On Microcomputers vs. Thinking and Their Respective Roles in Fisheries Research in Developing Countries

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On January 1976, J.C. Koster delivered at the University of Ghana, West Africa, a lecture titled "Computers–an aid to development or part of the problem?" Most computers at that time were extremely expensive affairs, demanding incessant care by a host of well-trained technicians. The software available then was, moreover, rather inflexible. The whole setup was such that it inexorably led to questions such as Koster's.

Ten years have passed, mainframe centers have spawned microcomputers, to which people have direct access, and an enormous amount of literature on computer use and its implications for people's thinking and creativity is now available. Given the diversity of opinions expressed in that literature, one could indeed be tempted to opt for the "golden mean" and summarize the experience of these last 10 years with a phrase starting with "Yes, computers are useful, but . . . ". I have resisted this temptation and will try to show below that no "but" is needed, especially so in fisheries research and management which nowadays must be done *quantitatively* if they are to be done *properly*.

On Thinking

Where do the objections to microcomputers come from? Having taught the use of microcomputers for fishery research in a number of training courses held in several developing countries, I have heard enough of such objections to be able to classify them. It turns out that by far the dominant objection (always professed by fishery scientists from developed countries, incidentally) is that fishery scientists (in developing countries!) should first learn "to think" (or "to think critically") before they use a computer.

Statements of this kind, usually by older colleagues (no worry, no names shall be given), and which, incidentally, one would never hear in the hallways of a European or US university, have, like all great fallacies, a ring of truth to them since indeed, one can make, in a thoughtless moment, very BIG mistakes with computers.

Also, computer users indeed exist (everywhere!) who run data through programs, get some results which they may or may not publish, yet do not in either case know what has happened to their data. The profoundly fallacious character of contrasting "critical thinking" and "using computers" stems, however, from the implicit assumption that whoever is not a computer user is *ipso facto* learning to think.

Now, having seen participants of many training courses and university students plod through paper-and-pencil estimation of the parameters of a linear regression or through yield-per-recruit computations, getting bored, failing to plot the graph required of them, then getting discouraged about the whole thing, has made me well aware that working without a computer doesn't necessarily make one think.

What, on the other hand, if the participants of training courses or university students are taught to enter their data into some well-tested standard routine, say a statistical package, then to analyze them using a variety of routines? Can't the lecturer use the time saved from tedious calculations by hand to explain what is happening? I believe so. Moreover the key gain is psychological: the trainees or students, upon seeing that their data can be interpreted via some sophisticated model, will be doubly motivated to learn about these useful models, about their assumptions, limitations, etc. Thus, I believe that computers paradoxically allow us to motivate students and trainees to *learn* new models *because they can experiment with them without having fully understood how they work*. Indeed, what we have here is a situation where using computers, rather than inhibiting "thinking" actually promotes it.

The situation is the same when one deals with a second frequent objection to the use of computers in fisheries research, i.e., that "people should first look at their data before feeding them into some fancy program". The point here is that software are now available which make "looking-at-the-data" the real pleasure that it should be, by reducing hundredfold the time needed to plot, replot and plot again the same set of data, e.g., when performing exploratory data analysis.

On Creativity

How about computers vs. creativity? One could for example point out that Isaac Newton, being the creative person he was, simply invented differential calculus when his research required it, and hence that in general, good scientists do not need pre-cooked solutions (as available in the form of various computer programs) to do creative work. This point (which I have really heard on numerous

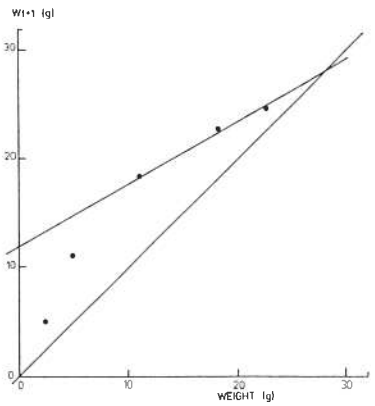

Fig. 1. An example of thoughtlessness in fishery science. The author wrote "The fit is poor as shown by the Walford plot. This could in part be due to incomplete recruitment giving an upward bias to apparent mean weight at age in the youngest age group. This could equally well be because growth in [our fish] does not follow this model." Actually, what is wrong is that the Walford plot is for *length* at age t + 1 against *length* at age t, or $\sqrt[3]{W_{t+1}}$ on $\sqrt[3]{W_t}$, but not W_{t+1} on W_t. The questions now are: (1) was this mistake done with or without a computer; (2) was this mistake done by someone working in a prestigious laboratory of the First or an unknown one in the Third World; (3) was this published in an unrefereed bit of grey literature or in a rather prestigious series?

occasions, although not with reference to Newton) is also profoundly fallacious, because the question is not asked how much farther he would have gotten, had differential calculus been invented say 100 years before he started his career.

"Thinking" may be roughly split into:

- applying established rules to known items such as to get a result whose basic structure is previously known (e.g., performing a multiplication), and
- combining in creative fashion items that had never been connected before, leading to unexpected results (i.e., having a "new idea", or making a scientific discovery).

The first of these two points is a very important, though extraordinarily time-consuming part of the work of fishery biologists, and indeed attempts have been made quite early to reduce the tediousness of that part of their work, e.g., by the dissemination of computer-based (!) "yield tables".

Computers can be used to reduce the boring part of a fishery biologist's work, giving her or him more time to concentrate on the creative aspect of thinking. Equally important moreover is the fact that, because of their inherent stupidity, computers and the now available software *force* their users when entering their data into a file to think more about them than when transferring them from one handwritten sheet to another. Thus, for example, setting up a computer database for length-frequency measurements requires, when using the newest version of the ELEFAN program, before even entering a single frequency value:

- stating to which *species* the data refer (I've seen lots of handwritten length-frequency data sheets which did *not* give any species name!)
- entering *where* and *when* the data have been collected (again, lots of data sheets may be found in various labs which omit this information)
- stating the *unit of measurement* (e.g., cm) used to express length (ever seen a data sheet or a publication which doesn't state this? I have)
- stating the class interval (e.g., 1/2 cm) into which the data are grouped (at which point many users realize that they wasted their time measuring 1 m fish to the nearest milimeter, etc.).

Now this I believe promotes thinking—in a small way perhaps, but more than is required by the filling of forms which will not beep—as the above-mentioned program will—if one of the entry fields is not completed. And if the reader feels that this is not "thinking", then at least we could agree that it is a small step toward getting organized. That the latter, finally, is good start toward better thinking, or even creative thinking is attested by no less than the physicist Wolfgang Pauli whose critique of an unorganized paper by some colleagues of his was that it was "not even wrong". ●

The ICLARM Software Project

ICLARM has initiated, in early 1987, a new activity, the "ICLARM Software Project", involving the dissemination of software for calculators and microcomputers, along with their supporting documentation (e.g., manuals or scientific paper).

The material now available for distribution presently consists of software produced at ICLARM (see below), but will in the near future include *public domain programs*, as well as software made available by their authors to ICLARM for free worldwide distribution. This software will include the areas of fish population dynamics, fisheries and aquaculture economics, fish genetics and other fields covering ICLARM's areas of interest.

All software will be made available at cost, i.e., including only material, mailing and handling costs. Copyrighted material will not be distributed. The availability of new programs will be made public through notices in Naga, brochures and the ICLARM publication catalogue. Software and supporting documentation presently available for distribution are listed below. Authors and potential contributors to this scheme are invited to write to the Director, Resource Assessment and Management Program, ICLARM, MC P.O. Box 1501, Makati, Metro Manila, Philippines. Note that check payments to ICLARM must be made to a US-based bank.

Item	Description	Medium	Documentation	Cost (US$)
Software for HP 67/97 calculators[a]				
1	Fitting of von Bertalanffy growth curve, including seasonal growth	2 HP 67/97 magnetic cards	Pauly and Gaschütz (1979)	3
2	Complete fish stock assessment package (growth, mortality, recruitment, production models, etc.)	30 HP 67/97 magnetic cards	Pauly (1984)	10
3	Bhatacharya's method of size frequency analysis, including chi-square test	2 HP 67/97 magnetic cards	Pauly and Caddy (1985)	3
Software for HP 41C/HP 41CV calculators				
4	Complete fish stock assessment package	142 magnetic or 1 microdrive tape	Vakily et al. (1986)[b]	15[c]
Software for Apple II (CP/M) computers and compatibles				
5	Fitting of von Bertalanffy growth curve, including seasonal growth and	5 1/4 diskette (1)	Gaschütz et al. (1980)	15
6	separation of mixture of normal distribution (NORMSEP)	5 1/4 diskette (1)	Pauly et al. (1986)	15
7	ELEFAN package	5 1/4 diskette (1)	Brey and Pauly (1986)	15
8	HIRES graphics for ELEFAN package	5 1/4 diskette (1)	Lieu (1986)	15
Software for IBM PC and compatibles				
9	ELEFAN package	5 1/4 diskette (1)	Brey and Pauly (1986)	15
10	Miscellaneous routines for stock assessment including fitting of von Bertalanffy growth curve, Fabens' method, etc.	5 1/4 diskette (1)	Gaschütz et al. (1980) and references to original literature	15

[a] Note that HP 67/97 magnetic cards can be read by HP 41C calculators.
[b] Not supplied with software, must be purchased from a United Nations outlet.
[c] Magnetic cards not supplied; costs shown here are for recording programs onto cards supplied by user, and for mailing these.