Bridging the Gap Between Explosion Research and Industrial Needs

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> *The [US] Institute of Medicine estimates that it took "an average of 17 years for new knowledge … to be incorporated into practice, and even then application [was] highly uneven." Progress in medical science occurred one funeral at a time. If doctors didn't learn something in medical school or in residency, there was a good chance they never would.* - Ian Ayres[1]

Are engineers any different? Read the following before you decide.

Most of the following applies to all research, not just explosion research, and much of it applies to the transfer of other information.

Conference proceedings are full of papers in which researchers describe equipment and/or procedures, both technical and managerial, which they have devised, often in co-operation with industry, but which are never adopted even in the companies that participated in their development. The researchers are not all academics but can include the research functions within companies, consultants, and manufacturers. The new information may have come from experience on other plants rather than research. Sometimes the proposals are too complex or expensive for regular industrial use but often the researchers have not approached industry in the right way.

Colin Ramshaw, when he was in ICI, pointed out that anyone who wants manufacturers to adopt their ideas, needs a champion within the operating departments. When he found one his ideas were accepted. Without one they were not. One of his major inventions was the Higee distillation process which has never caught on, even in ICI, partly because it has never found a champion in industry able to overcome the natural reluctance of people to accept innovation (see Appendix 1). According to Mike Spear, there is a rush to be second in adopting process intensification[2].

Wherever you work, if you want something done by another department, you are most likely to succeed if you can identify the person in that department whose support is necessary before anything gets done He or she is known as the Gatekeeper and is often not the most senior person in the department. He or she may turn out to be your champion or may be able to introduce you to a possible one.

Do not aim too high when trying to find a champion. The best person to approach is someone at the lowest level that has the authority to adopt your idea. Don't try to sell your idea to a director or the whole board. Even if they agree to adopt your idea the people below them can find numerous reasons for not adopting it (see Appendix 2). When I was trying to extend the use of Hazop I did not start by asking the Division board to agree that all new designs should be Hazoped. Instead I persuaded individual project engineers to try it. They did and

liked it and it became the custom and practice, the “common law”, of the Division. Later it was written into the design procedures and became the “statute law”.

Let us look at two examples of information on explosions that did not reach all the right people. It was information derived from experience but was followed by the development, particularly in the second example, of new protective equipment.

Can Cold Petrol Explode in the Open Air?

An underlying cause of the Buncefield explosion was the belief that cold petrol vapour could not explode in the open air, a belief shared by the oil companies that owned the site, those that authorised the development of the adjoining industrial site and the regulators.

The industrial estate had been sited near the Depot and allowed to expand as all those concerned were unaware of similar explosions in Newark, NJ in 1983[3,4,5],.Naples, Italy in 1995[6], St. Herblain, France in 1991[7] and elsewhere[8]. The Newark explosion received substantial coverage in the UK and US technical press. The group of oil companies that owned the Depot claimed that an explosion of cold petrol in the open air had never occurred before. Two chemical engineers interviewed by the BBC soon after the explosion mentioned the Newark incident but a regulator, also interviewed, denied any knowledge of it. Damage at Buncefield was, however, more extensive than at Newark and elsewhere.

In this case it seems it was no one’s job to make the information known to the management or operating team. The senior safety advisers in the owning companies either did not know about the Newark explosion or did not see it as their job to inform the staff of a company in which they owned only a small part.

Can Diesel Engines Ignite Flammable Vapours?

In 1969 in ICI a leak of about 4 tonnes of hot hydrocarbon vaporised and exploded, killing two men and seriously injuring several others [9, 10]. The source of ignition was a diesel engine. The incident got a lot of publicity as it was not realised before the explosion that diesel engines could ignite mixtures of flammable vapour and air. A press release by ICI was copied in many technical magazines, eg, in Chemical Age (very widely read at the time), 12 Dec 1969, p 40 and 9 Jan 1970, p. 11.

After the explosion I was told that diesel engines had ignited flammable vapours on at least four occasions but the results of the ignitions were never widely publicised. Later in 1969 I wrote an internal report describing the various ways in which diesel engines can ignite vapours and the action we should take to remove or minimise the risk. Copies were given to many other companies. Initially we had to improvise equipment but after a few years proprietary equipment became available. In 1977 Wiley (UK) published a report, *Recommendations for the Protection of Diesel Engines Operating in Hazardous Areas*, prepared by the Oil Companies Materials Association. There are later publications but this one shows that the information has been available for over 30 years.

Despite this some similar incidents have occurred since 1969. I was surprised to be told recently that in the United States many companies and some regulators are unaware that diesel engines are sources of ignition and continue to use them in areas where leaks of flammable vapour can occur. Again it seems to have been no one's job to pass on the information to those who needed to know. It seems that US chemical engineers are similar to US doctors (see the quotation on page 1).

Appendix 1 THE WHEEL: A NEW INVENTION

Please imagine that wheels were unknown until recently invented.

There was much interest, at a recent conference on new technology, on the description by International Chemicals Inc. (ICI) of the WHEEL, a new device **WH**ich sp**EE**ds trave**L**. Because there would be no advantage in putting chemical plants on WHEELS, ICI intends to fit them to fire engines so that the engines can get to the scenes of fires more quickly than current technology allows.

Although there was praise for the company's ingenuity, most speakers expressed reservations. Joe Brown, speaking for the construction industry, thought caution was needed. The value of the WHEEL could not be fully assessed, he said, until several years' experience had been obtained. There might be unforeseen snags that would not become apparent until the device had been in use for some time. He drew attention to the unforeseen effects of other changes, such as the temporary bellows at Flixborough.

Thomas Dowting, of the Chemical Industries Federation, regretted that the device had been made public before the views of other companies had been obtained. The government might expect other factories to adopt the WHEEL. Although it might be useful on large sites (although this was not yet proven), it was not appropriate to the needs of smaller factories, where fire engines did not have to travel so far.

Dr Werner Hackenschmidt (Gesellschaft fur Unsinnfabrikat) asked how WHEELS would be fabricated. The production of continuous rotating load-bearing devices presented difficult metallurgical problems. What materials would be used? Little was known about the behaviour of metals when subjected to such unusual forces.

Professor Patrick Murphy, a member of the faculty of the University of Ballybunion, asked if maintenance had been considered. How could a WHEEL be removed for repair without the vehicle tipping up?

Fred Bloggs, speaking for the Fire Departments, felt that fire appliances should not be used as subjects for experimentation. Had fire-fighters been consulted? He was sure their view would be that safety equipment should stick to well-proven designs. If smoother travel was needed, why not dig canals between the fire station and the plants?

Dr Angus McGregor, from Crianlarich Polytechnic, said that as WHEELS could operate only on smooth surfaces, he could not see how they would be

economic when the cost of road improvements was taken into account.

Bill Muddle (consultant) said that it was a mistake to assume that speedier travel to the scene of a fire was always desirable. Using present methods of travel, fire-fighters had time during the journey to formulate their plan of attack. There would be no gain if fire-fighters rushed in unprepared.

Myfanwy Price, of University College, Blanau Ffestiniog, said that the idea was not new. A similar device was in use at the Annisgrifiudwy-Cymysglyd factory when she worked there over 30 years ago, but it had fallen into disuse, as no one had been able to devise a satisfactory way of stopping the vehicles. Hexagonal WHEELS had been found to assist braking but were disadvantageous in other respects; the ride was no longer smooth.

In his summing up, the Chairman said that the trials will be watched with interest, but in the meantime other organizations seemed to prefer to wait.

Appendix 2: Excuses for not Doing What Researchers and Others Would Like Us to Do:

- "The industry standards don't ask for it."
- “Our competitors don't do it."
- "We have been doing it this way for 20 years and never had an accident."
- "Why should we be an industry leader?"
- "We can do it by changing the method of working without the need for new equipment."
- "I can't really believe in low probability numbers."
- "It's not my job."
- "I don't have the resources" ... and so on[11].

With such people, at least we know where we stand; we know we have to persuade them to do what we want. A greater menace is the person who says, "Yes, certainly. No problem. I'll do what you want", and then does nothing. He or she also has a battery of excuses:

- "I've been exceptionally busy."
- "We had a breakdown/major shutdown last month."
- "It's in next year's capital programme."
- "It's not a good time to ask the boss for the money."
- "We're looking for a suitable supplier."
- "My right-hand man just left."
- "I heard you had second thoughts about the project."
- "I thought we ought to get the project committee’s view."

- "We didn't have time to discuss it at the last design meeting."
- "I thought we might do it as part of the next revamp."
- "My boss isn't convinced it's a good thing."
- "There's a new code of practice out next year so I thought we ought to wait and see what it says."

You can probably add some more.

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