Spreading the Word - The Use and Future of IChemE's *Fundamentals of Process Safety* Course

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IChemE's Fundamentals of Process Safety (FOPS) course has been successfully teaching people about the concept and importance of process safety for 10 years. In that time it has had a global reach and has been highly praised by the hundreds of attendees. However, process safety continues to develop as do delegates' expectations of taught courses. The paper reviews the success of FOPS and suggests ways it can continue to serve IChemE, the needs of delegates, and the goal of spreading the word about the vital role of process safety.

The History and Development of the FOPS Course

Introduction - The Development of Process Safety as a Subject

Thirty years ago Process Safety was barely a "thing". The UK Health & Safety Executive (HSE) was just changing the name of their Fire and Explosion Specialists to Process Safety Inspectors. "Hazards" Conferences had papers from what are now reaction hazards testing houses explaining how they could measure the hazards of reaction chemistry, and why it was a good thing to understand this. Other papers extolled the virtues of HAZOP and HAZAN to the sometimes sceptical operators of hazardous processes: the first notice one of us served as an HSE inspector was on a (respectable) company, requiring them to carry out a HAZOP, something of which they had no knowledge, on a process which had suffered a serious loss of containment. The "Process" in Process Safety was largely the chemical process and its characteristics, and the idea that Process Safety was itself manageable was - for much of industry - a novel and still developing idea.

We have come a long way since then, even if there is not - yet - a single definition of Process Safety in general use. IChemE does have a definition of Process Safety, though rather by default than by design. It is the one which starts the Institution's Fundamentals of Process Safety (FOPS) course and it reads:

> "Process Safety is a systematic framework for the management of the integrity of hazardous processes.
>
> It uses a blend of engineering, management and leadership skills focused on preventing major accidents; particularly explosions, fires and toxic releases.
>
> It focuses on three key aspects:
>
> - Plant (hardware);
> - Process (systems); and
> - People."

The definition was designed to be reasonably memorable and not too long, it often finds its way into the questions asked in the assessment paper at the end of the course. It has withstood the test of being taught to hundreds of people, a good number of them sceptical and argumentative, around the world.

Most importantly it does capture the essence of the course; perhaps that is why the course itself has stood up quite so well over the last ten years. The definition emphasises that Process Safety is a "systematic framework for the management" of hazardous processes. The inter-relatedness of the different elements of process safety is hard to over-stress and is emphasised in the course by the use of the International Safety Centre (ISC)'s process safety wheel at the beginning of each section. This understanding grew, perhaps, from the concept of the (process) safety chain (originally developed by ICI in the UK) which graphically portrayed how a safety system can fail if one element is broken. It showed that all elements of process safety must be managed to ensure that hazards are controlled effectively. To exemplify, a Management of Change system can never stand alone, it relies for its effectiveness on many other elements of the process safety management system and is ultimately only as strong as that overall system. The FOPS course was (and is) designed to provide an overview of Process Safety but one vital message is the interconnected nature of an effective process safety system, needed to protect against major accidents.

The Origin of FOPS

There is no doubt that the course has been a success and no doubt that it has filled the need Robin Turney identified when he got a group of people together to discuss and then write the course in 2007-8. That group brought together a set of people with different backgrounds and experience, and indeed a differing set of views as to what process safety actually was. The group included a representative from HSE and was greatly assisted by representatives from BP; they brought their experience of and learning from the internal and external investigations of the 2005 Texas City accident. They also brought the experience of writing a similar course for BP's internal use and access to BP's training resources, generously shared with IChemE and others, including video and animation sequences which form an important part of the IChemE FOPS course today.

The members brought different experiences and ideas to the group - and differed amongst themselves quite sharply in the first couple of meetings. However the group quite rapidly came to an understanding and agreement on what the course should look like, what it should cover, and how it should be structured. The process was helped considerably by asking the question "Who do we see in front of us?" By defining who the course was aimed at, the group could answer questions such as: "What knowledge and experience are we assuming?"; What do delegates need to take away?"; and "What is the delegate's employer likely to regard as a successful course?".

The delegate the group chose was a graduate chemical engineer, probably in their late twenties, in their first or second job, working towards Chartership within a couple of years. This delegate was, it should be stressed, intended to be at the centre of the intended audience and definitely not meant to exclude anyone else. The course was always intended for delegates with a wide range of backgrounds and experience. However this choice enabled the individual modules, initially drafted by different members of the group, to be assessed against the likely experience of the target delegate, hopefully giving the modules a common standard.

There was a period of quite intense discussion about the form and contents of the Course. It was agreed that the Course should have modules covering different topics. Each module should include an exercise to get the delegates talking to each other and to prevent them spending long periods watching PowerPoint presentations. A target size of 4/5 groups of 5/6 delegates was set, to enable delegates to interact and learn from each other. More difficult was deciding what subjects needed to be covered and what was not required, a surprisingly contentious issue. There was much discussion about which subjects required a complete module to themselves and which could be brought together in a single session. All members contributed to the group's knowledge base and it was in fact quite a learning and broadening experience for a number, perhaps most, members.

Members of the group then selected modules they were prepared to draft either alone or in conjunction with one or two other group members. The early ideas and drafts were discussed by the group, either in meeting or by circulation, to give an outline of each module all members were happy to endorse. Fortunately IChemE, having realised the potential value of the course, supported one of the members to spend the not insignificant time required to draw all the draft modules into a useable course the group was happy to approve.

One final decision was whether a course assessment was required. The group felt that if the course was to show proper learning - and given the importance of process safety to the future of the process industries proper learning was essential - some form of assessment was required. This would be particularly useful for our young Chemical Engineering graduate hoping to become Chartered where success in an assessed course was much more powerful than a simple certificate of attendance. The group was helped by having a member from a university chemical engineering course, who offered to write a suitable paper.

Early Experience of the Course

The first iteration of FOPS was presented to a semi-public course in late 2008. "Semi-public" as a good number of the delegates were associates of group members or were co-employees in the companies who had given group members the time to help develop the course. None the less the course was both full and well received by the delegates present. That first outing rapidly grew into the successful series of public course which IChemE runs 3-5 times a year in the UK, together with courses around the world. The course was also adopted by a number of companies - often with some modification to reflect the company's business - as an essential in-house course, both in the UK and in a number of other countries where major process industries operate. The course has also been adapted to individual industry sectors with tailored courses for the oil and gas and nuclear industries being offered both publicly and in-house.

The 2014-15 Revision

The course materials underwent a significant revision in 2014-15 which brought a welcome uniformity of style to the course and captured a number of innovative improvements that individual tutors had introduced, learning from their own teaching of the course. The revision increased the use of video and animated material and these were embedded into the slide pack. The course material was also put into a centralized "controlled document" format, with much more oversight of any changes which were requested by course tutors.

Unfortunately, whilst there was some consultation with course tutors, the revision was not overseen by a formal group to ensure accuracy and to ensure that tutors as a group were all happy with the changes. Also there were no changes made to the assessment paper which, as discussed later, has been a problem for international delegates.

Feedback - How Successful Has FOPS Been?

The continuing success of the course, and the value it continues to provide to delegates, is clearly demonstrated by the extensive feedback that IChemE gathers from delegates. As an example of this, the feedback from more than 50 delegates from three courses held in 2018 is summarised below:

Aspect of Course	Rating of Course - % of Delegates		
	Excellent	Good	Good or Excellent
Content	77	21	98
Teaching	82	13	95
Materials	65	31	96
Workshops	69	28	97
Objectives	54	45	99

These comments from delegates in 2018 are typical of the good feedback that tutors have received throughout the history of the course:

- "I really enjoyed the course, especially the mixture of theory and classroom exercise".
- "Trainers had deep knowledge of process safety, and created an atmosphere where people were encouraged and comfortable to discuss opinions and experiences".
- "Trainers were engaging and interactive".
- "Group exercises and opportunities for discussion were the most valuable aspect of the course".
- "The best course I've ever been on".
- "I finally see why you talk about Process Safety Management Systems, and how it fits together".

Although feedback is generally very good, there is also occasionally less positive feedback. IChemE provides all the detailed feedback from each course to the tutors involved in that course, and also analyses the feedback from the courses collectively to look for trends or weight of opinion which might indicate improvement opportunities. Examples of this are the volume of PowerPoint slides and the desire of some delegates to receive further supporting materials in a more "textbook" format as well as the slides used in the course (which are now provided in print and electronically). This feedback information has been used by the authors as a principal source for the ideas for change outlined below.

Possible Ideas for Change

Supervisory Group

If we agree that FOPS has been an undoubted force for process safety good, we must have mechanisms to ensure the course remains relevant, accurate and up to date. It must also speak clearly and attractively to future delegates. Just as the course was written by a group of interested and reasonably expert people, there is a need to have a continuing supervisory group who are looking at the course on a regular, perhaps biennial basis. They need to be asking a series of questions including:

- "What has happened in process safety since the last review, which should be reflected in the course?"
- "What major accidents have occurred which should be mentioned in the course? What major learning is there from those accidents?"
- "Have there been any new techniques developed which have begun to be incorporated into process safety practice?"
- "Is the course still attractive and is it still fulfilling its purpose?"

The outcome of the review should naturally be reflected in the course material. There needs to be an accompanying mechanism to ensure all tutors are aware of the changes and able to present the new material effectively.

As well as overseeing the future development of the Course, it would be useful for the Supervisory Group to oversee the selection and performance of tutors, ensuring that high standards of accuracy, awareness of current trends, and effectiveness (as examples) are maintained by all tutors. They should also set up and run a system for moderation of the Course Assessment papers, again ensuring accuracy and consistency in marking. Where a course certificate is given or not given based on a score in a written assessment, IChemE has a duty to ensure the all candidates are treated equally. Overall, the aim of the Supervisory Group would be to ensure that the course continues to offer excellence in process safety training, with an up-to-date, effective course, upholding the consistency of delivery and assessment that has been established to date.

The Course in Future

Having described a possible mechanism for supervising the further development of FOPS, what do we, as three tutors with considerable experience of teaching the course, feel needs to be done to keep the course fresh and relevant?

Course Structure

The structure and content of the course still seem broadly right. The general thrust of any changes needs to ensure that the modules, especially the ones which are currently less engaging, fit the "Introduction, Exercise, Discussion, Systematise and Reinforce the Learning" model, which was the original design intent for the course. We would accept that through the aim of ~1 hour modules is right, though not all important units are 1 hour long, some are shorter and some longer. It is more important to keep each module focused than force them into a common length. However the use of at least one exercise per module is, if not absolutely essential then at least highly desirable. We learn by doing rather than sitting and listening, and each exercise provides the opportunity for delegates to share their own experience and knowledge. Good exercises, well moderated by the tutors are an essential learning tool - sometimes for the tutors as much as the delegates!

Some of the exercises and some of the examples currently used refer to incidents which happened a long time ago. We need to recognise that it is harder for a twenty something delegate to relate to an incidents that happened when their parents were young. We must teach about the classic incidents such as Flixborough and Bhopal, the learning and consequences are far too important to be omitted, but they need to be reinforced with more recent events. We need to ask the tutor group, the Supervisory Group and the general membership for examples of more recent events which we can use to broaden and refresh the course, and which will allow a choice of examples and exercises tailored to particular audiences.

The revision exercise conducted in 2014-15 brought a welcome uniformity of style to the course and did very good work embedding video and animation into the slide pack. However not all the video clips illustrate the point being made as well as they should and the course still relies very heavily on slides - the ever present pitfall of "Death by PowerPoint" remains. We need to revise, and wherever possible expand, the use of video clips and animation in the course to ensure it is engaging and relevant to a younger audience. That is not to say that the written word is not important, we must not forget that what is written is more likely to be useful as reference material and needs to cover the actual, correct material that we are using.

Course Content

International Relevance

Although developed and launched initially in the UK, FOPS has now spread world-wide and is regularly delivered in South Africa, Australia and Malaysia, in mainland Europe, New Zealand and Singapore, At the same time, UK-based courses have become increasingly popular with overseas delegates, which has enhanced the general delegate experience by spreading the experience base available particularly in the group exercises. The increasing international popularity of the course has thrown the UK bias of the current material into sharp relief; references to HSE, except as a source of reference material, are not very useful in Malaysia. There is a clear need to make the course materials more international in nature, by:

- including fewer UK references and more references to international standards;
- Including more examples drawn from events and experience outside the UK, US & Europe,
- improving the comprehensibility of the materials and the Course Assessment, linguistically and culturally, by checking that it is easily understood by delegates from different countries;

Interactivity

From a teaching point of view, much of FOPS is very interactive, as was intended in its design. From the feedback it is clear that many delegates value the interactive nature of the course highly. However, as has been said earlier, there is a large volume of presentational material and some sections, notably those on the consequences of releases are very slide-heavy and perhaps have too much information at a level beyond a Fundamentals course. Reducing the volume of this material should be an aim of any review and would allow for an increase interactivity for example by:

- more use of video; and
- more case studies and workshops.

Interactivity could be increased even further by the use of real-time voting software, available using delegates own smartphones, allowing rapid feedback from delegates for, for example, confirmation of understanding, or discussion of experience and prior knowledge. Its use to guide - or possibly rate - course tutors should not be discounted!

Recognised Good Practice

The course's definition of Process Safety, emphasising its systematic and managerial character, and the inter-relatedness of elements of Process Safety, emphasised by ISC's process safety wheel, is essential learning from the course. It represents best practice and any revision should strengthen this message further. It is self-evident that FOPS should provide delegates with an understanding of current recognised good practice in process safety management, and so a future review of the course content should:

- critically examine the content and relative depth of each subject to ensure that good practice is incorporated;
- increase the linkages between modules beyond the use of the ISC 6 Pillars Model;
- incorporate new guidance, such as onshore safety critical elements guidance.

Personal Planning

The Course has always ended with the Assessment, followed by a relatively short "Closing Circle", during which delegates are invited to share their impressions of the course and any "wow" moments of sudden insight. It may be useful to supplement this by including time for some personal planning of what delegates plan to do differently as a result of their week spent on the Course. This may be a more "positive" way to end than with an exam, as is discussed further below.

Supporting and Reference Information

As mentioned above, a common theme that has emerged from feedback has been the desire for less PowerPoint material and more textual supporting material in the Course Manual. This could be done by:

- providing a reading list;
- providing a guide to further resources;
- providing more supporting documents in printed or electronic format, for example relevant LPB articles, TCE articles or regulatory or international standards guidance.

Delivery Options

There may be value in considering options in addition to the standard 5-day classroom delivery of FOPS, which could improve the learning experience for some delegates and provide individuals and organisations with more flexibility, thereby making the Course more attractive. Examples could be:

- modular classroom structure (1 day per week or per month for example);
- on-line (webinar-style) modules;
- video-conference delivery (for limited numbers of delegates);
- in-company delivery with content tailored to the client based on a review of the company's operations.

The Course Assessment

The Course Assessment has certainly proven effective in engaging the attention and participation of delegates through what is for many an intensive, challenging week. Whilst the assessment does not show competence in Process Safety, it does show that delegates have been listening and have absorbed key points. It has also provided tutors with an effective way to structure day-by-day reviews of the previous day's content. However, it is also clear that for some delegates, especially this those with English as their second language but also those with less experience of process safety,the assessment introduces a degree of unwelcome stress - the question, "is this in the exam?" is a common one that all tutors have experienced!

An analysis of the questions which delegates get right or wrong shows that apparently simple questions are often misunderstood by non-UK delegates. For example the question "Give three sources of further information about process safety", intended to produce answers such as "IChemE, HSE, CCPS" all of which are explicitly referenced in the course, was answered correctly by only half of the delegates on a recent course in Israel. Many did not even attempt the question. One delegate asked after the assessment if the answer should have been HAZOPs and other hazard studies.

There is an urgent need to make the Assessment questions clearer, totally unambiguous and linguistically and culturally transparent. The question above should probably be recast as "Give three organisations which can be sources of process safety information" - though that needs to be tested around the world to ensure it is in practice properly understood.

There are other improvements which are clearly needed. One is to increase the number of questions available so that the Assessment Paper is not essentially the same time after time. Care will need be taken that the possible question sets are fair, that there aren't hard papers and easy papers. Importantly, the availability of more than one paper would help with the problem of delegates who fail the Assessment but want to revise further to pass. A second area is to re-assess the number of questions, again especially for non-UK delegates. Taking an exam in a second language is always more difficult, even for an excellent candidate. More time or fewer questions would help with this problem.

There is also the timing of the Assessment. It is the last element of the course apart from the Closing Circle, often taken just after lunch on a Friday. In Muslim countries especially, with delegates who attend Friday prayers, this is a bad time. It also, being a formal written assessment, tends to leave people drained once they complete it, meaning the closing circle is often very "flat" with delegates keen to return home. However, the majority of the final morning is been taken up with the extended Texas City case study. This is a key part of the course and well received by delegates but it is not assessed, as such. It would be possible to have the assessment early on the last day, then follow it with the case study and closing circle, hopefully giving delegates a better send off from the course. We believe this approach is worth a trial at least.

Conclusion

The best managers of high hazard processes, sites and companies are imbued with a HealthyUnease. Unease because they are aware that things can - and will - go wrong. Healthy because they manage a suitable and effective Process Safety system, with the right managerial metrics to ensure it is working properly, to prevent, control and mitigate process safety accidents and incidents.

IChemE's Fundamentals of Process Safety course has proved a world-wide success in its first 10 years, helping delegates to understand that message. It has been and continues to be highly rated by delegates. Over this period a large amount of information has been gathered – from tutors as well as delegates – telling us which aspects of it work well and where there is scope for further improvement. IChemE needs to respond to these improvement opportunities to make sure that FOPS continues to reflect current industry recognised good practice. It requires an effective mechanism to do this and this paper has suggested such a mechanism. We have outlined some areas where we think further improvements can be made and we look forward to the next revision of the Course. We hope that this paper and its authors will prove useful in that process.