MUSICAL INTERLUDE

Sound editors perform another very useful function by utilising the computer's disk or cassette drive to store voice data and thus allow huge libraries of sounds to be built up at a fraction of the cost and with greater security than by using the synth manufacturer's RAM cartridges.

Midi master keyboards

A final symptom of the manufacturer's chronic cost-cutting is the quality of the synthesiser's keyboard. Although very few go quite as far as providing 'dead flesh' rubber keys, many manufacturers use very small and unresponsive devices or, indeed, go so far as to provide no keyboard at all.

The answer to this problem lies with midi master keyboards, which are distinct from synthesisers in that although they have a piano-like keyboard, they don't have any sound generation capabilities at all – their sole function is to control synthesisers via the midi interface.

Master keyboards vary in quality considerably. Those at the top of the range, costing thousands of pounds, are the 'weighted action' eight octave keyboards, which respond to the velocity and pressure that the individual keys are played with and feel rather like a real piano to play. Cheaper keyboards are available for only a few hundred pounds and besides being smaller, with perhaps only five octaves, may lack some of the features of their bigger cousins and use simple spring mechanisms to return the keys to the 'up' position once they have been released by the musician.

PRESET 05	PORTAMENTO OFF	VIBRATO ON

LINE SELECT	MODULATION RING	MODULATION NOISE	DETUNE +/-	DETUNE OCTAVE	DETUNE NOTE	DETUNE FINE	VIBRATO WAVE	VIBRATO DELAY	VIBRATO RATE	VIBRATO DEPTH	OCTAVE +/-	OCTAVE RANGE
1+2'	OFF	OFF	+	3		10 03	∿	51	52	05	0	

DCO1		1	2	3	4	5	6	7	8
	STEP RATE	99							
	LEVEL	00							
	SUS.								

DCO2		1	2	3	4	5	6	7	8
	STEP RATE	99							
	LEVEL	00							
	SUS.								

DCW1		1	2	3	4	5	6	7	8
KEY FOL. 9	STEP RATE	63							
	LEVEL	00							
	SUS.								

DCW2		1	2	3	4	5	6	7	8
KEY FOL. 9	STEP RATE	99	99						
	LEVEL	40	00						
	SUS.	*							

DCA1		1	2	3	4	5	6	7	8
KEY FOL. 3	STEP RATE	94	55	21	60				
	LEVEL	99	99	00	00				
	SUS.			*					

DCA2		1	2	3	4	5	6	7	8
KEY FOL. 3	STEP RATE	99	56	38	46				
	LEVEL	44	28	00	00				
	SUS.			*					

RETURN to MAIN MENU

Fig 1

Roger Howorth is a freelance computer journalist and sound recording engineer who owns and experiments musically with an Atari ST. If you would like to share your musical experience with Roger or you would like to pass on any interesting snippets, why not write to him care of *PCW*, VNU House, 32-34 Broadwick Street, London W1.

NUMBERS COUNT

You don't have to be a mathematical wizard to read and understand 'Numbers Count'. All you need to know is basic arithmetic, while Mike Mudge explains the behaviour of a simple sequence of positive integers.

There is no need for mathematical background beyond that of addition, multiplication and division this month. So, come on everyone, read a little further, and then carry out some experiments for yourselves . . . and do write and tell me the results of your experiments.

$$x_0 = 1,$$

$$x_1 = \frac{1 + 1^2}{1} = 2$$

$$x_2 = \frac{1 + 1^2 + 2^2}{2} = 3$$

$$x_3 = \frac{1 + 1^2 + 2^2 + 3^2}{3} = 5$$

$$x_4 = \frac{1 + 1^2 + 2^2 + 3^2 + 5^2}{4} = 10$$

$$x_5 = \frac{1 + 1^2 + 2^2 + 3^2 + 5^2 + 10^2}{5} = 28$$

Fig 1 A possible sequence of integers

Will the sequence (shown in Fig 1) defined algebraically by the formulae: $x_0 = 1$, $x_1 = 2$, $(n + 1)x_{n+1} = x_n(x_n + n)$ for n greater than or equal to 1 always yield an integer? Notice that the values of x_n increase quite rapidly, $x_6 = 154$, $x_7 = 3520$, $x_8 = 1551880$, $x_9 = 267593772160$ . . . But what about x_{43}?

The corresponding sequence with squares replaced by cubes has been reported on by Boyd and Alf van der Poorten with a suggestion that integers are generated certainly as far as x_{89}, although complete analysis is not known to the author.

If, however, fourth or higher powers are used in the sequence it is believed that no results have been published.

Alf van der Poorten asks what is going on in the case of the squares displayed above. Readers are invited to answer this question and to extend the investigation to higher powers as suggested, or indeed in any other way that they feel appropriate.

Submissions containing attempts at this problem, together with general thoughts on empirical number theory using a personal computer, may be sent to Mike Mudge, 'Square Acre', Stourbridge Road, Penn, Staffordshire WV4 5NF, tel: (0902) 892141, to arrive by 1 March 1988.

All submissions will be judged using subjective criteria, and a prize will be awarded by *PCW* to the 'best' contribution received by the closing date.

It would be appreciated if such submissions contained a brief summary of results obtained, in a form suitable for publication in *PCW*.

Please note that submissions can only be returned if a stamped addressed envelope is provided.

Review: The Left Factorial Function (June 1987)

The first problem was the least popular: Slavic has used a computer to

END ZONE

NUMBERS COUNT

establish that !n is not exactly divisible by n for $3 \leq n \leq 1000$. Wagstaff verified that the highest common factor of !n and n! is 2 for $n \leq 50000$.

Interested readers are referred to:

- *A note of the left factorial function* by L Carlitz (Math Balkanica, volume 5 (1975) pages 37–42); and
- *On some new left factorial propositions* by Duro Kurepa (Math Balkanica, volume 4 (1974) pages 383–386: *Mathematical Reviews*, volume 58, number 10716).

The second problem, based upon a paper in *Mathematics of Computation*, volume 46, number 174, April 1986, pages 715-716 by Mok-Kong Shen produced many extensive replies. None of these solutions included the 'numbers having 6043 digits or more' mentioned in the paper!

The additional solutions 93527, 228727 and 373457 requested were readily obtained.

Shen's paper establishes that each of the congruences: $2^{n-k}i \equiv 1 \pmod{n}$ $i = 0,1,2 \ldots$ where $k_o = 2$ and $k_{i+1} = 2^{k}i - 1$ has infinitely many solutions n.

After much thought, this month's prizewinner is Frank Webster of 125 Coniston Grove, Middlesbrough, Cleveland TS5 7DF who used an Acorn Electron programmed in Basic and Assembly language.

It should be observed that several very detailed theoretical submissions were received accompanied by well-documented computation (including the first ever contribution from Spain). It was felt, however, that the submission of Frank Webster was the 'best' within the subjective criteria and the general aims of the 'Numbers Count' column.

It is hoped that non-prizewinners will continue to show an interest in the application of computing to number theory and encourage friends to share this interest!

Mike Mudge welcomes correspondence on any subject within the areas of number theory and other computational mathematics. Particularly welcome are suggestions, either general or specific, for future Numbers Count articles; all letters will be answered in due course.

Isolated readers can be put in contact with others sharing the same interests. However, greater efficiency regarding published problems should result from contacting the prizewinner.

LEISURE LINES

Brainteasers courtesy of JJ Clessa.

A Merry Christmas and a prosperous New Year to all followers of Leisure Lines. This month's quickie (don't send answers – no prize) comes from Mr D Brown of Lincoln.

Dec 87

Quickie

The following equation can be made correct by the addition of a single straight line

2150 = 10 10 10

(Please note that you are not allowed to make the equals sign into a 'not equals'.)

Prize puzzle

An easy puzzle since it's Christmas — but it might require a micro.

Which two numbers, which together contain all the digits 1-9 used once only, when multiplied together produce the highest number, which also contains the digits 1-9?

Answers on postcards or backs of envelopes only to arrive not later than 31 December 1987.

Send your entries to: Leisure Lines, December 87, PCW Editorial, VNU House, 32/34 Broadwick Street, London W1A 2HG.

Prize puzzle winner

A reasonable response — about 70 entries — for the puzzle in logical deduction. The killer was, of course, Betty Smith, as most entrants managed to fathom out.

The winning entry came from Mr O'Shaughnessy of Dublin.

Congratulations, Mr O'Shaughnessy — and to the also-rans, keep puzzling, it could be your turn next.

DIRECTORY OF USER GROUPS

MACHINES A–K

APPLE MACINTOSH
John Lewis, Macintosh User Group UK, 55 Linkside Ave, Oxford, OX2 8JE. (0865) 58027. £25. Professional.

APPLE MACINTOSH - BBS
David Nicholson-Cole, MacTel, 15 Elm Tree Avenue, West Bridgeford, Nottingham, NG2 7JU. Board (0602) 817696 or (0742) 350319; V21/22/23.

APPLE SYSTEMS
Sheila Hurst, Apple2000, PO Box 177, St Albans, Herts, AL2 2EG. (0727) 73990. Used to be called BASUG. Local groups; newsletter; BBS etc.

APRICOT
Apricot File, TP Group, PO Box 509, London, N1 1YL. 01-833 3501. Detailed technical newsletter.

ATARI
N Lewis, Atari National User Group, 13 Weavers Walk, Courthouse Green, Coventry, CV6 7LG. Newsletter; SAE.

ATARI 8-BIT USERS
Atari Correspondence Club, 160 Newland Rd, Withywood, Bristol, BS13 9DX. (0272) 647196.

ATARI LOCAL GROUPS
Association of Atari User Groups, 45 Coleburn Road, Lakenham, Norwich. (0603) 661149.

ATARI ST
Paul Glover, ST-Club, PO Box 20, Hertford. PD software.

CAMBRIDGE Z88
Roy Woodward, Z88 Owners' Club, 68 Wellington Street, Long Eaton, Nottingham, NG10 4NG. SAE.

COLECO ADAM
Keith Marner, UKAS, 33 Homer Rd, Croydon, CR0 7SB. Bi-monthly journal. SAE.

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Jack D Cohen, ICPUG, 30 Brancaster Road, Newbury Park, Ilford, IG2 7EP. 01-346 0050 home; 01-579 1229 day. £10 +£1 entry fee.

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Graham Bettany, UKEUG, 80 Dales Road, Ipswich, IP1 4JR. £15. Monthly newsletter. SAE.

ENTERPRISE
Independent Enterprise User Group, PO Box 13, Crowborough, E Sussex, TN6 1QX. (08926) 3890 Mon-Sat 7pm-10pm.

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Bruce Ainge, HICUPS, Foxberry House, 16 Foxberry Road, London. SE4 2SP. 01-691 5202.

IBM PC
IBM PC User Group, PO Box 830, London, SE1 0DB. 01-620 2244. £25 personal; £95 corporate. Professional.

JUPITER ACE
Mr J R Charter, Jupiter ACE Users Group, 8 Abney Close,