mechanism can be obtained by solving the Navier–Stokes equation for an incompressible fluid in the vicinity of the jet outlet (Peter Hoekje, Univ. Northern Iowa). The results of Hoekje's model confirm that mode locking and octave overblowing occur in an instrument whose frequency response has near-harmonic resonances, but not in one whose second resonance is much higher than twice the first resonance frequency.

"All well and good," responded Steven Wasser (Vern Q. Powell Flutes, Inc.), upon hearing these scientific papers, "but manufacturers of musical instruments are under constant pressure to improve productivity and enhance the performance qualities of their products." It is the responsibility of the manufacturer to establish a dialogue between the subjective artistic requirements of the musician and relatively objective manufacturing factors such as material properties, dimensions and processes. To illustrate his point, Wasser brought along Jerado di Stefalo, a professional flautist, to demonstrate the sounds of flutes made from gold and silver.

Ancient instrument, modern theory — the Flemish hammered dulcimer (P. Schenk, Collection Haags Gemeentemuseum).

Since 1986, the Hyperinstrument Group at the MIT Media Laboratory has been designing intelligent, interactive musical instruments that measure and interpret musical performance, among other things. Composer Tod Machover (MIT Media Center) discussed and demonstrated the current generation of hyperinstruments that incorporate MIDI controllers, samplers, custom signal processors, special input controllers and instrument sensors, and — of course — digital computers. Until 1991, Machover's hyperinstruments were designed primarily for virtuosos such as cellist YoYo Ma, and emphasis was placed on measuring very subtle differences in interpretation and articulation from performer to performer. Since 1991, however, the hyperinstrument model has been extended for use by amateurs not proficient on an instrument, in an attempt to stimulate the imagination and allow room for growth and learning.

Mixing synthetic and acoustic sounds in a live performance requires the synthetic instruments to track the tempo and pitch of the acoustic performers in the same way an accompanist would. A computer model of human auditory sensing and pre-attentive processing can provide a good approximation of the conditioned stimuli with which the musical brain actually works (Barry Vercoe, MIT Media Center). A real-time model in which the first derivative of a constant-Q filter bank is fed into a temporal pattern detector to provide control for synthetic instruments needing to play in synchrony with the acoustic source was described. Live and videotaped demonstrations showed how well Vercoe's instruments can track variations in tempo and pitch by performing musicians.

Much can be learned about musical instruments by combining musical performance with scientific papers and acoustical discussions. The acoustical properties of hammered dulcimers, which originated in the Near East some 5,000 years ago and later became popular in Europe, China and the United States, have not been studied scientifically until very recently. A theoretical model of string vibrations in hammered dulcimers (illustrated here) has only just been developed (David Peterson, Central Arkansas Univ.), and the vibrational modes of the dulcimer soundboard and body have been studied by means of holographic interferometry and experimental modal testing (Gregory Canfield and T.D.R., Northern Illinois Univ.). The value of these models in understanding the dulcimer and its music were aptly illustrated by listening to the sounds of several hammered dulcimers, both by themselves and in ensemble with fiddle, guitar and voice, as in Southern folk music styles (David and Donna Peterson, Central Arkansas Univ., and Christopher Peterson, Washington Univ.).

Dialogue between performers, listeners and instrument makers is also important in understanding the acoustics of bowed string instruments. The Tokyo String Quartet offered a chance to compare the sounds of four different sets of instruments, their cherished old Italian instruments included. □

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DAEDALUS

Fractal money

MONETARY inflation, says Daedalus, is curiously popular. Steadily rising prices and incomes give a sense of progress. The endless pass-the-parcel rush as everybody tries to get rid of their money before it loses value is often mistaken for dynamism and economic vigour. An outmoded part of an inflating economy can decline discreetly without its turnover shrinking in numerical terms.

The trouble starts when the process accelerates into hyperinflation. The government prints more and more money, which loses value faster and faster. The traditional cure is a new currency. Sadly, this often catches the disease as well, so the process recurs.

Daedalus wants to tame this process by making it predictable. His model is the steady-state theory of the Universe. Galaxies expand apart; but as fast as they do so, new galaxies appear between them. The Universe inflates steadily for ever, always looking much the same. Similarly a currency (the pound, say) could depreciate steadily, predictably, until it was worth 10 per cent of its original value. The government would then decree a New Pound worth ten old pounds. It would exchange all cash and amend all accounts accordingly. This cycle would repeat endlessly.

As with all inflation, the government makes a steady profit. By printing money and spending it, it enriches itself while robbing its citizens. And a well designed steady-state inflationary regime, says Daedalus, could fund the government totally. Taxation could be abolished.

Modern taxation requires a vast state apparatus of questioning and snooping and grabbing. The oppressive, intrusive bureaucracy calls forth from the citizens even vaster amounts of form-filling and defensive accountancy. Freed from this massive unproductive burden, and with steady-state inflation safely stable and predictable, the real economy would surge forward as never before.

So Daedalus is wondering what steady-state inflation rate would allow the state to command half the citizens' wealth (a typical ambition these days). The naive answer is just 100 per cent, with money losing half its value per accounting period. Such an economy would replace its currency with new tenfold units every 3.3 such periods (with a small gain to the government each time: not all the old currency would be handed in). This answer ignores various subtleties; much hard-won experience will be needed to achieve the right steady-state inflation in practice. But the advantages for honest, fast-moving toil, and the disadvantages for cash-rich money-launderers, seem compelling. David Jones