returned to McGill and the Pulp & Paper Research Institute of Canada (PAPRICAN) in early seventies, he initiated research with combined experimentation with modeling using CFD techniques for the first time at McGill and possibly in many Canadian universities at the time. Several others followed his initiative in following years and discovered the power of CFD in many research fields.

Prof. Mujumdar's initial research soon after his Ph.D. was concerned with several topics including but not exclusively on drying, impinging jet heat/mass transfer, drying of paper, particulate collection in turbulent bed contactors, numerical studies of free convection, etc. Earlier, during his graduate studies he had already published several papers dealing with

mixing in stirred tanks, wake flows of single and multiple cylinders in cross-flow, and had measured Strouhal numbers for an astounding 40 different blunt bodies with potential as “shedders” in vortex-shedding flowmeters. It is noteworthy that he had already successfully used the concept of the vortex-shedding flowmeter, which became a commercial success in early seventies, several years prior to the first patent in his wind tunnel studies for his M.Eng. research at McGill! Those were the days when universities had not become entrepreneurial!

Prof. Mujumdar became interested in impinging jets as they formed the basis of the novel Papridryer design for drying of newsprint, a problem of major economic value to Canada. This dryer, developed by PAPRICAN, employed a multiplicity of high temperature, high velocity jets impinging on the fast moving wet sheet of paper giving drying rates that were an order-of-magnitude higher than those found on conventional multi-cylinder paper dryers. The pilot and mill dryers were designed without in-depth knowledge of impinging jet heat transfer, particularly in the presence of suction at the surface and moving wall. In addition, complexities arose from the need to select a nozzle design, geometric pattern and account for the effect of large temperature differences between the jet and the moving paper web (sheet). What followed was a very major, decade-long research program directed with Prof. W.J.M. Douglas involving dozens of M.Eng and Ph.D. theses. It is a pity that a large fraction of this extensive body of knowledge remained in theses, as there was little pressure and incentive (as well as time) to publish the work in journals. Nevertheless, this is probably the only body of extensive literature even today that provides information, both experimental and analytical, on various aspects of impingement flows and heat transfer.

A new drying process for paper that he conceived and developed initially without any funding is the superheated steam drying process for newsprint and tissue paper. He presented the idea at an invited presentation of the Institution of Chemical Engineers conference in Chennai, India in 1981, and also published it in a special commemorative issue of Titaguh Paper Mills on their 100<sup>th</sup> Anniversary in that same year. During the next 3 years he showed the feasibility of this technique through a mathematical model followed by static lab tests of drying kinetics as well as quality tests. He published this work in DRYING'84 and in Drying Technology; he was awarded the first Hemisphere Award for Innovation in Drying at IDS'86 held at MIT in August 1986. A Finnish company tested and confirmed the feasibility in a pilot rig where the system was dynamic. Indeed, the process is available commercially now although a mill order is yet to be received. This example also shows the risk-averse nature of industries where the capital costs involved with dryers are very high so that introducing truly innovative technologies is very challenging.

After making very significant contributions to drying of paper, Prof. Mujumdar moved on to other areas, e.g., drying of particulates such as grains and of sludges. He had a number of postgraduate students and postdoctoral fellows to study vibrated beds, agitated fluid beds, spouted beds, jet-zone beds, spout-fluid beds, etc. He was the first to propose 2-D spouted beds as a means of avoiding scale-up problems. Later he proposed rotating jet spouted beds as a way to save energy when drying resistance is mainly internal to the particle. His brief review on spouted beds for drying in 1985 provided a multitude of new ideas for utilizing the spouting concept and numerous researchers around the world followed the guidance provided in that article, which appeared in DRYING'85 (Hemisphere, Washington DC). As for sludge of colloidal particles, he initiated research on electro-osmotic dewatering and was instrumental in developing an interrupted power EOD process to enhance the dewatering effectiveness. His work on vibrated beds is considered seminal and used extensively by industry internationally. This is true impact of engineering research, not citations in journal publications that remain unread and certainly untested by any one anywhere for the most part!

With more than 300 publications in refereed journals, more than 250 conference presentations and more than 50 edited books to his credit there is no doubt that Prof. Mujumdar has excelled as a researcher and an inventor. He is indeed a thinking machine, which creates new ideas and perspectives on research at almost all times. One of his former graduate students, who had a privilege of spending many lunch hours with Prof. Mujumdar, noted that he had got most ideas for his research during lunches. One of his most innovative ideas on impingement heating/drying of droplets on a hot plate indeed came during his cooking experiment on a weekend at home trying to make the Indian pancake called “dosa” (which he claims has been another challenging and delicious area of research for him!). This led to a Polish patent on spray drying of suspensions by impingement on hot metal surfaces!

More importantly, Prof. Mujumdar has placed high emphasis on disseminating of his (and of members of his research group) research results, so they become widely available to the research community and not only to any particular groups of people. He also never hesitates to exchange ideas, knowledge and experiences with others, whether they are fellow academics or those from industry. His open-minded approach has led to the rapid development of the research in heat/mass transfer in general and drying in particular, on a global scale. Talking to him is similar to reading results digested from many sources, either conventional as textbooks and journals or contemporary as the Internet. He spends some of his leisure time surfing the Internet to become familiar with areas of his current interest but also newer areas. This illustrates his true nature of being a researcher (viz. the one who search and search again) very well. A separate manuscript accounting his research contributions will be available soon. It is noteworthy that he has ongoing research collaborations with scores of research groups in various countries; all his collaborative projects have been success stories leading to archival publications.

Prof. Mujumdar believes strongly in interaction between academia and industry; this especially true in drying. At a recent IDS meeting he said, “I know of no university that designs, builds or operates large scale dryers.” Clearly, the implication is that all drying R&D by academia is intended for industrial consumption. For rapid technology transfer and for proper definition of research problems in academia industry input is necessary since even excellent solutions to imaginary problems will benefit no one. He formed a small consulting company called Exergex Corporation back in 1989, which provided mainly R&D consulting in drying and related areas to industry and research institutions until he left McGill to join NUS in 2000. His choice of research projects are influenced by his exposure to numerous real problems faced by industry. Indeed, some of his solutions to major industry drying problems have been extremely valuable and impactful. However, they cannot be disclosed due to highly proprietary nature of the work. What is interesting also is that Exergex supported research projects through its own funds and many of these resulted in journal publications. Even the Guide to Industrial Drying one of us (SD) edited was published by Exergex in 2000; a large number of copies were then distributed freely around the world along with free translation and reprinting rights given to many non-profit institutions in the interest of disseminating widely the knowledge about drying basics and technologies.

Although here we have emphasized only contributions to drying, it is noteworthy and indeed surprising to many that he has published with equal vigor papers in many other areas as well which do not impinge on drying, e.g., melting and freezing heat transfer, opposing jet flows, fluid bed gasification, electro-osmosis, electro-kinetic remediation of contaminated soil, non-Newtonian fluid heat transfer in arbitrary section ducts, etc. In drying, his focus has been on development of novel dryers using mathematical models as a tool for intensification of innovation.

## A HUSBAND



It remains a secret how Prof. Mujumdar can handle so many official tasks while maintaining a happy family life (in fact, one of the most important research results he has never published is his principles of time management skill). In addition to the voluntary help and understanding from his wife Purnima Mujumdar, we believe Prof. Mujumdar must also be a caring husband. First of all, Prof. Mujumdar treats Purnima as a friend and never takes her for granted. On many occasions, he has noted that without Purnima's assistance, he could not have accomplished as much and made so many contributions to the drying field. If there is glory in it, he makes sure that his wife is recognized also. He remembers the special dates (not an easy task), and lets Purnima know that he cares about her and appreciates her help. His move from Montreal to Singapore is, we believe, partly to make Purnima happier because she likes the climate there and its proximity to India. She also enjoys travel in the various Asian countries.

Purnima is the hostess of the numerous social gatherings they like to hold at home. In Montreal they had a large friends circle as well. Prof. Mujumdar would help her in making the tables, preparing food, and cleaning the dishes. For matters he does not know, he would openly admit it and joke about his ignorance. At this moment, Purnima would be his "savior." Frequently people might think that the drying guru should live like a king and be treated like one. To us our king treats his wife like a queen and the queen rules the family. For everyone who has read Prof. Mujumdar's many books and papers, the name Purnima is perhaps as familiar as the name Arun! Many drying researchers and students of Prof. Mujumdar are indeed good friends of Purnima as well. In this case it is not unnatural that the rising sun (Arun) exists simultaneously, but happily, and with the full moon (Purnima). It is interesting to point out that both Mrs. Mujumdar and Prof. Mujumdar like to do their bit in terms of helping the needy, wherever in the world they maybe. Thus, they sponsored two children through World Vision in Guatemala and Ethiopia for over twelve years. Also, they sponsored scholarships for meritorious students in their schools in India. Very large quantities of books

and journals he edited were also given freely to deserving students and institutions around the world.

## A FATHER



Prof. Mujumdar probably inherited his interest in engineering; his grandfather was a civil engineer, his father an electrical engineer and a number of his uncles from both paternal and maternal side were engineers as well. What is intriguing is that his daughter, Anita, too followed her father's footsteps although Prof. Mujumdar assures every one that he had nothing to do with her decision to become a chemical engineer! However, when Anita was asked about her father, here is her answer: "I have always been in awe of my father, so much so that I decided to follow in his footsteps and pursue my education in Chemical Engineering at McGill University."

It was not easy, to say the least, having a father stand up in front of the class. For example, in Prof. Mujumdar's famous undergraduate Fluid Mechanics class, although Anita was already very familiar with the "lectures" at home, Prof. Mujumdar's lectures in the classroom were still captivating for her. Prof. Mujumdar's ability to hold the attention of a classroom of young university students was remarkable. It made Anita so proud that she would constantly be whispering to her fellow classmates, "Pssst - That's my father!" Of course, she had no choice but to get an "A" on the course!

Prof. Mujumdar's constant guidance, support and encouragement and his devotion to his family has made Anita and his son Amit the successful persons they are today in their own words. Prof. Mujumdar serves as the wonderful role model for them. "From our father, we learned to be noble, humble and modest persons. Even with all his numerous accomplishments, awards and international distinctions, my father has always remained very modest, humble and simple. I admire this about my father the most. These are the qualities in him that makes him easy-going, personable and so down-to-earth." Anyone who has ever sat in his classroom, attended his seminars or worked with him will understand what Anita and Amit mean here. His ability to see the bright side of the world and make them into something more hilarious is his another skill as well.

The "Gang of Four" at the Mujumdar household would joke that Arun had two families – one where he taught, the other where he lectured. Anita and Amit claimed that they were never quite sure which family they belonged to! Anita is following Prof. Mujumdar's career footstep, Amit clearly found in a different direction – preferring to deal with finance



than engineering. Nevertheless, Amit feels that his dad left him with very large shoes to fill. Of course, this goes to the very fundamentals of Prof. Mujumdar's success: intelligence, collegial and passion about his work. "As if these attributes and accolades were not enough, he is also worldly, kind, compassionate, giving, artistic and humorous (or at least he thinks so!). I must leap in order to reach his step," says Amit, who now works in the Silicon Valley in the field of high finance.

We are sure that Prof. Mujumdar is a proud father of his excellent two children. He is much excited and proud about their achievements and shares his feelings with his friends. We all know Prof. Mujumdar is extremely busy but he never lets his children feel left out. He always remembers to drop a line to them by e-mail or call now and then to see how they are doing. Rather, they are very happy and proud of what Prof. Mujumdar has achieved and often help him in one way or another. To mention one example, Prof. and Mrs. Mujumdar held as many as three "wedding parties" for Anita respectively in USA, India and Canada. Amit was encouraged to explore the world by traveling to many countries even when he was relatively young.

### **A FOREVER YOUNG FRIEND**



While writing this article, we were asked what the simplest description about Prof. Mujumdar would be. The majority agrees that he is our forever young friend, a friend that cares about you, a friend that gives advice when asked, a friend who cheers you up, a friend who shares your happiness, and a friend you can trust to tell your concerns in confidence. We are lucky to be his friends. Any colleagues of his can also be his friends as he treats everybody with his sincerity and equality. Compared with his most co-authors, Prof. Mujumdar is about a generation senior. However, we never felt the age gap. This is probably true for the even junior people working with him currently. He keeps himself updated not only on the scientific front, but he also likes to learn about new developments in music, sports and politics around the world. He used to be quite a fan of the Wrestling Show while in Montreal. We suppose that was stress relief!

Arun, in Sanskrit, means the rising sun; it reflects Professor Mujumdar's personality well. He is just like a rising sun, energetic and forever young. For the past few years, we sometimes heard him complain about his getting tired now and then. Yet, his record shows

that there is not a sign of slowing down, instead there is a marked increase in output from his research groups after his move to Singapore.

At the National University of Singapore (NUS), he is supervising 7 Ph.Ds, 2 master's and over 10 final year project students. He is also jointly supervising more than 10 Ph.Ds and master's students in several different countries, such as PR China, India, Thailand, Canada, etc. He teaches postgraduate and undergraduate courses (of more than 300 students!) as well. He also serves on many committees at NUS. Thus, his plate is more than full at any time; yet he never claims to be busy. It is not surprising to get reviews of thesis chapters, revisions of paper drafts, even referee reports on grant applications and reference letters for promotion and tenure within 24 hours of receipt by Prof. Mujumdar. He says he likes to see his Outlook Inbox clear by midnight everyday. Not an easy job in the present days of spam! As he once said he has no desire to waste his time by complaining that he is busy!

Since he is a very famous professor, has published in many fields and has wide connections all over the world, he needs to review more than 120 papers for Drying Technology and other prestigious journals related to chemical, mechanical and food engineering annually. He takes this as a normal professional obligation. On the other hand, in recent years, every year he has presented up to 20 refereed journal papers, 15 conference papers and 5 plenary lectures – all this while holding full teaching and administrative loads inherent in a senior academic job at a major research-intensive university.

## **CONCLUDING REMARKS**

On the occasion of IWISD, we have this precious opportunity to introduce Prof. Mujumdar to you as a person. We thank UICT, University of Mumbai, for this distinguished graduate it has produced for the world community in drying as well as in heat and mass transfer research. We are, as the international drying community are, proud of having Arun Mujumdar as our leader.

We have tried our best to present Prof. Mujumdar and show him from different angles. There is an old Chinese proverb called “blinds descriptions of an elephant.” It describes how each blind man touches only a part of the elephant and yet proclaims finding the true nature of the whole body. In fact, the collective feelings of the blind men can only represent a part of the whole elephant. Thus, we consciously know that this manuscript serves as only a brief introduction of Prof. Mujumdar. The detailed virtues and character remain to be found by more “blinds” in future in order to have a true description of the “elephant guru” of drying.

## **Acknowledgements**

The authors are grateful to Anita and Amit for their help in providing the materials on their father. We thank Purnima for being a wonderful friend, for her care of Prof. Mujumdar, and for her proofreading of this manuscript. We appreciate the contributions by one of his former students, Prof. A. Lawal of the Stevens Institute of Technology, USA. Our heartfelt thanks also go to many other individuals who read and made comments on this manuscript.