The History and Philosophy of our Course

Sheffield Fracture Mechanics is a practical course that began in 1979 as a collaboration between Open University and Sheffield University lecturers who had worked on the production of the OU distance teaching course, *'Materials under Stress'*, at a time when most university engineering courses didn't teach Fracture Mechanics.

Distance teaching courses could not be the traditional "*Hey, here's some theory from my book, and I'm going to test you on it.*" because studying at a distance is a lonely business. Students saw the material before paying so could, and did, vote with their feet — the antithesis of a conventional university course for 'captive' students.

Our solution to the problem was to develop industrial case-studies from problems ranging from pipelines to aircraft spars, using fracture mechanics for analysing failure, or for design and inspection, supported by videos. This was an expensive, time-consuming business that could not be emulated in a conventional university.

Despite this privileged start it has been a hard road and the course has evolved significantly. It still has a bedrock of genuine industrial case-studies that delegates work on in small groups from different industries.

Our aim is to train fracture mechanics practitioners, not merely to introduce the subject. So, what has changed over thirty years?

Mostly it is in the detail of the relationship between practice and theory. We work hard to dispel the idea that practice is the application of theory and have removed all useless theory. Useless theory is legion!

We have put the rest of fracture mechanics theory 'in its place' by emphasising its shortcomings and showing how practice takes these shortcomings into account.

For example, the R6 failure assessment curve, which is continuous between LEFM and Plastic Collapse, is based on a 'fudge' because the two theories use different stresses (far field and ligament) but joining the theories requires the use of one stress, so one theory had to be compromised. This isn't in the text books!

For the nuclear industry this didn't matter because they were concerned about fracture at low Lr values without forcing these procedures on structures that would fail plastically at high values. It was a clever fudge because they weren't that interested in the accuracy of the curve where the it falls rapidly between the two extreme failure modes.

Also take the *J*-integral, which is a very poor model for a growing crack because it has no wake, so models a tearing crack as a series of 'still photographs'. So *J* has a limited range of validity — not suitable for, say, assessing the integrity of weld defects during pipe reeling at, say, 2% strain, which is one of our case studies.

This type of thinking pervades all of our training material, producing the obverse of the mathematical approach found in most academic engineering literature.

Practical Fracture Mechanics is not the "*Appliance of Science*".

Most national and international delegates come from our established industrial relationships and some industries have course attendance as one of their requirements for SQEP status.

"*Many thanks for an entertaining and practical course. This is the first course I have come away from with a feeling that I can engineer better as a result of the knowledge I have gained.*" (James Larcher, Pall Aerospace).

"*Many thanks for this, and also for the last 6 days, it was unquestionably the best course I've ever attended.*" (Adam Towse, Head of Stress, Assystem).

"*I went on this course in 1996 and have used the contents and principles ever since in my engineering career. It was the best technical course I ever went on: a well-balanced mix of teaching and hands on application in workshop examples. In my current role, I have been sending my team on the course for over ten years. Every single one of them has found it pivotal to their role, and agree with*

me that it's the best technical course they've ever been on! Thank you, Sheffield Fracture Mechanics." (Steve Wheat, Head of Stress at Rolls Royce Submarines)