MICROCOMPUTERS, USAGE AND DESIGN

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MICROCOMPUTERS, USAGE AND DESIGN

eleventh EUROMICRO symposium on microprocessing
and microprogramming

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edited by

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INTRODUCTION TO THE PROGRAM

The annual EUROMICRO symposium is one of the leading conferences concerned with microprocessor systems and microprogramming. It attracts contributions as well as participants from nearly all European countries, the United States, China and Japan.

The theme of the conference this year in Brussels, the eleventh in the annual series of successful EUROMICRO symposia, is

microcomputers, usage and design.

Newly developed microcomputers (supermicros) are characterized by an increasing degree of complexity accompanied by fast growing performance capacity. Therefore the differences between microcomputers, minis and mainframes are in a process of vanishing.

A consequence of this new line of (VLSI)-processors are extended applications of microprocessors and new fields of usage. Some examples in this context, which just arised, are the

- applications of microprocessors in complex systems (embedded systems),
- workstations,
- interprocess communication in UNIX,
- fault tolerant systems,
- role of microcomputers in networking,
- software engineering for microprocessors,
- voice and data integration,
- dataflow applications,
- advanced applications of microcomputers etc.

The capabilities of modern VLSI-technology allows to design architectures specially tailored to support a defined range of applications. In consequence new application-oriented processors have been designed with architectures dedicated to the supported areas.

On the EUROMICRO 85 symposium, these topics are took in consideration by the sessions

- high-level language computer architecture,
- vertical migration,
- computing structures,
- VLSI oriented architectures and algorithms,
- multiprocessor system.

The main problem in designing VLSI chips is the control of the high complexity of such circuits.

The expense for the design increases approximately exponential with the number of transistors, assuming the classic methods of design. Therefore new methods, tools and languages have been developed to reduce time and manpower in designing chips. The same aspects have to be considered with respect to testing VLSI chips.

In these proceedings you will find these problems discussed in the sessions

- high level system simulation,
- software and hardware development tools,
- hardware description languages,
- test of VLSI systems.

Several topics of this broad program are surely theme of special national or international congresses. In contrast to this, the EUROMICRO 85 symposium in Brussels tries to present the state of the art in these fields and to show the relations and interference between usage and design with respect to microprocessors.

Planning this conference, the board of directors of EUROMICRO made an important decision. Instead of the full length paper only a three paged abstract was required for the reviewing process and the program committee decision.

Both, the very actual topic of the conference and maybe this new rule attracted about 120 technical papers. The majority of them are of high quality, much more than we could accept. The program committee accepted 67 papers. To take advantage of this large number of high quality papers three parallel sessions have been set up this year.

The program committee wishes to thank all of those who submitted papers, the referees and session coordinators for reviewing the papers very carefully and the authors of the accepted papers for their cooperation in contributing to the conference and in particular these proceedings.

EUROMICRO 85 is particular proud of three keynote presentations, which highlight the main theme of this years conference from different reasons, views and influences.

A good tradition of EUROMICRO symposium is the short note presentation, a session of very up-to date contributions. The late deadline allowed for submission of these brief presentations makes it impossible to publish them in the proceedings. Like at the last years symposium it is planned to publish the accepted short notes in a special issue of the journal "Microprocessing and Microprogramming". Bjørn Myrhaug was responsible for the short note program.

Three different tutorials, closely related to the main theme of the conference, open the symposium at the first day.

Before concluding, I would like to express my appreciation to Bjørn Myrhaug, the deputy program chairmen, to thank all program committee members, all referees and the EUROMICRO administrative manager, Mrs. Chiquita Snippe-Marlisa, for their assistance and support in "making" the program for EUROMICRO 85.

Have a good conference

Klaus Waldschmidt
Program Chairman

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SESSION K1: **KEYNOTE SESSION**

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OPENING ADDRESS

The fully automated factory and society

Oscar Steenhaut
Rector of the Free University of Brussels
Brussels, Belgium

Microcomputers, usage and design
K. Waldschmidt and B. Myhrhaug (eds.)
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THE FULLY AUTOMATED FACTORY AND SOCIETY

Oscar Steenhaut
Rector of the Free University of Brussels
Brussels, Belgium

Let me first extend to you a most warm welcome at our University.
Let me say that we feel honoured that you have chosen our University for your conference. We hope that you will have a pleasant stay, interesting exchanges of views and many fruitful discussions.
Since I am in charge of the destinies of this University, for exactly 3 years now, I am less actively engaged in the development of the science which is the topic of this conference. So I am grateful to be given the opportunity to address myself to this eminent assembly and talk about a matter, which in my duty as head of an educational establishment is of the formost importance: the trends in today's advanced technology, the impact upon our industrial structure and the relation of this technology to society.
First of all, the electronic engineering and computer science community is basically an optimistic community. Since the start of electronics, let say in the early twenties and the start of computer science in the late forties, progress has been almost continuous. When apparently a deadlock was blocking further progress a timely invention appeared making new progress possible. Whatever one may think, however timely, none of these inventions was neither logically nor physically necessary. When at the end of the forties, the limits of what could be achieved with vacuum tubes was reached, the transistor was invented. Notice that this invention is due to the remarkable fact that at room temperature two materials Germanium and Silicium cristalize as semiconductors.
If room temperature should be around 200° C neither of them would be useful as semiconductor elements and diamonds would still not be usable. It might be considered as an accident of nature that the range of the temperatures suitable for life is the same range where Ge and Si microcrystals behave as semiconductors suitable for transistors.
Electronic engineering and magnetic engineering, have been the main supports on which computers could develop. When generations of computers are distinghuised, it is by the electronic and magnetic technology used, much more than by the inherent advances in computer concepts. However one could classify the generations by purely computer concepts. As for instance, computers with stored program, computer with indexed adresses, high level language computers, computers with micro-programmed control, computers with virtual and cache memory, computers with multi-user operating system, computers with stack architectures, computers with I/O coprocessors, vector computers, highly parallel computers, data flow computers. Computer generations however are not classified by the imbedded computer concepts but by the technology by which they are built.
A comparision between computers, basically processing machines, supported by electronic technology, and cars, basically transportation machines supported by mechanical and electrical engineering might be useful. Existing wheels and the invention of the combustion motor made the car possible. The following developments brought the car to full development: air tyre, clutch, hydraulic brake, synchronized shift gear, the lead battery, startmotor, electric generator, electric lights. I probably leave out a few other contributions. However by the mid-thirties the car had reached its maturity, and has changed only marginally since. It is the introduction of the micro-processor which will allow for much finer control that will bring forth the next big jump in car technology, 50 years after reaching maturity; and from a technology not related to mechanical and electrical engineering.
In spite of its apparent perfection compared to the horse as a transportation machine, a car can still not jump, not swim, nor climb stairs and is more and more tied to excellent roads.
So it is not clear to me if the main progress in computers the last 10 years has not been so much in computer concepts or in the advent of the micro-processor, which relied up till now upon the very conventional Von Neumann structures. The micro-processor has opened total new fields for computer applications first in industry, where it made robotisation possible and lately in the so-called personal computer which has really popularized the use of computers..
The conventional microprocessor has also allowed the development of the digital telephone exchanges, which made it possible to exploit fully the communication capacity offered by optical fibers and satelites.
The new concepts like data flow-machines, vectorized calculations reduction machines, highly parallel machines have, maybe, dominated the thinking of the computer

specialist, their impact has been far less.
Progress in electronic technology fringes on increasing the number of elements on a single chip. This is determined by two quantities, at the one hand the chipsize, which has been regularly increasing and the minimum feature size which has been regulary decreasing. As increasing chipsize also increases the cost, let us concentrate upon the minimum feature size. From 10 micron in 1970, allowing 4 kb, 5 micron in 1975, 3 micron in 1980 and 1,2 micron in 1985, together with an increase in chip size from 2 mm^2 to 10 mm^2, has this allowed chips to grow from 4 kb to 256 kb as a standard product. This has been achieved by improving optics, improving foto-resists, improving etching techniques (wet etching - dry etching). By use of deep U.V. or E-beam lithography, without drastic change 0.6 micron may be reached. X-ray lithography may, with enormous difficulties still improve on that, so chips of a few Mb may be reached in the early nineties.
Without radical new inventions, that will be the mature active memory chip not much different from the chip we know today.
And I know, especially in Japan, one talks about the 3D chip. I often wonder, if it will be really neccessary to really make a break in the existing technology. The 5Mb chip, conventionally (between brackets) produced, will probably cover 99 % of our needs.
Popularisation of mass storage on optical disks, already a fully developed technology for the consumer market, may in the long run be much more important.
Use of associative memories, a long dormant concept, might reduce requirement for core memories drastically.
However I don't see yet how they are going to be produced.
Even with the 1.2 micron technology, already available, the 32 bit microprocessor with powerful built - in I/O structure and quite number of redundant elements is already well in reach. This calls however for the end of classical DIP package which, with 64 pins, has really reached its maximum usefullness. Several techniques are for the moment competing, most of these techniques however do not allow insertion mounting so that retooling of the actual production plants based on wave or flow soldering is necessary. Packages using either chip carriers or pin-grid arrays, having a few hundred pins will come up. Further progress will probably be more delayed by the apparently simple handling problems of these new packages than by anything else.
So by the early nineties the PC may reach maturity. It should be based on a 32 bit processor with powerful I/O and communication capabilities, a few Mb core memory and a Winchester storing around 50 Mb.

All conventional computers are the Von Neumann type of Time Serial Processing System.
However, with the technical advance of hardware with the ultra LSI, the required function level for the computer has apparently greatly increased. Especially, as we are told, there is now a need for information processing equipment with an artificial intelligence capability in addition to the conventional computer with just numerical computing capability.
Conventional Von Neumann type computers which were originally intended for numerical computation, have now progressed far beyond the level of elementary Data Base processing. However, they are not suited for artificial intelligence applications. Therefore, moving toward the 1990's, computer engineers promised to develop 5th generation computers through substantial changes in the design concept.
Notice that the 5th generation is the first generation of computers defined by the imbedded computerconcepts.
Following are typical examples of functions which were going to be performed by the 5th generation computers :

1. Function to Solve Problems and Make Logical Analysis.
   When given a research problem to solve, the system should be able to discover a way to solve the problem based on the known facts (knowledge).
2. Function to Study, Recognize and Understand.
   Recognition is an intellectual process for gaining knowledge through study and understanding.
3. Function to Analyze and Understand Natural Languages.
4. Intelligent Interactive Function and Knowledge Base.
   The fifth generation computers will develop its own programs from its own reasoning power and knowledge basis, given a few elementary commands.
   Accordingly, the three fundamental functions of 5th generation computers may be :
   1. a "knowledge and learning base" that is capable of systematically storing data and patterns instead of a data base that systematically stores data;
   2. a "reasoning function" that extracts necessary knowledge concerning a given problem and solves the problem by reasoning with the extracted knowledge.
   3. it should, like humans, be ambiguity tolerant (intelligent interface function)

I often wonder if the 5th generation was not dreamed up by a science fiction writer anthropomorfizing a computer rather than by a panel of engineers.
In spite of its early promises, progress in artificial intelligence is painstakingly slow. The successes in expert systems, should not hide the fact, that the real reasoning power behind these expert systems is still extremely limited. Our machines understanding of natural languages under the form of connected speach is as far away as ever, as well as our understanding of the methods by which humans store visual patterns. We have not the slightest idea how human reasoning and learning works, and ambiguity tolerance seems to be in contradiction with the logical way of working of computers.
So the 5th generation computer may come, but it will not be for the nineties.
However the publicity around the 5th generation has had one big advantage, it pushed the European Community into the Esprit program. This wisely concerns itself much more with applications of the conventional microprocessor than with the advanced concepts behind the 5th generation computer.
Applications, especially in the field of production (robots-CADCAM systems), office automation, advanced telecommunication systems have taken the upper hand. And it must be said, limitations are felt much more in developing in time very conventional software, than in the lack of new concepts.
Besides the advances in production equipment and computer aided design, the much less publicized office revolution is taking place. Office workstations, incorporating informations processing functions, connected in networks to file servers and sofisticated printing and copying equipment have started their silent invasion, blurring the distinction between office equipment, computers, communication terminals, graphic equipment.
All this automation will however not replace the personal secretary which can lie about your presence at the office, smile at you in the morning and bring your 10 o'clock tea.

So in order to get insight into future impact of the technological development on society, we have to look first at the possible trends of our society

- evolution of the value system
- evolution of the required skills
- evolution of the "general culture"

In the tradition of a positive scientist we will make use of models, which represent only a skeleton of reality, it will have the advantage however of making the main points clear. Society can be seen as an organised group with as aim the exploitation of environment in order to produce the means of livelihood and to produce material value objects. It hereby uses a given technology.
In order to exploit optimally environment with a given technology a well adapted form of social organisation is needed.
That existence of organisation implies that the individual members accept given rules of behaviour, fullfill a variety of composed tasks and accept a hierarchical structure.

Accepting rules of behaviour and commands of the hierarchy sets of course bounds to the individual freedom. These bounds are rationalized by the higher total output obtained by the organised form of using the available technology.

Except in the most primitive societies, the hierarchical structure is no voluntary cooperative where members can retire at will.
Maintaining the structure requires coercion. The implementation of the necessary coercion is done by setting up a political system, lead by a ruling group making use of a repressive apparatus.
This ruling group is to be distinguished from the managing group forming the top of the hierarchy in the productive organisation.

The hierarchical production structure and the political system grow usually value judgements about the tasks to fullfill and about the role of individuals in society. These value judgments give rise to an unequal distribution of the total of the material output among the members of society. The so called "upper layers" (managerial, political) become privileged.

The repressive apparatus will not only be used in its rational function to maintain the organisation which maximizes the output, but it will also be used to defend the privileges of the upper layers and this independently of the required productive organisation.

Naked repression by force is usually avoided by creating a coherent value system in which the justification of the form of society, religion, rules of behaviour, group loyalties and purposes of living all find their proper and interlocking place and which every member of society is supposed to accept.
This value system forms also the ethical base for the privileges of the upper layers of society.
A social group comes into being with as main task the clear formulation of the value system, the propagation of the value system and the transmission of the value system, so that it permeates all layers of society. Let's call it for the time being the educators. This group, in fact not needed for the production, creates for herself a complex of rules of behaviour, value judgments (among others canons of beauty) and value objects. This complex forms the so called "general culture".
This general culture needs for this expression material objects.
These are the works of art. These works of art are also the more permanent carriers by which the value system of society is propagated and transmitted. The kind of material carriers used for the propagation of the message is again closely linked to the available technology.
As long as computers cannot produce works of arts, they will not belong to the culture, then will remain machines.

A case to illustrate the point. A gothic cathedral is a sturdy building without doubt, it also is a magnificent work of art, moreover it expresses very clearly the value system of the time.

No society is completely static, due to the growth of knowledge in the natural sciences technology develops and so the hierarchical structure to use it has to adapt and with it the value system. So in any value system, we find an historical component, no longer justified by the required productive organisation. So, when the form of social organisation is determined by the available technology, the political sustem with its repressive structure contains usually a historical component.

One may say that historically the main task of the educators in a world with changing technology is to rationalize the new hierarchical structure and to formulate the new value system.

When C.P. Snow talks about the two cultures : the humanities and the sciences he passes over the really relevant difference. Humanities have to do with the value system of a society and science today fundamentaly with the development of the technology.
Usually, technology develops rather slowly, and evolution of the value system can adapt without to much social strain.
When, however, sizable jumps in the technological development occur, the setting up of the new required optimum structure and value sustem, becomes necessary in a very short time.
The salient characteristic of periods of fast technological change is the great social mobility. The society members with the necessary skills needed for the setting up of the new structure become part of the upper layers.
I believe the recent developments of computer science and electronics are not a gradual development but rather in the nature of a big technological jump. While our production organisation is adapting quite rapidly. Our political organisation and value system is still completely geared to the pre-computer age and is for the moment in a state of confusion, it is losing its grip on the social reality.
Let us first have a look at our western world.
The western world is characterized by uniform technology, uniform organisation and uniform material culture. Material culture is here defined in the anthropological sense. It is the set of material goods to which a spatially localized human community has access at a given time. It is beyond dispute that the material culture of the western core world is rather uniform. Every non-marginal family has basic food and clothing assured.
This family lives in a brick house with access to public utilities like electricity, water, gas, sewerage, telephone. A car, radio, T.V., HIFI, camera, etc., are normal possessions. Houses are fitted out with heating equipment, bathing equipment and a lare range of other household appliance. The material infrastructure is also rather uniform. Roads, highways, railways, channels, bridges, dams, powerlines, airports cover the western geography with almost equal density.
The fundamental fact, and we are not always fully conscious of it, is that very few elements constituting this material culture were present 200 years ago.
They are the result of the so called industrial revolution, set in motion 200 years ago, at the end of the 18th century, the western world was agrarian with a value

system completely different from our own. I will not dwell upon it, only state that the main problem for the average family was obtaining the daily food and clothing. Individual freedom was almost non-exixtant. Loyalty was to the king and church, not to the national state. Division of Labour and systematic use of science are the foundations of the industrial revolution. It is this industrial revolution which is responsable for the enormous spread of the "industrial material culture" troughout the western world.

A remark is at order here. In the scientific industrial process of the production, the production line worker is conceptually reduced to a machine (robot) which can be trained (programmed) to execute a well defined set of coordinated movements on the basis of observations.
The programming (training) is exclusively determined by the requirements of a small task at hand, and starting from some basis knowledge the only thing the worker has to sell first, is his time to be trained and second his time to fullfil the task.

This production model has given rise to a very perculiar value system. Besides the always present values as respect for authority and tradition we may state as follows the basic premisses in condensated form.

1. There will be a continuous increase in the variety of elements constituting our material culture justification of the social organisation);
2. Material progress is a consequence of the progress of natural sciences (religious belief);
3. The indivudual citizen is only socially usefull, only produces values by contributing to the production or exchange of industrially produced goods (rule of behaviour);
4. The appropriate form of political development is the national state with democatric parlementary regime (group loyalty);
5. Obtaining the maximum quantity of industrially produced goods is the driving force for activity of man in society - consumerism (purpose of living).

So, the value system is completely determinated by the <u>industrial</u> production of goods, The political system and the social control mechanism are completely subordinated to industrial production.

Remark that this value system permeates the mental set up not only of the conservative parties but of the socialist parties as well. Employment is a case in point, whenever either one of these parties speak about employment, they mean, without saying as much, employment in the industrial sector.
The principal disagreement between conservatives and socialists is about the ownership of the means of production and the distribution mechanisms of the industrially produced goods. For the conservatives should ideally the market dominate, for the socialists the so called socialized demand. Now in every western nation, a compromis has been reached with different accents, but they are superficial in view of the underlying value system.
The differences are more historically determined than logical.
Robotisation of production will not only drive productions-line workers out of their jobs, also specialized drafts men, typists, cashiers, etc... Most jobs which do not require creative thinking will before long be taken over by flexible automata.

These factories together with automated money transfer, partial automated distribution of end products will result in a society where design, production and distribution of industrial end products will require a very reduced work force.

The introduction of distributed intelligence (due to the massive introduction of uP and in the very limited sense as used by Von Neumann) in the factory will not be limited to a few sofisticated machines. A modern factory will be a computercontrolled unit where computer aided design (CAD), computer aided production planning (CAPP) and computer aided manufacturing (CAM) will be integrated such that the tranformation from raw materials to half products, and from half products to packed finished products will happen with minimal human intervention. The fully automated factory is of course a dream.
The factory with fleible production processes and highly differentiated output and low employment is rather a nucleus of developing the neccessary software with well known methods than a nucleus of new principes.

Are there grounds to challenge the value premises of an industrial society?

1. It may be that we are reaching the stabilizing horizon of our material culture. Incease of new functional elements with emotional appeal may be rather limited. The idea of functional content and emotional appeal is to be stressed here because material progress will not stop at once. Cars will become safer and less polluting. This does not change it as a means of personal transportation and giving geographical extension. T.V. screens will become flat, this does not change the relationship between the viewer and the picture, even the addition of a number of additional channels will not basically change this relationship. Household appliances will all be fitted by P and become uselessly sophisticated. Of course a few new elements will be added, videofons, based on fibertechnology, 3D holographic fotography, homecomputers etc., will be part of the future material culture. Overall however, the rate of change of functional content of our daily material culture is slowing down enormously. The role of the homecomputer in this economic context is far from clear.
So the impact of the new technologies will be much more felt in the sfere of productionmethods, factory management, distribution and payments of goods then in the development of products with new emotional appeal.

2. Application of science will increase productivity and the quality of the products, no functionally new products will result. Also, the infrastructure is becoming more and more stabilized. As a result of the application of science,the industrial employment will go on declining.

3. The social organisation required by industrial production is creating new values which are however not yet recognised as such.

<u>Examples</u> :
Industrial production, requiring a well schooled working force as been the driving force for the enormous expansion of the educational sector. More and more, a good all round education is seen by all layers of society as a value in itself, independent of the usefullness for production.

The industrial production process, by drawing women in the factory, has been responsible for the creation of the day-nursery for children. This is the real reason why women have been freed from the all-time household slavery, and is the backbone of the so called emancipation. I don't think, wathever happens in industry women will want to go back solely to their kitchens.
Keeping the workers in good health was first a concern for the managers of the factories; in the fragmented factory, the illness of one, impairs the production, but public health care has lowly been extended to all layers of the population and in my opinion there is no way of going back, whatever Freedman may think of it, taking care of the total health of the citizen will remain a strong public concern.
Holidays were required to restore the mental balance of the workers facing all year round a boring but at the same time very complex task. But now, whatever task, having holidays is considered as an absolute right.
In short, by its side-effects, industrial production has created a series of activities, which are in the industrial value system parasitic, but are becoming more and more fundamental for the ordinary citizen.
We are also becomming aware that the safety of our houses depends more on the policeman on foot in the street than on the most sofisticated equipment installed in our houses. The public call for more safety is a call for more conventional policeman.

4. Telematics and tele-classing allows us to coordinate geographically widely separated production and design centra. Production can really become international. Clearly, the national state is no longer the adapted political framework to organize the social structure allowing optimization of the available technology. National states will be more and more reduced to their purely repressive roles. So the democratic parlementary system will become endangered, while it is the concept of national state that should disappear.

   In that respect we should also be carefull about the electronic cottage and telecommuting, it may that we will produce software at home. However, our home will be limtied to a two-way network allowing for much tighter control of the indivudual at home.

5. The value of an object is determined either by its rarity, by its "cultural" value or by the amount of work required to produce it. All industrial end products will require less and less work, they will moreover be produced in enormous quantities, none of the above criteria will apply to them, so they will loose social "value". Most of the industrial end-products will be reduced to their functional content.

Notice that the new values, education, health, culture, holidays, are all produced in the so-called welfare sector. A sector where no material goods - or very few - appear in the outpunt and especially the goods cannot be exchanged.
The welfare sector is essentially characterized by personal relations and emotional connections. Division of labour does almost not exist. Na exchange values are produced. In spite of the existing demand the possibility of high profit rate is very limited. In the industrial value system no substantial growth of this sector is possible. The decrease of employment in the industrial sector will create some illusions. The industrial labour unions, imbedded in the industrial ideology, will have as only requirement reduction of labour time by equal pay. The view of the unions, meeting the view of the dominant industrial elite is to put it bluntly : if you are not employed in industry you cannot do anything very usefull.
A reduction of labour time in the welfare sector results simply in a reduction of the quality and quantity of the services produced in this sector.
So the main problem which has to be solved is not the problem of reduction of labour time, but the organisation of transfers from the industrial sector to the welfare sector. It is the only sector in which employment can still substantially increase, and where, from the humanist vieuwpoint real intrinsic values are produced (culture, health).

If our material culture stabilizes, and as far as functional content is concerned, this seems to be the case, the industrial goods, produced with little collective effort will be felt as being part of the landscape. Possesion of them will no longer give social status. Acquiring them will no longer be a life goal for the younger generation, they will right away demand them.
A time of social trouble lies probably ahead. In the framework of the dominant value system no permanent solution for the unemployment problem is to be found. Reduction of labour time in a given country reduces the profit rate and squeezes capital out to more promising shores. Attracting capital may increase production but will further reduce the work force required.
The gap between the possible and the actual reality might grow. More repression will result, the unemployed will bė declared lazy and put to socially useless underpaid work, youth will be declared spoiled and curtailed in their educational aspirations, women will be driven back to their electronic kitchens.
As often happened in history, the victims will be the scapegoats.
If the immediate future may be less brilliant, the contribution of the micro-processor will in the longer run contribute to the creation of a society with more individual freedom, more choice and more affectional relations.
I hope your discussions may contribute to it and it is this required skill that really will popularize the home computer, much more then its possible use as an intelligent terminal.

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