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PENNIES EARTH QUAKES AND IDEAS

The penny is now a paltry coin, soon perhaps to be given the *coup de grâce* in Europe by the euro. The English language will be the poorer for this, as we lose many picturesque figures of speech. One of my favorites is: "The penny dropped". I suppose it derives from one of those old fairground contraptions in which the required penny would often get stuck in the coin slot until the machine was shaken or struck. Thereupon, bells rang, lights flashed, doors opened and perhaps a monkey delivered a piece of chewing gum. Mental processes are often like that.

To the modern scientist the earthquake or avalanche must be a better, if slightly sinister, metaphor. We are told by such experts as Per Bak that this kind of jerky motion is to be found in nature everywhere, even on the stock market. Its prime characteristic is the unpredictability of exactly when it will occur.

Pity then the poor academic theorist who has to write a research proposal to a national or European agency. For it demands that goals and milestones of constructive cerebration are specified in advance, that new ideas are timetabled. Pennies must drop at six-monthly intervals. It is an uncomfortably false model for both proposer and reviewer.

Alas, the penny will not drop in the human mind in response to a mere kick. Besides, it's no way to treat a graduate student.

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[Nasa's Daniel] Goldin'. Esa does have though, a science director (Roger Bonnett) who lays down guiding principles and who came up with the idea for Esa's grand plan, Horizons 2000, a set of four cornerstone missions and several medium-sized missions, and also a 50-year vision of Esa's future.

Some of the details of the grand plan have changed through the recent restructuring. With Cluster salvaged the four cornerstone missions remain. But two missions, the cosmic microwave background surveyor, Planck, and the cornerstone Far Infrared Space Telescope, may be merged to save money (and this has created a little disquiet among astronomers). And all medium sized missions are to be halved in cost, at some loss to the mission itself: 'You can not build the same thing for so much less money, and this means sacrifice. And what we are proposing now is a scientific sacrifice. We will not have the same scientific harvest in this plan as we would in the original plan.'

But cheaper missions might not be so bad. Nasa's Pathfinder mission to Mars has shown that cheaper (and faster) projects can not only get off the ground but be

successful (Pathfinder cost \$171 million to design and build which would have been just a scratch in the \$3 billion in today's prices of Nasa's last trip to Mars, the Viking mission of the 70s.)

'It's really an attempt to drastically lower the price tag in order to get the message to the scientists that they should really try smaller now. It was a tendency always to do the perfect thing, and this is not possible anymore.'

Projects completed over a shorter time scale are cheaper because the hours worked are less - it's a simple sum of wages. But cheaper missions also need a new style of working. 'Under the pressure of money we have to change our philosophy. We have to change procedures so that they go faster and we don't do so much testing. We are ready to take some more risk by changing the procedures to make them cheaper.'

Balsiger doesn't mean, of course, that there should be more risk of failure. After all, it was a lack of proper testing and a subsequent computer error that led to the loss of Ariane 5 and the need for all the recent restructuring.

'It was not a computer error, it was a human error,' Balsiger corrects me. And a little anger begins to show. He is clearly

frustrated by the loss. 'In my mind it's unforgivable that it happened. One doesn't talk too much about it, and it's no use to rub it in and repeat it, but clearly that should not have happened. Standard procedures would have avoided it. They of course say, "We were under pressure of money", but they skipped a few things which you can not skip.

'As you start skipping things you have to do the error analysis and find out: "Am I allowed to skip that?" If somebody should know this it's the space people, because the whole success of space is built on analysing risk.'

It certainly didn't make Balsiger's job any easier. 'Several times I said, "Why the hell did it have to happen to me?"' In Balsiger's universe you are allowed to be human, even a little bit selfish, but never irresponsible.

Before I leave I show him a news report in *Nature* about the last SPC meeting which says that France, Germany, Italy and the UK were unhappy about keeping up with the Horizons 2000 schedule. Balsiger looks puzzled, again. He frowns, saying he can't remember that from the meeting, he'd have to look it up in the minutes. The report is probably exaggerated and the meeting was as orderly as possible. *Balsiger* was there.