Splines and Mortality Modelling

or '*What aircraft design and actuarial work have in common*'

Some actuaries react to mathematics as if it were something to be avoided at all costs. Certainly, a commercial actuary has no business indulging in mathematics purely for its own sake, at least not while a client is paying for it. But this is not to say that mathematics - even advanced mathematics - is never commercially useful. One example is splines, a body of practical mathematics which has been used recently in an actuarial paper by Richards, Kirkby and Currie (2005). Are splines and all the fancy mathematics really necessary for modelling mortality? Surely such things are only for academics in their ivory towers?

Splines are no idle academic exercise, particularly outside the actuarial profession. If you watched Arnold Schwarzenegger's morphing adversary in *Terminator 2*, you were watching splines in action. Modern computer graphics use splines extensively for their efficient and economical representation of organic forms, whether animated or not.

Splines are not limited to the entertainment industry either. Asking about the impact of B-splines in geometric design, says Ray Sarraga of General Motors Research, "is like asking 'What is the impact of the gasoline engine in the use of cars?'" Tom Grandine of The Boeing Company adds, "No plane leaves Boeing without many billions of B-spline evaluations behind it. Splines demonstrate some of the good things that happen when you get the math right!"

The use of splines does not stop at computer-aided design. Another important application of splines at Boeing is in calculating optimal orbit and flight trajectories. The continuous variables representing the physics of the vehicle and its controls are replaced by spline approximations.

So if you are wondering if splines are really necessary, think about them on your next flight: you drove to the airport in a car designed with splines; you stepped onto a plane designed by splines; that plane is both controlled and flown with splines; and the graphics in your in-flight movie were created with splines.* You can't deny that splines have their uses!

In fact, splines have long been in use in actuarial work: actuarial tables since the 1970s have been graduated using splines. The key feature of splines - flexible yet economical representation of curves - is immediately applicable to the very essence of actuarial work: the mortality curve. When this flexibility is combined within a statistical framework, an actuary can balance the flexibility of fit with the degree of 'curviness' justified by the mortality data.

Yes, splines involve learning some new techniques, and even exposing oneself to some mathematics again. But in a low-inflation environment with low nominal investment returns, the role of mortality has once again taken centre stage in actuarial concerns. And in highly competitive markets, the scope for generous error-absorbing margins is gone. The use of splines - and other forms of mathematics - is now an indispensable part of the modern actuary's toolkit. To reject or ignore them because they are new or unfamiliar is to deny that the world has changed. Or would you prefer modern aircraft engineers to go back to using slide rules to design their planes?

Stephen Richards
7th April 2005
www.richardsconsulting.co.uk

With grateful acknowledgment of the work of Paul Davis, Dean of the Interdisciplinary and Global Studies Division at Worcester Polytechnic Institute in Massachusetts, U.S.A.

References

Richards, S. J., Kirkby, J. G. and Currie, I. D. (2005) *The Importance of Year of Birth in Two-Dimensional Mortality Data.* Submitted paper.

---

* If you're not watching a movie, but reading this note instead, then guess what lies behind modern scaleable computer fonts?