TRENDS AND POSSIBILITIES

By L. Vermij

During the 1950's, Prof. Lerstrup from Copenhagen made the statement :"fuse designing is an art, not a science". It seems to me that ever since it is becoming more and more a science. However, this science has not, up until now, produced any major break-through. At best, what has been achieved, is an explanation of certain aspects of the art.

Since the invention of the fusible link by Edison around 1880, only two major steps in the development of fuses have been made, viz :

- the current-limiting HBC-fuse.
- the M-effect.

All the rest are refinements and improvements. The major steps have been made during the "art-period" and did, roughly speaking, not result from science.

The last 10 - 20 years we entered the "science-period". What can be expected from putting more science in our designs? What are we going to do in our laboratories and institutes and what should be done in future? Perhaps this question can be put in another way :Why are we doing what we are doing and why are we not doing something else? Really the question is : how to realise a reliable protection at the lowest cost.

Let us realise that the best fuse is no fuse. That means that the ideal situation is a system which is so reliable that no overcurrent protection or short-circuit protection is needed. Probably such a situation can never be achieved. However it means that a protection device like a fuse is the best of all evils or, if you like, the most acceptable evil. Having said that, it may be concluded that a fuse must be :

- very cheap.
- not creating additional unreliability to the system.
- small in dimensions.
- easy to mount or to install.

We must realise that from a technical point of view a fuse still has some disadvantages, viz :

- it operates only once.
- it is a heat source.
- it is sensitive to environmental conditions, especially temperature.
- many types and ratings are required.
- obviously it is difficult to standardize.
- ageing still occurs with some designs.

Furthermore, there still are some difficulties in designing a reliable protection scheme, using fuses, viz :

- There is still a lot of misunderstanding regarding the functioning of fuses by users, system engineers, etc.
- Do we know exactly and in all detail what are the "ideal" or required characteristics of fuses from an application point of view? Sometimes it appears to me that we are making solutions and afterwards we are looking for the problems which belong to those solutions.

It is at least interesting to compare the above problem areas with the overview of recent advances Dr. Turner presented in her introductory lecture and with the topics presented during this conference. As an example, what has been done during the last years to overcome the problem of the "operating-only-once" of a fuse?

A couple of years ago, especially the Japanese did a lot of work on the so-called Permanent Power Fuse (PPF), using a liquid metal as a fuse element. Up till now it still not resulted in a completely reliable and economic solution of a "re-usable" fuse. At the Liverpool Fuse Conference in 1976 two papers have been presented on the PPF-fuse. The last three years only one (Russian) paper has been devoted to this subject. Why is that? Is it no longer promising to work on this? Or are the Japanese now quietly concentrating on making their PPF more reliable and economical?

Another example. We have seen recently the introduction in the market of the so-called self-restoring polymer fuse (also called current-sensitive resistor, or PTC current protector), for lower current ratings and for use in low-voltage circuits. The present devices have switching times of several seconds and depending rather strongly on ambient temperature. Furthermore, to keep such a device in the high-resistance-mode requires a minimum power dissipation which, in low voltage circuit as e.g. used in electronic circuitry, cannot be supplied by the energy source. So the device may start to oscillate under faulty conditions. As a conclusion at this point in time such a device cannot replace a fuse. However, can it be the start of a new generation of protection devices? That brings me to the question : what do we, fuse engineers, know about developments in adjacent areas of technology? In how far should the development of other current-limiting devices be of influence for future developments of fuses?

Another point I like to raise is the following :
From an application point of view mainly 4 areas in fuses exist, viz :

- high-voltage fuses.
- low-voltage industrial fuses.
- fuses for the protection of semi-conductor devices.
- miniature fuses.

The number of papers devoted to these main areas on the last Fuse Conferences and on the present Conference are shown in the following table :

	HV-fuses	LV-fuses	Semi-conductor fuses	Miniature fuses
Liverpool 1976	6	2	6	1
Trondheim 1984	10	5	2	0
Eindhoven 1987	9	4	1	7

I have the impression that the market volume in money is more or less in reverse proportionality with the figures for 1984 and 1987. It is certainly the case that at least two manufacturers of miniature fuses have each individually a turn-over in miniature fuses greater than the total market-volume in HV-fuses. It is also well-known that the market for semi-conductor fuses is huge in comparison with the HV-fuse market.

An economist, aware of market volumes but, knowing nothing of fuses, should possibly draw the following conclusions from the above table.

- There is no or only limited need for further R & D work on semi-conductor fuses. The big markets are there, also for the near future, and all problems have been solved adequately.
- A lot of R & D work has to be done on HV-fuses to develop this market further.

Or does the above table suggests that the HV-fuse is the most challenging to us (scientists and technicians), regardless what the market value is or will be? Do we create solutions without regard to the problems to be solved?

In the preliminary I raised a number of questions, no more than that. It is my believe, however, that putting the right questions may at least be helpful in finding the right direction for future work.

Although some people obviously still believe that fuse designing is an art, I think it is not exaggerated to state that fuse designing was an art, by now it can be a science. This science will bring us more optimized designs of fuses, will also create a better insight in requirements to be fulfilled and, possibly, will bring about new designs and concepts. It is my believe that some areas need more attention, as there are :

- Thin-film technology. Only one paper presented to this Conference touches on this area. However, without doubt this technology opens new and unexpected possibilities. We look forward to a number of papers on this subject on the next Fuse Conference.
- The use of ablative materials. During this Conference we had two papers on this subject, but both restricted to miniature fuses. It seems to me that this subject needs also attention in other fuse areas.
- New possibilities stemming from material sciences and solid-state physics, including manufacturing technologies used in these fields of activity, need our attention.
- More attention should be paid to adjacent areas of technologies which are influencing or might influence the application of fuses.

At the next Fuse Conference a great deal of the subjects will of course be discussed again. Not all problems have been solved yet. I do hope, however, that new subjects will be added to the existing ones. Let us try to answer real questions, not finding answers on questions which never have been raised.