

# MARKETING OF SCIENCE FOR PUBLIC UNDERSTANDING

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*It is well accepted that sincere efforts need to be made to enhance public understanding of science. This is necessary not only for intellectual fulfillment but also for positive gains for individuals and society and national prosperity. There must be planned programs to achieve this. This article discusses the subject in some detail. It explains the meanings of the key words in the title of this write-up and outlines how different segments of the society need to be approached for better marketing of science. There is also a discussion of various recommendations that have been made by scientific bodies and some individual scientists who want better public understanding of science.*

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## Introduction

*'We live in a society exquisitely dependent on science and technology in which hardly any body knows anything about science and technology'*

– Carl Sagan

The author has previously published in this journal an article which discussed alienation of scientists in society<sup>1</sup>. The main conclusion of the article was that there was a gap between scientists and the public and it was the responsibility of the scientists to bridge the gap. The subject of public understanding of science and technology has been of much interest in academic circles for several decades now. To know how remedial measures can be taken one has to first know how the public feels and knows about science in general.

Public Awareness of Science (PAS), Public Understanding of Science (PUS) and Public Engagement with Science and Technology (PEST) are terms that relate to attitude, behaviour, opinions and activities of the general public or by the society and a whole, *vis-à-vis* scientific knowledge, scientists and scientific organizations. It is well known that exposure leads to interest and interest to desire to know and awareness. Finally, this awareness may lead

to the actual action of knowing and understanding under motivating circumstances. Motivation may be created by employing principles of marketing of products to potential customers.

Market is a place where there is demand for a particular product or service. This demand may exist already or it can be created. Bhaumik<sup>2</sup>, famous for his CO laser that found signature application in corneal sculpting (the corrective eye surgery best known as LASIK), writes that initially the real world applications of lasers were not immediately apparent. For a while 'it was characterized as a solution in search of a problem'. Scientists had to create the demand for lasers by demonstrating the benefits of their inventions. The demand for understanding science amongst the public has to be similarly stimulated by scientists themselves through their lectures and demonstrations.

The general public may be indifferent towards scientific questions in astrophysics, gravity waves, quantum mechanics, genomics and so on but they do generally have interest in subjects such as climate change, use of vaccinations, water and air pollution and their harmful effects, agricultural topics and the etc. The awareness results from exposure to the media and scientific debates on the subject. A recent issue of National Geographic magazine (March 2017, Editorial) says that two thirds of Americans now accept that the threat of climate change and global

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warming is real. The present U.S. President, however, does not accept that.

There are, of course, many misconceptions amongst the scientists about the public and *vice versa*. It has been said that the public will care about the scientists only when scientists care about the public.

### **Some Well-accepted Facts**

The following statements are likely to be accepted by most people.

- Some scientists, immersed in narrow specializations, themselves need wider exposure to science in general.
- The common language of communication among scientists does not transmit well scientific ideas to members of the public who need a language or a dialect that they are comfortable with.
- People disbelieve scientifically supported information when it contradicts some core values and scientists should be sensitive about this.
- Facts and evidences are not very effective in changing people's beliefs when they find scientists arguing among themselves e.g., the cases of genetically modified cotton or brinjal.
- Even highly educated people can be irrational in refusing vaccinations for children, not accepting climate change or even theory of evolution. They may believe in astrology, *Vaastu*, *Feng Sui*, miracles and so on.
- Things are no different in the so-called advanced countries.
- Science literacy may be increasing among the public but it is inadequate to make an informed population.
- The world would be a better place if the public understood science better.
- The Government can implement many development schemes better if the understanding scientific principles are understood better by the public e.g. in the areas of land fertility, use of fertilizers, water conservation, clean water and air health and hygiene e.g.,
- People do not need more information, they need better communication, preferably from someone who speaks their dialect.

- It is not the responsibility of the public to be aware but it is the responsibility of the scientists to create awareness about scientific issues.
- Public should know what is happening in the country in the areas of aerospace, defence, atomic energy, biotechnology, materials science and various revolutions – green (agriculture), white (milk), blue (informatics and electronics), brown (Leather) and pink (pharmaceuticals).
- Sometimes awareness about issues of science and technology may create entrepreneurs.
- Scientists are generally accepted as competent but are perceived as remote and unfriendly.
- Occasionally a negative attitude towards science and technology is created by some isolated incidents e.g.- disasters in Bhopal, Chernobyl or Fukushima. The public though does not agitate against deaths from water and air pollution, a traffic accidents or.
- Public understanding of science and technology can be advanced by measures such as the following : science communication in the mass media, better text books and class rooms, better teachers, consumer education, social movements such as street theatre, fixed or mobile science exhibits, debates over public concerns in some areas, science museums, zoological gardens, and botanical gardens.
- With the rise of power and privilege of the bureaucracy in India and high salaries being offered in the Information Technology (IT) sector, students in schools and colleges are showing declining interest in science subjects, preferring instead in commerce, management and computer courses. Even students graduating from engineering or medical colleges have veered towards administration and Information Technology (IT). India's leading scientist Professor C. N. R.Rao has called the young people joining the IT sector, Infotech Coolies (Several Government departments have tried to address the problem by offering scholarships to University toppers and exposing them to lectures from eminent scientists. Some guardians were also exposed to such efforts to promote science. In one such event a guardian rose to say to the author, 'Sir, I very much want my bright son to go for science but he does not listen, he will join the IT sector only').

- The powerful visual media continuously dishes out only entertainment that is devoid of thinking. (A famous Hollywood actor once said that she disliked new wave cinema because it made her think !) The public has to be induced to be curious about things and enjoy thinking.
- It is necessary to have surveys to assess the level of public awareness and understanding through proper surveys. Generally surveys of adult population are of attitudes to rather than understanding of science.
- We need to understand the principles of marketing and apply them to take science to people.

The public that includes political leaders, are often skeptical about scientists and, sometimes, fooled by charlatans who claim to know things better than the scientists. Thus, some twenty years ago, one Rajan Pillai became a national sensation by claiming that he could change water into petrol by using some herbs. He gave small scale demonstrations and began to sell his cheap petrol too and then asked for large funding from the Government to put up a production plant. Feeble protests by scientists about the absurdity of the claim was dismissed—that a pinch of herbs cannot supply carbon atoms for petrol was considered an irrelevant observation. Eventually a demonstration of the process was arranged for a high level Parliamentary Committee in CSIR-Central Building Research Institute and the show was recorded. (The author has seen the film). Even any second rate magician (such as the author) could get the trick immediately. (Magicians never tell ! But here is a hint. After some this and that Pillai added the herbs to boiling water and as he filtered the liquid it separated into two layers with a lighter layer at the top which was shown to be gasoline by burning. The volume, however, increased suddenly and he used an oversized funnel). In the audience were several very senior leaders including our present President of India. The spectators had no clue but mercifully the project did not go any further and the months of patronage (free travel and accommodation for his team) that Pillai enjoyed stopped. The whole thing did not add stature to scientists.

### ***The Terms : Science, Public and Understanding***

The word ‘science’ may be broadly interpreted as mathematics, technology, engineering, physics, chemistry, biology, zoology, medicines etc. where systematic investigations reveal the truths about the natural world and indicate practical applications of knowledge derived from

these investigations. Understanding implies not just the facts but, rather, the nature of the scientific activities. The public should know at least elements of some of the findings. We will come to the word ‘public’ later.

In recent decades the subjects of PUS, PES and PEST have been much discussed by many scientific bodies and scientists. Many reports have been published, events organized and some universities have established special departments and Chairs. A lot of literature is available in the internet too. Recently the Indian Science News Association (ISNA), Calcutta and Indian Association for Productivity, Quality and Reliability (IAPQR), Calcutta organized jointly a one day seminar (February 24, 2017, Basu Vigyan Mandir, Calcutta) where some excellent talks were delivered. In the internet there is a Royal Society Report titled Public Understanding of Science<sup>3</sup>. Some of the ideas presented during the one day seminar, the Royal Society Report and other materials available in the internet are included in the subsequent discussions.

The word ‘public’ mainly refers to the predominantly nonscientific people but general scientists are not entirely excluded. However, we may consider here only those who are not professional scientists. We can consider the following categories :

- a. The general public.
- b. School and college students.
- c. People employed in skilled and semi-skilled professions.
- d. People in the industry, specially in the middle ranks of R & D and management.
- e. Professional or trade union associations.
- f. People in position to make major decisions in the Government administrators, members of the Parliament and State Assemblies, ministers in Cabinets, planning bodies etc.
- g. People who play an important role in shaping public awareness e.g. those in the print media, radio and the television, cinema, theatre and journalists.

In the ISNA-IAPQR seminar, mentioned previously, a management expert said that in any single day a newspaper typically carry 80-85 ‘stories’ (the author has checked this to be true). However, only around 5 stories appear per week around science and technology, that too around some sensational event such as launch of a satellite. For all the categories of public listed previously exposure to media is the first step towards awareness. In some

advanced countries such as the U.S., Germany, France or Japan. There are special TV channels that present stories around science and technology. In India there is virtually no science content in TV channels. Popular science journals too are also fewer.

### **Marketing of Science**

In the industry marketing persons talk about a model called AIDA where the letters stand for, respectively, Awareness, Interest, Desire and Action. As mentioned earlier, awareness comes from exposure and that is what advertisements provide. Because of the influence of exposure the general public is far more aware of Tendulkar than of Einstein. Not many in the general public know of Professor C. N. R. Rao who also received the Bharat Ratna along with Sachin Tendulkar.

There are different ways of creating interest from awareness. Years ago when the author held a responsible position in a R & D laboratory he was required to constantly market the know-how generated in the laboratory to seek funds from various government agencies and, specially, the industry. To understand some basic principles of marketing he interacted with some medical representatives who are forever trying to get doctors to prescribe the medicines of their companies – both established drugs and also newer products. These representatives all carry with them special documents that describe the special features of their medicines their efficacy etc. with lots of attractive pictures. They are trained to engage the doctor into a dialogue by asking some leading questions that draw their attention. They focus on the benefits to create a desire in the doctor to prescribe their medicines to patients. Of course, as is well known, doctors are sometimes offered incentives, some of which may be quite ethical whereas some others may not. The author tried a similar method for the industry for which he had to prepare some special documents with less science and more pictures. He also had some videos made.

Not all segments of the public are made aware by the same methods. The industry is always sensitive about investments and returns. For them the desirability (D) of a proposal can be expressed by the following equation :

$$D = \frac{\text{Chance of success (C)} \times \text{Potential benefits (P)}}{\text{Time required (T)} \times \text{Inputs needed (I)}}$$

The time horizon is generally short in every industry. They respond positively if convinced of the viability of the process through laboratory demonstration and if they see good profit (P) with reasonable inputs, specially

financial inputs (I). Lectures on the laboratory's past achievements, qualification of scientists, facilities available or laurels earned, seldom influence the industry in making a favourable decision to invest in a project. The industry may be induced to carry forward an invention to make it an innovation for serving the society if only they are convinced by the techno-economical feasibility and quick returns with minimum risk.

For other segments of the public their special needs must be considered. Political leaders need to be concerned more about the possible effect of any science or R & D work on their constituency in terms of creation of jobs and solution of problems faced by many. Journalists like stories that appeal to the readers and so the science has to be packaged differently. The case of students in schools and colleges and educated members of the public is discussed later in some detail.

In marketing the efficacy of communication of the seller is most important. Scientist must not only be willing but also learn the right language to do so. Some great scientists such as Carl Sagan, George Gamow, J.B.S. Haldane, Richard Feynman, Stephen Hawking, Roger Penrose have written exceptional popular science articles for the public. But these are exceptions. Not all great players make great captains and *vice versa*. Mike Brearly, a poor batsman proved to be an outstanding cricket captain for England while Ian Botham, one of the greatest all-rounder of the game failed miserably in captaincy. The hockey wizard Dhyan Chand tried to be a coach after retirement but he failed, he knew how to play but not how to teach others to play well. Hemant Kumar or Sachin Dev Barman were exceptions because they excelled both as singers and music directors, generally this does not happen. A very good TV science series called The Turning Point had to use a film actor Naseeruddin Shah to present scientific ideas. Amitabh Bachchan, wearing a doctor's coat, have advertised vaccination in the TV. There is a flip side too, Amir Khan once said in TV that he had personality verified results of some 30 experiments which proved that water used for a cold drink was absolutely pure, again wearing a Lab coat. Actors are believed because few scientists are as good as them in communicating in the TV. This has to change.

The need to have some scientists specially trained for communicating with the public need not be overemphasized and the government and academic bodies should give top priority to PEST. Scientists do not like any dilution or distortion of science, not even simplification, but these may be necessary to some extent to attract the public. Scientists should conduct special workshop for journalists, editors and



their senior staff members to create interest in scientific matters.

We need more of popular science articles and magazines. Magazines such as the National Geographic, Scientific American and Science. have done wonderful work in this area for years.

In the past three years National Geographic ran 34 stories on Climate Change including a special issue entirely devoted to the topic. In India, Science Reporter has remained a popular publication because of the variety of topics covered, good pictures and the attractive presentation style. Unfortunately, two other excellent magazines, *Science Today* and *Science Age*, are no longer published. *Science and Culture* is a unique journal but it is essentially for the erudite. *Everyman's Science*, published by the Indian Science Congress Association, unfortunately, is not for everyman, essentially it publishes some short review articles for some scientists interested in that area only. The format prescribed for the authors—Abstract, Introduction.... down to Conclusions and References, as in standard for scientific papers, does not attract the public. Once a well known expert in the area of water submitted for publication a 100 page article with around 100 references suggesting that it could be serialized! The author, as an editor, condensed 'the article to around ten pages leaving only around ten references to make the article less unreadable by 'everyman'. It certainly made the expert very unhappy.

The Royal Society Report made a very important and interesting recommendation. It suggested that every Ph.D candidate should, on completion of the work, write a simple article for the public to explain the essential background and nature of his/her work. Few fresh Ph.D's will be able to do that.

### **Attracting School and College Students and the Educated Members of the Public**

Students today, unfortunately, are rarely encouraged to ask questions about the world around beyond what is in the syllabus. However, they can be motivated to be more curious about things and think. Many in the general public are also potential converts. They all can be made curious by exposing them to interesting questions. Here are a few examples of some interesting questions that the author has tried out on students and the public. For these short answers are also provided. Those interested can find out more by reading the reference cited or from the internet.

Question 1 : How does a small violin produce so loud a sound ?

Answer : The sound we hear is the forced vibration

of the air in the body of the violin. The bow creates the primary vibration in the strings and the bridge provides the coupling with the body. The matter, however, is more complicated.

In a violin four strings pass over the bridge that rests on the upper surface of the violin's body. Between the upper and lower surfaces of the body rests a vertical piece of wood (sound part) placed where the right foot of the bridge rests (See Fig.1).

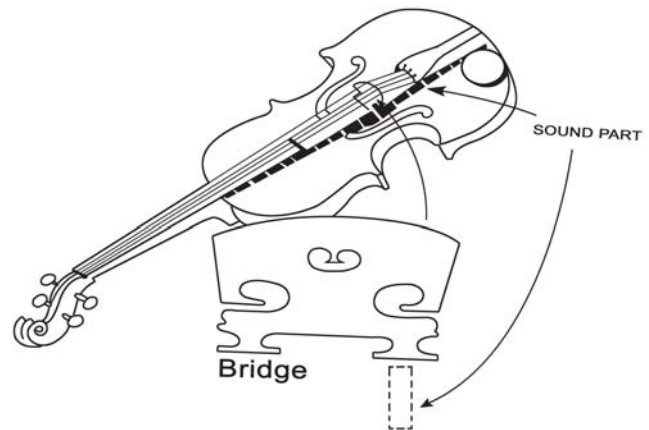


Fig.1 : Forced vibrations and sound of a violin.

The foot moves very little being just over the sound port and the bridge rocks about this foot in its own plane. The vibrations caused are communicated from point to point in the wooden body to the contained air. (The author discovered the mechanism when his own violin once fell apart !)

Question 2 : Why did Alexander leave India after winning the famous battle with King Porus ?

Answer : One theory is that he was told that the Nandas ruling in the East had 2000 war elephants. The only 200 war elephants of King Porus had caused enough trouble. (Incidentally Akbar the Great would have in his army 40,000 war elephants of which 5000 were personally owned !). However, Venetsky<sup>5</sup> says that one important reason for the retreat was that his army suffered from serious gastronomical disorders. Yet, Alexander and his commanders stayed relatively healthy because they ate from silver plates from which little amounts of silver dissolved to keep the offending bacteria at bay. The soldiers did not have silver plates.

Question 3 : Can there really be a cloak like what Harry Potter wears to become invisible ?

Answer : The author of Harry Potter books, Rowling has hit upon the right idea perhaps inadvertently. Note that not only Harry Potter but the cloak also becomes invisible.

One can actually achieve this effect by using on an object a layer of some special materials called ‘meta materials’ which do not allow light falling on them either to reflect back or go through but makes the light travel along the layer. So the light from behind an object can emerge in front and the object is invisible, what is seen is what is behind it.

Question 4 : What role does the Fibonacci series play *vis-à-vis* aesthetics’ ?

Answer : The following are examples of the Fibonacci series :

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55...

0, 2, 2, 4, 6, 10, 16, 26, 42, 68, 110...

0, 3, 3, 6, 9, 15, 24, 39, 63, 102, 165...

In each of the above any number is addition of the previous two numbers. Any such series has some very interesting features and there are innumerable articles devoted to the subject. One interesting feature is that as one approaches infinity the ratio of a number divided by the previous number approaches 1.61803. A rectangle where the two sides are in this ratio is aesthetically attractive and pleasing to the eye. It is called a Golden Rectangle. Geometrically this can be constructed as shown in Fig. 2

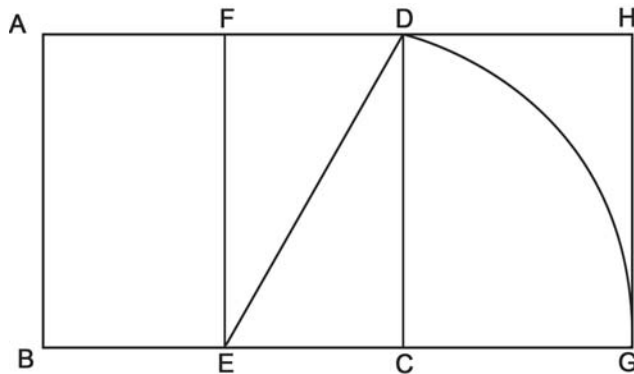


Fig-2 : To know more about the subject consult references listed at the end <sup>6</sup> .

In Fig. 2 ABCD is a square, E is the mid point of B and C, and F that of A and D. ED equals EG. ABGH forms a Golden Rectangle where  $BG/AB = (1+\sqrt{5})/2 = 1.61803$ .

The golden rectangle encloses many buildings, paintings, advertisements, beautiful dance postures, books, business cards, consumer items etc. (See Fig.3).

Question 5 : What is similar in the lives of some small and large creatures ?

Answer : If you hold a small bird in your hand you will feel that the heart beats rather fast. Actually, smaller

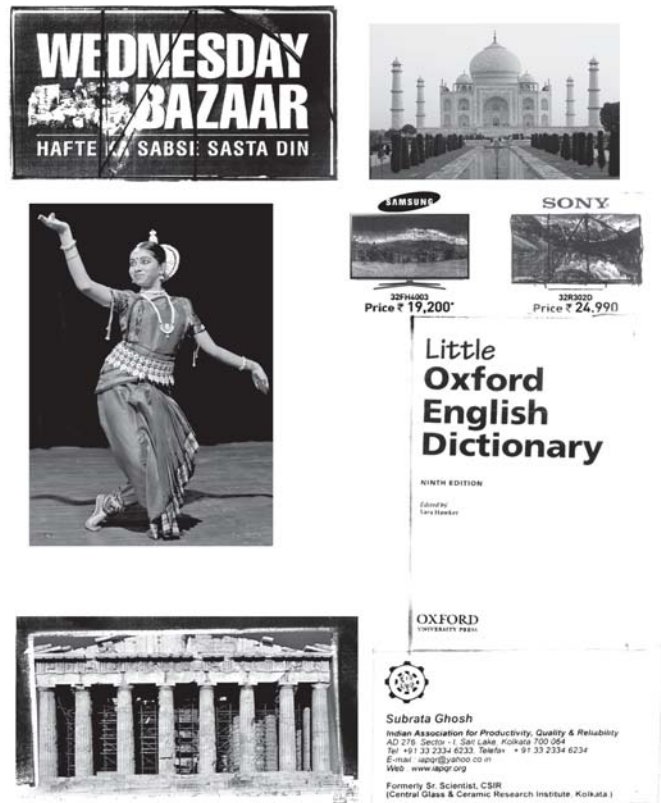


Fig. 3 : The aesthetically appealing Golden Rectangle.

the creature the faster the heart beat. Gould<sup>7</sup> says that during an average life all mammals have nearly the same number of breaths and heart beats. The are as follows :

$$\text{Breath time } t_1 = 0.0000470. (\text{body weight})^{0.28}$$

$$\text{Heart beat time } t_2 = 0.0000119. (\text{body weight})^{0.28}$$

In fact, there is another interesting relation and that is,  $t_1 / t_2 = 4.0$

Question 6 : We know that a plank can be moved smoothly against another if there is in-between a roller. Can there be roller whose cross-section is not circular ?

Answer : There is a cross section as shown in Fig.4 which will do what a circular cross section does. It is formed by drawing arcs around the three points of an equilateral triangle.

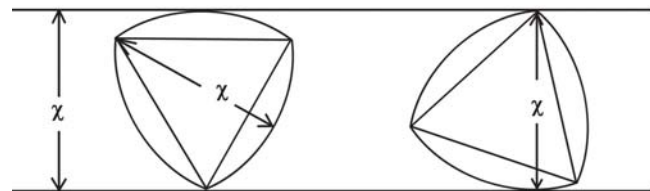


Fig. 4 : A roller with a non-circular cross section.

Note that no matter what the position, the opposing points touching the two horizontal planes the distance

between the plants remains the same (one of the 3 corners will always touch a plank. This geometry has found some applications in engineering, for example the 'rotary' engine for automobiles.

Now some interesting questions are listed for which readers should find answers by themselves. For some, references are cited for further reading.

- In human evolution what was more important- the heat from fire or the light ?<sup>8</sup>
- How does a gekko (i.e. *tiktiki*) stick to the ceiling and hang upside down ?
- If a wife has five daughters in a row whose 'fault' is it – the wife, the husband or God ?<sup>9</sup>
- Why do we need darkness ?
- Why does a golf ball has dimples all over ?
- Why ordinary paper becomes almost transparent when greased ?
- How does a sprouting seed or water freezing in a crevice crack a rock ?
- Why leather shrinks when heated ?
- What decides the spacing between electrical poles ?
- Why cross sections of a pencil is generally a hexagon and not circular ?
- Why man – holes (drain covers) are circular ?
- How can one tell if a pencil's eraser or a wrist – watch band belongs to a left handed person?
- Why do the course of many rivers nearly follow a sin curve ?
- Most solids expand on melting but ice contracts. Why ?
- Can a bird reared in isolation build its nest ?
- What is more tiring- continuous smiling or continuous frowning ?
- Do tree trunks become narrower higher up ?
- In a multistory building several lifts go up and down continuously. If you try to take one down from a floor near the top you find most lifts going up. On the other hand, if you are nearer the ground, you will find them going down when you want to go up ? Why ?
- Which animals have a sense of self awareness ?
- Is there any living thing that employs circular motion for locomotion ?
- If a tiger's body is completely shaved will one find stripes on the bare skin ?
- How does a sail boat with no engine sail against the wind ?<sup>10</sup>

The questions listed above are not silly and in the answers for most of them there is interesting science. The answers to some of these and many other questions are available in one of author's books<sup>11</sup>.

A few years ago the government took a decision to expose undergraduate students in all streams of education to environmental science. Perhaps there should be similar decision to expose everybody to science in the environment.

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