

# Development Informatics

## Working Paper Series

The Development Informatics working paper series discusses the broad issues surrounding information, information systems, and information technology in the process of socio-economic development

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### **Romania's Hardware and Software Industry: *Building IT Policy and Capabilities in a Transitional Economy***

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# Romania's Hardware and Software Industry: *Building IT Policy and Capabilities in a Transitional Economy*

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## **Abstract**

This paper reviews the past, present and future of Romania's information technology (IT) industries. It describes Romania's IT industry under Communism and the changes in both IT policies and the IT industry following the December 1989 revolution. Though flawed in many ways, Romania's Communist-era isolationism did lead to some build-up of IT-related technological capabilities.

Post-1989 liberalisation has encouraged a suppression of higher-level capabilities but a substantial increase in lower-level IT skills. Hardware capabilities have been lost far more than those in software. In part, this is due to various 'natural protections' that shield the domestic software market from foreign packages. In part, it is due to continued state support for Romania's software industry.

Future development of this industry is likely to focus more on services than packages, and more on the domestic than the export market. However, future development will depend on continuing government intervention: not the state ownership and regulation of the Communist era, but promotional interventions that support what will be a vital keystone of all national economies in the 21st century.

# **1. Background**

Romania is situated in South-East Europe. It is similar in area to the United Kingdom and has a population of roughly 22 million. The largest centre of population is Bucharest, the capital.

Following the Second World War, the Communist Party took power and, under Nicolae Ceausescu's authoritarian regime, Romania formed part of the 'Eastern bloc' of Soviet satellite states. The Romanian regime was at times portrayed as taking a somewhat independent line on certain issues. Nevertheless, it adhered largely to the model of state socialism found in the other Comecon countries, based around central planning and a high degree of state intervention.

The dramatic events of December 1989 overthrew Ceausescu's regime and ushered in a new era for government. In common with other transitional states (those in transition from a centrally-planned to a market-oriented economy), the Romanian government introduced a series of policy liberalisations that affected areas such as:

- *Trade*: a reduction in import barriers, some reorientation away from import-substitution and towards exports, and devaluation/convertibility of the leu (Romania's national currency).
- *State controls*: a decline in central planning, fewer regulatory controls on industrial production, fewer promotional investments by the state in industry, and a reduction in price controls and subsidies.
- *Foreign investment*: increasing encouragement for foreign investment, and a reduction in regulatory barriers to such investment.
- *Ownership*: reorientation away from public ownership and investment toward private ownership and investment, including the privatisation of state-owned enterprises.

The process of liberalisation has been gradual rather than revolutionary. In part this can be put down to the great degree of change required in setting up a market economy, and to budgetary constraints. In part, too, slow progress with reform was laid at the door of a lack of political commitment and of administrative incompetence within government up to 1996. As in a number of other countries, liberalisation was also beset by a series of political and financial scandals.

Since 1997, a new coalition government led by President Emil Constantinescu has been in power. This has voiced a stronger commitment to the process of liberalisation

than the previous government, though the process of structural adjustment remains one of constant challenge and constraint. It has, for example, been able to make rather more progress in liberalising foreign investment than in the process of privatisation.

New regulations have been issued that allow:

- Romania-based companies with either complete or partial foreign ownership to own property and have all other attached rights over land;
- foreign investors to purchase state bonds; and
- capital gains and initial investment monies to be repatriated.

Privatisation nonetheless remains a central focus of current government resolve and of external agency (e.g. International Monetary Fund) encouragement. The new government has taken direct control of the State Ownership Fund, which still owns and administers most of the country's major industries, and has initiated a programme across all industries to break them up into smaller units ready for privatisation.

Since 1989, Romania has experienced a typical transitional pattern of economic indicators:

- *GNP per capita*: has fallen slightly to around US\$1,500.
- *Foreign debt*: has ballooned from zero in 1989 to more than US\$7.5bn by 1997.
- *Trade deficit*: has been consistently around the US\$2bn mark, though both exports and imports shrank by about 5% per year during the 1990s.
- *Foreign investment*: has grown, though not as much as anticipated, with total investment from 1989-96 totalling US\$1.6bn.
- *Private sector*: has increased its contribution to GDP from around 17% in 1990 to more than 35% in 1995 with estimates nearing 50% for 1998, with small and medium enterprises being particularly active. Conversely, though, the state sector remains massively important and transition has not progressed as far as in a number of other former Eastern bloc nations.
- *Inflation*: rocketed upwards from 2% to reach 300% in 1993, fell to less than 30% in 1996, rose to more than 100% per month early in 1997, and then fell sharply again.
- *Unemployment*: has grown, with 1 million registered unemployed in a working population of around 6 million, and with a significantly higher number in the ranks of the hidden unemployed and under-employed.

This paper focuses on one particular part of the Romanian economy – the IT industry. This can be seen as covering a wide variety of products, but here the focus will be on just two: hardware and – to a greater extent – software. The discussion of hardware

will look mainly at production of computers, and discussion of software will look mainly at provision of software services. The information technology sector was chosen because IT is diffusing rapidly and globally into all industrial and service sectors. It is now seen as one of the most crucial technologies affecting economic growth, and some form of local IT production capacity is seen as vital for economic development – even economic survival – in the 21st century.

Data presented in this paper was gathered from a research project undertaken during 1996 and 1997, including fieldwork in Romania with interviews of Iliescu government officials and with IT industry managers and staff.

## **2. The Romanian IT Industry Under Communism**

The trade regime under Ceausescu was one of protectionism verging on isolationism. No information technology was readily imported from Western economies, except through clandestine routes. Even IT imports from other Warsaw pact countries were relatively limited. Opportunities for IT staff to travel or even to access foreign IT publications were limited.

Isolation from the West arose partly because it was externally imposed by Cocom (the Coordinating Committee for Multilateral Export Controls), which blocked the export of many IT items to Communist regimes. However, this is by no means a complete explanation since export of computer systems with limited power was permitted.

Romania's isolationism also arose from:

- a self-imposed desire to prove and develop national independent capacity,
- the national obsession with having no trade deficit, and from
- governmental suspicion about Western IT applications, with fears that computer science and related IT disciplines were, as one interviewee put it, "capitalist sciences likely to bring unemployment."

Autarky and development are not mutually exclusive, even in relatively high-tech areas. Indeed, strategies of autarky and, particularly, less extreme strategies of protectionism have worked well for some countries. Open economies can become awash with imported products representing foreign capabilities. Where these foreign capabilities can be kept at bay behind trade barriers, local capabilities can instead be developed based around local production and local products.

Nevertheless, such strategies have been a mixed blessing. On the one hand they may allow local capabilities to be developed. On the other, they may allow local production to remain uncompetitive, prices to remain high (and consumption concomitantly low), and technology to remain out-of-date.

The secret of successful protectionism has been to ensure that it is an actively-managed protectionism with clear goals and a competent bureaucracy. This strategy aims to reap the positive benefits of protectionism, but damp down the negative outcomes as they emerge.

In India, for example, national IT capabilities were built up by firstly providing tight protection from imported technology (Heeks 1995). By 'reinventing the wheel' – i.e. by building up capabilities through copying foreign products – behind high protective walls, an infant industry was nurtured. Then, a series of trade and other liberalisations (perhaps more fortuitous than judicious) provided infusions of competition and technology upgrading. As a result, prices fell, technology lags shrank to zero, and at least some parts of the local industry became highly innovative.

In Romania's case, protectionism was not actively-managed. Instead, the Communist regime maintained a fairly steady isolationism until its demise. The result can, at best, be regarded as very much the mixed blessing described above.

## **2a. The Development of Capabilities Under Communism**

On the positive side, Romania built up reasonable levels of technological capability in the production of both hardware and software following the building of its first computer in 1957 (Filip 1996). Lall (1987) identifies 'technological capability' as a crucial determinant of industrialisation, yet one which is ignored by many quantitative-oriented researchers. Although this variable does not lend itself to outright measurement, some kind of scale can be drawn up for the technological capability of producers, as shown in Table 1. In Table 2, this general scale has been modified for one of the IT areas – software – to provide a clearer idea of what is involved (levels 3 and 4 are reversed because of the ease of copying software).

Following Lall (1987), one may define technological capability as the general ability to undertake the broad range of tasks outlined in the table, and technological development as growth in the capability as defined by movement up the categories and regardless of whether or not the final stage is attained.

These capabilities are actually embodied in the skills and experience of individual workers, often seen as the most critical resource for information technology industries (O'Connor 1985, Kumar 1988). In this case, technological development will be the accumulation of increasingly skilled workers.

**Table 1: Scale of General Technological Capability**

***Level 1: Non-production operational capabilities***

- 1a: Using the technology
- 1b: Choosing the technology
- 1c: Training others to use the technology

***Level 2: Non-production technical capabilities***

- 2a: Installing and troubleshooting the technology

***Level 3: Adaptation without production***

- 3a: Modifying the finished product to meet local consumer needs

***Level 4: Basic production***

- 4a: Copying technology
- 4b: Assembling technology
- 4c: Full production using existing products and processes

***Level 5: Minor production modification***

- 5a: Modifying the product during production to meet consumer needs
- 5b: Modifying the production process to meet consumer needs

***Level 6: Production redesign***

- 6a: Redesigning the product and production process to meet local consumer needs
- 6b: Redesigning the product and production process to meet regional/global consumer needs

***Level 7: Innovative production***

- 7a: Developing a new product to meet local consumer needs
- 7b: Developing a new product to meet regional/global consumer needs
- 7c: Developing a new production process
- 7d: Transferring a production process to other producers

Source: adapted from Narasimhan (1984), Lall (1987), and Schmitz & Hewitt (1991).

**Table 2: Scale of Software Technological Capability**

***Level 1: Non-production operational capabilities***

- 1a: Using a system of menus
- 1b: Using a conventional package (e.g. word processor)
- 1c: Choosing a software package
- 1d: Training others to use software

***Level 2: Non-production technical capabilities***

- 2a: Filling a package with situation-specific data (e.g. spreadsheet)
- 2b: Filling a package with situation-specific data (e.g. database)
- 2c: Installing and troubleshooting software

***Level 3: Basic production***

- 3a: Making copies of an existing software product

***Level 4: Adaptation without production***

- 4a: Creating a situation-specific application from a package (e.g. creating menus and queries with simple programming; using macros; developing Web pages)

***Level 5: Simple software production***

- 5a: Creating a new set of interfaces for users
- 5b: Creating a program to move data between applications
- 5c: Creating a small utility program
- 5d: Modifying an existing program to meet user needs

***Level 6: Software redesign***

- 6a: Redesigning a program to meet local user needs
- 6b: Redesigning a program to meet regional/global user needs
- 6c: Minor process change: modifying the software production process

***Level 7: Skilled software production***

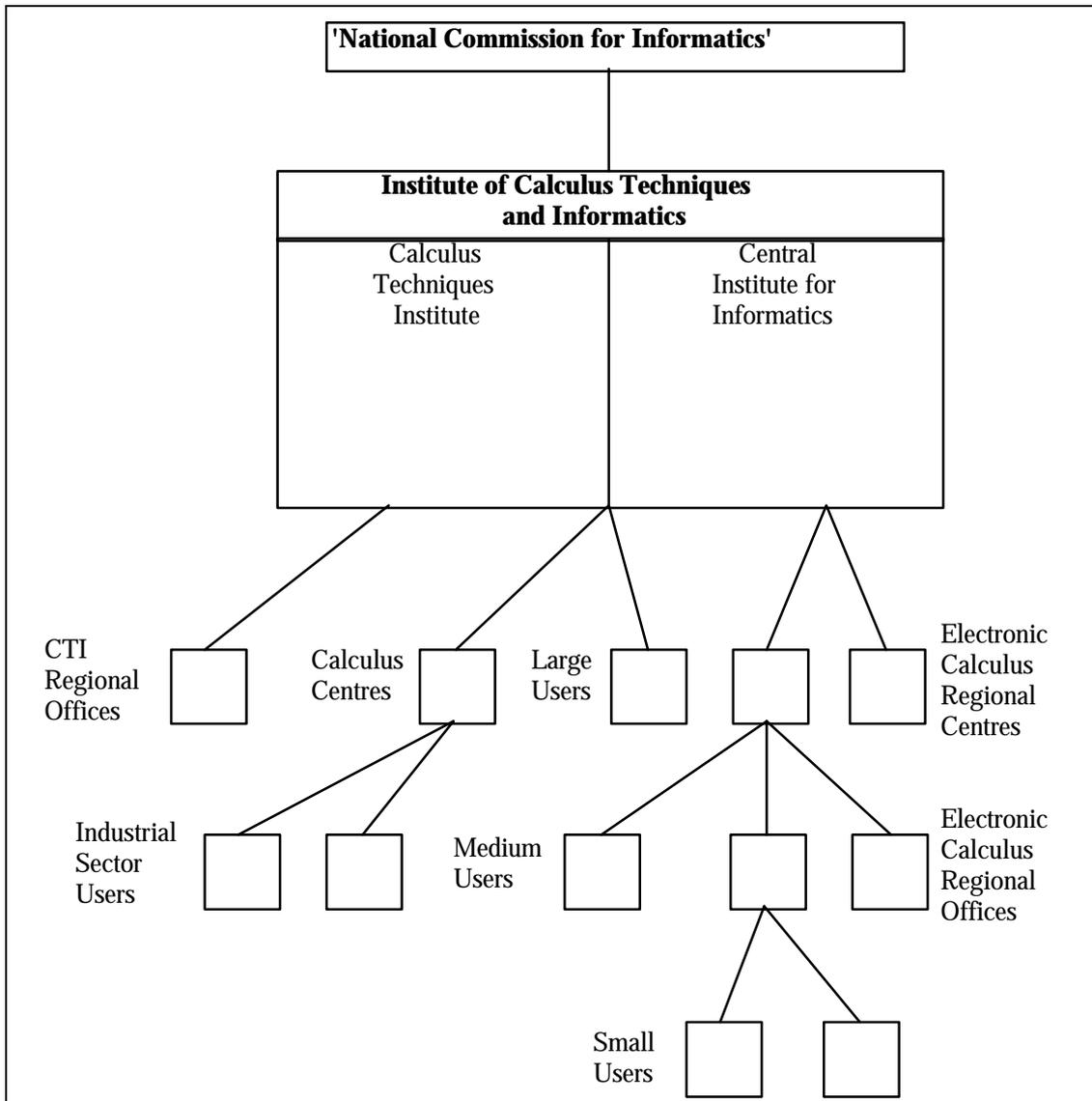
- 7a: Local product innovation: developing a new program to meet local user needs
- 7b: International product innovation: developing a new program to meet regional/global user needs
- 7c: Major process change: redesigning the software production process
- 7d: Process innovation: designing a completely new software production process

During the Communist era, most of the state's IT institutions could be rated at around levels 4 to 6a on the scales above. This represents a significant achievement when compared, say, with the situation in many developing countries. For example, Romania had one main computer production facility, the imaginatively-named Computer Manufacturing Company (FCE Bucharest), that produced mini/microcomputers for the local market (Filip 1996). There were also a number of producers, including ROMCD (Romanian Control Data), making computer peripherals (disk drives and printers) for domestic consumption. ROMCD also had a 'steady, but modest, hard currency export market' (Goodman 1991).

The work of these organisations included both product and process modification for the Romanian market. They were capable of producing industrial process monitoring and control equipment, which used microelectronic components and operating software put together in a customised way for particular applications.

Thanks to national IT programmes in 1967 and 1972, there was also state funding for a major series of research and development (R&D) institutions administered by the forerunner of the National Commission for Informatics (NCI) (see Figure 1). These undertook R&D work on both hardware and software, and they created a large number of skilled employees. Although they were involved in theoretical work, these institutions also undertook a lot of 'applied research', which encompassed the development and implementation of thousands of computer applications in many different Romanian organisations.

**Figure 1: Romanian IT Institutions (Pre-1989)**



In most economies, there is a divide between state-funded R&D institutions, and private sector software development and implementation firms. Only the latter tend to be thought of as 'the software industry'. In Romania, no such divide existed and the former therefore constituted its software industry.

The largest and most important research institution – located in Bucharest under the government's watchful eye – was the Institute of Calculus Techniques and Informatics (ICTI), which employed around 3,000 IT specialists. It was divided into two parts:

- The Calculus Techniques Institute (CTI), founded in 1968, which focused on hardware components, boards, and microprocessor operating systems. It had a set of CTI Regional Offices representing it throughout the country.

- The Central Institute for Informatics (CII), founded in 1970, which focused on software production. In the main, this was produced for major national projects, such as the running of the Cernavoda nuclear power plant. There was also a very limited amount of 'export' work writing software for state institutions in other Warsaw pact countries or in friendly nations such as China and India.

The CII also had responsibility for coordinating the work of 40 Electronic Calculus Regional Centres (ECRCs) which were spread throughout Romania. They had three main roles:

- To design, construct, implement and maintain information systems (IS) for factories and other state-owned organisations (e.g. town halls) which lacked sufficient resources to develop their own systems. These organisations collaborated with the ECRCs partly because central directives instructed them to do so, and partly because all the information systems work and equipment was paid for from central funds funnelled through the ECRCs.
- To provide advice and assistance for larger state-owned organisations, which could afford to purchase their own hardware, but which needed help in setting up a data processing department and/or help in writing the software to drive their applications. In many cases, the ECRC would write and maintain the software, leaving the 'client' with only a few data processing clerical staff.
- To provide a variety of training courses for computer operators, analysts and programmers.

The ECRCs also had a fourth responsibility: that of coordinating the work of the Electronic Calculus Regional Offices (ECROs). Several of these came under each ECRC, each based in a small town within the particular ECRC's remit region. The ECROs were essentially computer bureaux running ECRC-written software on ECRC-owned hardware. The clients of these regional offices were the local factories and other state organisations that lacked the resources to install and run their own computers. They provided input data to the ECRO which would then produce required output reports.

There were two further locations of IT expertise in Romania under Communism. The first were the computer departments of the very largest state enterprises, which could afford to set up an autonomous operation without the need to refer to their local ECRC. The second were 'Calculus Centres', which specialised in servicing the needs of particular industrial sectors (e.g. the mining industry).

Where software was developed, then in almost all cases applications were custom-built, representing the greatest use of technological capabilities (see Box 1).

### **Box 1: Software Development Approaches and Technological Capability**

There are four main approaches to software development, each of which involves a different set of technological capabilities:

- *Custom-built*: creating an entirely new piece of software from scratch; typically involves capabilities up to level 6.
- *Re-engineering*: modifying an existing custom-built piece of software; typically involves capabilities up to level 5.
- *Customisation*: modifying an existing software package to suit a particular user's needs; can involve capabilities up to level 5, though sometimes only at level 2 or 4.
- *Software package*: buying a ready-made program 'off-the-shelf'; typically involves capabilities up to level 2.

The software developed covered all types, from programming tools to operating systems to horizontal applications (such as word processing) to vertical applications that addressed a particular industrial sector or particular organisational function. The degree of local innovation within such software varied, since at least some of it was based on 'reverse functional engineering' (Heeks 1996). This is the process by which Romanian software developers – unable to access the program source code of packages pirated from the West – relied on discovering what the software did (i.e. what its functions were) and then imitating these by writing their own programs.

## **2b. The Downsides of Communist Policies**

Having presented the positive achievements of Romania's Communist-era isolationism, we now turn to the negative aspects. As stated, there were many thousands of computer applications in Romania developed by the research institutions. However, the quality of these was poor and they were "all characterised by a low degree of integration and effectiveness" (Filip 1996:151). Romania's R&D base in IT also remained limited (though more limited in hardware than in software), with an estimated value of installed computers equivalent to less than US\$5 per head at the end of 1989.

The applications produced were heavily skewed towards certain sectors. In particular, IT was focused on military applications and on internal security, with applications such as tracking movements of 'suspects' (of whom there were many under the paranoid eye of the Securitate) and tapping, recording and analysing telephone conversations.

By contrast, other applications of IT were provided with much more limited funding, leading to delays in systems development of anywhere from three to twenty years (Filip 1996). The state research institutes were significant users of IT, as were some of the large state-owned enterprises. Within these, the focus was on relatively low-tech 'number-crunching' applications such as statistics, payroll and accounting systems. There were no major public applications and awareness of IT was consequently low in Romanian society.

There was no policy of large-scale IT diffusion but, more, there was an active policy to constrain diffusion. Government suspicion of IT was noted above. This constrained IT diffusion partly as a result of concerns about unemployment, and partly because IT was seen as a tool of potential power and control which should remain largely in the hands of the elite or their trusted subordinates, not in the hands of the populus at large.

Consumption of IT was therefore very limited, very undemanding, and very much related to politico-institutional linkages rather than any kind of market mechanism. An uncompetitive domestic market isolated behind high trade walls had the expected effect of producing IT of poor quality at high cost and very slowly. As so often, there were isolated pockets of genuine state-funded innovation and professionalism, but these arose more by accident than design.

Despite its isolationism, Romanian IT was largely based on Western technology. However, there was a major technological lag between Romanian-produced hardware and that available in Western nations. The mainstays of Romanian production during the 1980s were minicomputers:

- the Felix C, licensed from the French Iris-50, which was compatible with, and based on, the Honeywell Bull C11;
- the Independent which was compatible with, and based on, the DEC PDP/11;
- the Coral which was likewise an unlicensed relative of the DEC VAX 11/730.

ROMCD was – against all the odds – a joint venture with the US IT firm, Control Data Corporation, making products under licence, with its main product of the '80s being a 58MB disk drive licensed in 1977 (Goodman 1991).

In all cases, the technology was at least ten years out of date. Whilst the West was in the throes of the PC explosion, Romanian computer operators were still running batch jobs using punch cards, with waiting times of several days at some installations because of the backlog of runs.

Eventually, towards the last part of the 1980s, a combination of reverse engineering, access to components from South-East Asia, and some local innovation produced the first Romanian microcomputers: the Felix M18 and M118 series that ran CP/M, which were then succeeded by the Felix PC that initially ran a localised MS-DOS variant in 128K of memory.

To be fair, this represented some degree of 'catch-up', being only just over five years behind Western technology. However, Romania did not really succeed in its goal of independence. It did not attain the higher levels of technological capability in hardware production, and it remained a dependent follower of Western IT trends more than an independent innovator. Interest in local microcomputers was also limited at a time when foreign PCs were starting to leak into the country.

The lag in software was smaller but still present, with the programming mainstays being Cobol, Assembler, Fortran, and Pascal. Again, isolation had bred belated imitation, not independence.

In summary, Romania's IT industry under Communism built up a base of capabilities but one which was limited and which was, as Goodman (1991) notes, oppressed on all sides by:

- Ceausescu's isolationist policies,
- weak indigenous R&D and poor management of R&D funds,
- centralised government control of all major industries,
- a lack of domestic supporting industries,
- undemanding internal markets, and
- Cocom export controls.

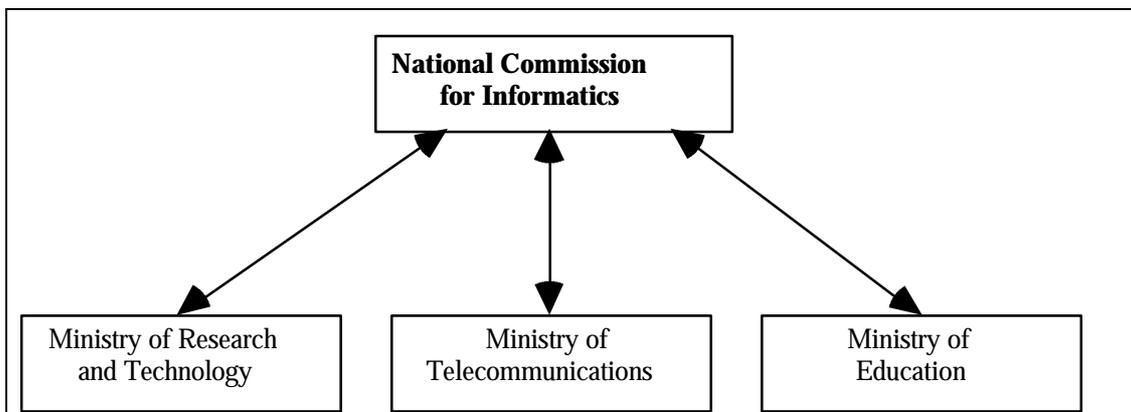
### **3. Romanian IT Policy in Transition**

#### **3a. IT Policy Institutions**

The National Commission for Informatics was created in 1990 as the apex government body dealing with IT in Romania. It is responsible for developing strategic national IT policies and plans, and for ensuring that they are implemented.

NCI shares responsibility with a number of other government institutions for particular aspects of informatics policy, as summarised in Figure 2. With the Ministry of Research and Technology (MRT), it initiates and co-ordinates national R&D programmes in the field of informatics. NCI collaborates with the Ministry of Telecommunications on issues of public computer network creation and connection to international networks. NCI and the Ministry of Education plan the programmes for educational institutions in the domain of informatics.

**Figure 2: Romanian IT Policy Institutions (Current)**



#### **3b. Policy Changes**

Romanian IT policy changes since 1989 can be described overall as 'measured liberalisation' with the maintenance – albeit at declining levels – of existing promotional interventions for the local IT industry and a slower recognition of the need for new promotional measures.

Changes to general policies that have affected the IT arena include:

- *Trade*: a removal of import blocks and a reduction in import tariffs that has enabled foreign hardware and – to a lesser extent – software to become the norm for Romanian users. This clearly represents a major change since 1989, when IT was often an out-of-date copy of foreign IT but was, nonetheless, locally produced. Export of IT has been encouraged only to a limited extent.
- *State controls*: a slow reduction in state regulation and investments, requiring previously state-owned IT institutions to become more autonomous.
- *Foreign investment*: the granting of permission for, and encouragement of, subsidiaries of foreign IT multinationals. This, too, represents a major change from pre-revolution days.
- *Ownership*: the gradual divestment of public ownership. As generally, progress on this has been modest in the IT sphere.

One IT-specific measure was the introduction in June 1996 of a new Copyright Law, which particularly covered the issue of software piracy. Piracy levels have historically been high throughout the Eastern bloc. The roots of this lie in the Communist era. First, pirating of Western software was encouraged at the time: it helped develop the national IT base, it saved money and, for the ideologically-minded, it could be seen as a blow against capitalism. Second, there was no concept of personal intellectual property (Agamirzian 1991). Software did not belong to the programmer who made it, or even his/her organisation: it belonged to the state and, hence, to everyone. Such attitudes have been hard to change.

As has been the case in many transitional and developing economies, the new law was introduced as much for external as internal consumption. In other words, one principal intended effect was that Romania should be seen to be doing something about piracy in the eyes of foreign IT multinationals, foreign governments and multilateral organisations. There has been the commonly-observed subsequent pattern of implementation challenges. Piracy levels in Romania remain high – as in the rest of the former Eastern bloc – but the law has encouraged some decline. The legitimate software market is therefore both sufficiently large and growing fast enough to attract the attentions of software multinationals and to support a local software industry.

On the international front, Cocom rules were steadily relaxed until they and the organisation have ceased to create any effective impediment to Romania's IT trade. Cocom was disbanded in 1994 and Romania was itself a founder member of its successor – the Wassenaar Arrangement – which was launched in July 1996.

## **Research and Development**

Direct funding for the state IT industry has fallen considerably and steadily since 1989. For example, by the mid-1990s the total budget for R&D on electronics, higher education, telecommunications, and IT and computing applications, was less than US\$20m. Of this, less than US\$1m was allocated specifically for informatics R&D (National Commission for Statistics 1995:319).

However, this figure is deceptively small since Ministries and public sector enterprises spend much more than this on the 'applied research' that is, effectively, a set of public sector contracts for information systems development. Put together with European Union (EU) funds for the development of applications in government, these sums mean that the state remains by far the most important locus of money for the local IT industry. State spending on IT procurement and R&D plus state-oriented EU funding ensure the continuing employment of several thousand IT staff and, hence, the continuing preservation of Romanian IT capabilities.

However, the returns on Romanian R&D investments still remain too limited. Applied research investments tend to lead to a single working application. Other R&D work has sometimes been even less successful, leading to a prototype software program from which there are no returns except the employment of its developers.

Because the majority of these programs failed to be commercialised or even used, the government set up the Agency for Technology Transfer in 1996. The Agency is supported by PHARE funds: a European Union aid scheme supporting reform in Central and Eastern Europe. This will provide half of the money necessary to commercialise software programs from a working prototype to a marketable product.

## **Human Resource Development**

The single most important input to the IT production process is skilled labour. So too, IT consumption levels cannot rise without a skilled workforce. Limitations on IT skills and IT training therefore represent a key constraint to Romania's vision of a more IT-intensive future.

By the mid-1990s, for example, only just over 5% of all secondary school children were studying computer topics: 40,000 from a total of just over 720,000 children (Ministry of Education 1994). This was because:

- there is a lack of IT resources in schools,
- computer studies is not a compulsory subject, and
- computing is treated as an isolated topic, with use of IT not integrated into other parts of the curriculum.

Higher education institutions are somewhat better resourced and focused on IT.

There are three main types:

- *Polytechnic Institutes*: these provide hardware-related skills and cover areas such as electronics, computer science and automation.
- *University Institutes of Economic Science*: these provide software-related skills for applied work and cover areas such as cybernetics or informatics.
- *University Institutes of Mathematics*: these provide software-related skills for an academic or research career and cover areas such as mathematics or informatics.

Despite the usual need to expand IT resources and update curricula, these three institutions provide a major part of the basic skills for those who take up work in Romania's IT industry. To take one example, virtually all members of the Research Institute for Informatics (RII) – Romania's largest software producer – were trained at one of the three types of institute.

Nevertheless, there is a limit on the numbers able to undertake such qualifications and, with the current constraints on IT resources in education, private training firms have been allowed to mushroom (see below). As is common in situations of high demand and little regulation of training, courses offered by some training firms suffer one or more of the following problems:

- *inappropriate general content*: teaching computing theory rather than practical skills;
- *inappropriate skills content*: teaching skills that are outdated, not in sufficient demand, or too complex to ever be used in the workplace;
- *inappropriate technique*: teaching by 'chalk and talk' or rote learning rather than through practice;
- *inadequate resources*: having far less than one PC per student when trying to teach hands-on skills.

The result is a poor return on much of the training investment being made. These training companies may help in the spread of IT *use* skills, but only a few are making any real contribution to the development of IT *production* capabilities in Romania.

The main focus of human resource development has been initial IT education. Action on continuing professional development has been more limited. The growth of training in foreign language skills and greater freedom of travel have made it easier for Romanian IT workers to keep up-to-date with global technical developments. So too, has the increasing provision of Internet links, allowing IT staff to connect to global special interest groups and electronic lists on relevant technical subjects.

Magazines such as PC World, Computer World, Telecommunications, Network World, PC Record, and Computer Aided Design are available in edited versions written in Romanian, and these are widely read. The Romanian edition of PC World, for example, has a circulation of around 15,000.

IT exhibitions have also been encouraged. They now cover all the major towns and are typically supported by one or more of the IT multinationals. Whilst their main function has been to raise IT awareness in the general population, they have also helped stimulate IT consumption in the country, and have even provided a means for some IT professionals to update their skills and knowledge. RII has been a prime mover in the organisation of some exhibitions and also of more focused IT workshops, targeted at IT professionals and at general managers.

All IT workers pick up a significant proportion of their technological capability 'on the job'. However, formal training courses also have a role to play and there has been a fairly predictable hierarchy in the provision of such courses:

- Private sector firms linked with foreign partners, such as multinational subsidiaries, have typically been most likely to send their IT staff for training.
- Government institutions are next in line, though far less likely to provide training overseas.
- Large enterprises will provide limited training to IT staff; perhaps one or two days per year. Some firms prefer to hire a new person with the right skills than to train an existing employee.
- Small and medium enterprises tend to provide no formal training, and expect either to hire staff with requisite skills or for staff to train themselves.

'Hire rather than train' strategies are possible these days thanks to the combination of greater access to training and/or training materials, and of labour market deregulation which has created much greater labour mobility and fewer obligations of employer to employee. Where once employees stayed with the same enterprise for life, staff now move jobs more regularly, and part-time and temporary employment are both used.

The downside of formal training being both limited and often of poor quality is reflected in the 'seat of the pants'/'trial and error' methods used in both the development and use of computerised information systems. Perceptions of the poor quality of local software development have contributed to the rapidly expanding popularity of imported packages. It is this, in part, that has led to a European Union-funded project to improve the quality of software development methods in Romania.

### **Telecommunications**

After 1989, telecommunications remained a state monopoly, with prices set by the Ministries of Telecommunications and Finance, and with Romtelecom providing the main telecommunications services. The major towns have had digital transmission and switching technologies introduced, but most other links remain unreliable. There is pent-up demand for millions of new telephone lines and connections, which is only slowly being met. Huge investments are still required to meet both the quantitative and qualitative telecommunications demands of a modern economy.

The first public computer networks were introduced to Romania in 1991, with international network connections brought in during 1993. There are currently two main public international networks, both of which have needed external funding in order to sustain them:

- The National Computer Network for Research and Development, which is aimed at Romania's research and development community and serves around 200 institutions. The central connection node is at the RII in Bucharest, from which there are connections on to other R&D institutions within Romania and to international nodes in Vienna and Budapest. The purchase of telecommunications equipment and applications, the operation of the RII node servers, the maintenance of the communication software, and the European communication tariffs are paid through government and European Union funds. The network helps keep R&D institution staff in touch with research collaborators overseas, and provides access to global information resources.

- The Higher Education Data Network, used by college and higher education students. The central connection node is at Bucharest's polytechnics, from which there are connections to other higher education institutions within Romania and to international nodes in Stockholm and Amsterdam. The connection costs have been paid by European governments, the Romanian Ministry of Education and Soros funds. The network has no direct impact on the IT industry, but does provide international information access and awareness for future IT professionals.

Since 1993, there has been an explosion of independent commercial operators working in partnership with foreign firms to provide a range of telecommunications equipment and services outside the core services reserved for public sector monopoly. These include:

- design, installation and maintenance of local area networks;
- electronic mail services and systems;
- satellite communications;
- ISDN (integrated services digital network: a high performance digital system) connection;
- cellular systems; and
- Internet service provision.

A number of these initiatives have allowed enterprises with sufficient funds to leapfrog current telecommunications constraints and, in 1996, there were an estimated 10,000 Romanians with Internet access (El Jisr 1996). We estimate that this figure has risen to 50,000 in 1998.

In general, though, the state of telecommunications in Romania is holding back both IT consumption and IT production. Computer networking applications, which have become the norm in Western nations, lag behind in Romania. IT producers seeking local and foreign partners are similarly constrained by telecommunications problems. The current set-up mixing a basic monopoly with 'value added' liberalism has been the outcome of various forces: political inertia, bureaucratic self-interest, and external and internal pressure to liberalise.

The likely route forward under the current government is greater liberalisation, greater access to telecommunications, higher prices, and pressures to provide a second-class service for those who are economically and politically on the periphery. The main change in 1998 is the intended partial privatisation of Romtelecom; that process being financed by a US\$200m loan from the European Bank for Reconstruction and

Development. The company will initially have the state as its sole shareholder. Then 30% of it will come to market, with an expectation that this will raise up to US\$4bn.

### **3c. Policy Developments**

Two forward-looking policy documents of relevance to IT have been released in recent years, each of which is discussed below.

#### **National Strategy for the Information Society**

This is a strategy document first released by the NCI and its collaborating institutions in 1992 (National Commission for Informatics 1992) that sets a target of transforming Romania into an 'information society' shortly after the year 2004. This envisages that Romania will, by then, be transformed into a society that is fully integrated into the democratic, economic and cultural environment of European market economies. Decision-making would be decentralised to local collectives and to individual citizens by IT. Romania would be part of the global communication network and the global market place thanks to extensive use of broadband networks.

It is recognised that the information society initiative needs to be supported by specific legislation; by IT standards; by investment in more IT R&D; and by development of Romania's commercial, industrial, telecommunications and educational infrastructure. The fact that the Romanian state is strapped for cash is recognised, and so a number of cost-minimising measures are proposed:

- Development and promotion of information standards across both public and private sectors to avoid duplication of effort and to maximise information sharing.
- Development and promotion of national IT technical and software development standards in order to ensure system compatibility, labour mobility, and scale economies in training and purchase.
- Prioritisation of state spending on information systems that have greatest economic impact on export earnings, production output or efficiency gains.
- Partnership initiatives between public and private sectors to tap into private sector capital.
- Strategic partnerships and co-operation with specialised EU institutions to transfer information technologies effectively into Romania.

Ideas such as these can fall down in three ways:

- The inertia of the legislative system means that turning the component parts into law could take a number of years.
- The inertia of implementation may lead to underachievement, particularly the inertia caused by inadequate funding, which cost-minimisation measures cannot completely bypass.
- The problem that NCI is regarded as the lead institution for the initiative. Other key Ministries may take only limited ownership and NCI lacks sufficient political clout to force through either policies or implementation actions.

In practice, the strategy has been able to overcome or avoid some of these barriers, with sufficient consensus having been achieved despite the change of government to turn the strategy document into an Informatisation Law. The law was passed in December 1997 and officially published early in 1998. Implementation barriers may remain but, nevertheless, this strategy is both bold and pragmatic, and is very much the type of policy initiative that must be followed if Romania is to develop both IT consumption and production.

### **Horizon 2000**

Horizon 2000 ('Orizont 2000') is Romania's National Programme of Scientific Research and Technological Development for the years 1996-2000 (Romanian Official Monitor 1996). In it, government plans for IT to the end of the century are outlined. The Ministry of Research and Technology is the lead ministry for the project, reporting to the Interministry Council for Science and Technology.

The Horizon 2000 programme covers an ambitious range of areas, seeking investments and development for Romanian IT in technical domains that include multimedia, modelling and simulation techniques, artificial intelligence, computer networks, distributed systems, executive information systems, real time systems, graphical interfaces, interactive systems, security systems, and software development quality standards. The programme is intended to support a myriad of different economic sectors including telecommunications, transport, medicine, agriculture, banking, commerce, law, industry (both product and process innovation), environment, public utilities, energy industries, construction, public libraries, museums, higher education, workforce training, and other public services.

As well as being bold in its ambition and objectives, the Horizon 2000 programme also seeks to implement a wide range of actions including:

- Creation of laboratories integrated with other EU laboratories and programmes. These would be equipped with the latest equipment and supported by a legislative and managerial infrastructure.
- A set of innovative R&D projects (in the areas described above) identified and evaluated as being appropriate to national goals and supported by active mechanisms of technology transfer.
- Development of necessary infrastructure and services for technology transfer. This to include legislative reform, dissemination of technical and scientific information, a revived patent system, accessible R&D records for various sectors of activity, creation of scientific/technological parks and of innovation and business centres.
- Provision of up-to-date scientific and technical documentation.
- International co-operation initiatives to achieve integration with European and global research programmes through collaboration in research application and development projects, and participation at international conferences, congresses, symposia, exhibitions, etc.
- Training of specialist personnel to European standards, thereby making Romania internationally competitive in R&D. This is intended to be achieved through management training; guidance, selection, and evaluation of R&D personnel; international exchanges of staff with specialist experience; translation of specialist publications; and further education and co-operation with foreign research and development institutions with similar interest areas.

Horizon 2000's strength has lain in the boldness and optimism of its vision, and in its recognition of the immense impact that national R&D programmes can have on the future development of the local IT industry, through both innovation and the development of local technological capabilities:

"...total economic return on investment in R&D is several times as high as that for other forms of investment. ... Because the benefits of technological progress are broadly shared, innovators lack the financial incentive to improve technologies as much as is socially desirable. Therefore, the government can improve the performance of the economy by adopting policies that facilitate and increase investments in research." (Cohen & Noll 1994:59)

Two main types of policy can be effective, both of which have been adopted in Romania. First, protection of intellectual property rights in order to increase returns on private R&D investments. Second, direct R&D investment. Programmes of R&D investment in IT have been seen to produce results in the US, in many European countries, and in Japan.

However, there has been a major gap between intentions and actions as far as Horizon 2000 is concerned. Its intention was to capture political attention and, thereby, capture funding. In practice, the required funds have not (yet) been made available. Fortunately for its creators, Horizon 2000 was kept short on detail, leaving it open to various interpretations and prioritisations, and so allowing it to move with political tides whilst still claiming some degree of success.

## **4. The Romanian IT Industry in Transition**

### **4a. Overview**

After the 1989 revolution, the leading IT R&D institution – the Institute of Calculus Techniques and Informatics – was split into three institutions:

- The Calculus Techniques Institute (CTI), which has been partially privatised, but which remains substantially state-funded. CTI has found it hard to maintain its hardware R&D work and is consequently struggling to extend its role into software development.
- The Research Institute for Informatics (RII), which remains state-owned under the National Commission for Informatics, but which is financially autonomous and must win all its income through contract bids.
- The Informatics Perfection Centre (IPC), which is partly state-funded and which is mainly involved in running training courses in (foreign) computer applications such as Microsoft Office.

The ECROs were closed down whilst the ECRCs and Calculus Centres became independent commercial societies (Societies for Informatics Services: SIS). They are financially autonomous, are actively seeking foreign investors for future privatisation purposes, and receive no subsidy from the state, but they are still seen as a responsibility of the National Commission for Informatics. The NCI provides them, for example, with journals, magazines and other material to help keep them up-to-date with the latest IT developments. Hardware-producing enterprises similarly became financially autonomous, but with close links to government for those that survive.

Partly as a result of outflow of staff from the state organisations, there has been a rapid growth in the number of small software and hardware firms in Romania.

A number of user organisations – especially within government – are still running their existing applications on locally-produced hardware. However, where resources have been available and/or where client demand has forced it, information systems have been updated.

AHDC (the Autonomous Headquarters of Deva Copper, a former Calculus Centre for the mining industry), for example, invested US\$400,000 in Romanian hardware shortly before the revolution but felt pressurised to replace this equipment with imported PCs soon afterwards. Fortunately, it was able to sell the Romanian computers.

Unfortunately, it was only able to sell them as scrap, for US\$2 per kilogram. The existing software applications were no longer usable, and had to be re-written from scratch.

As in AHDC, many applications have had to be completely re-written when new hardware has been imported. In other cases, though, existing programming code has been reused and the application migrated from the Romanian to the imported platform. In both situations, this has provided much-needed work for the former software R&D institutions.

However, the most common option – when old hardware is exchanged for new, or when an organisation computerises for the first time with imported IT – is for the software used to be an imported package. There has been a major shift, therefore, from custom-built applications to customisation of foreign packages. This is likely to have involved some loss of technological capabilities.

#### **4b. Statistics**

The pattern of company size and ownership throughout the IT industry is one of a few, large state-owned organisations and very many, small private-owned companies which typically employ only one or two people. The state-owned firms are mainly those that were formerly regarded as R&D institutions, which have now been pushed into financial autonomy.

For example, the pattern of enterprise in the Romanian software industry in 1996 is shown in Table 3.

**Table 3: Registered Romanian Software Companies (1996)**

<b>Type of Ownership</b>	<b>No. of Companies</b>	<b>No. of Employees</b>
State	26	1,350
Mixed	2	6
Private	333	478

Source: National Commission for Statistics (1996b)

Turnover for these firms has been relatively modest. The largest state producer, RII, had a turnover of US\$2.8m in 1995. The former Calculus Centre, AHDC, turned over US\$80,000 in the same year and represents a typical mid-sized enterprise. The smallest firms turned over as little as US\$1000-2000. By contrast, for example, Timisoara's beer factory (one of forty large breweries in the country) had a US\$26m turnover: probably more than the entire Romanian software industry.

As with turnover, so with employment, as can be seen from Table 4.

**Table 4: Registered Employment and Unemployment in Romania (1996)**

<b>Category</b>	<b>No. of People</b>
Population	22,650,000
Total Employed Population	6,160,000
Registered Unemployed	998,400
Employment in IT and IT-related Occupations	14,391
Employment in Registered Software Companies	1,834

Source: National Commission for Statistics (1996a:8-10)

Registered employment in IT therefore makes up just over 0.2% of total Romanian employment, of which work in software firms constitutes roughly 13%. The actual number of software developers in Romania will be much greater than this because the 1,834 figure takes no account of:

- software developers working in general IT firms,
- software developers working in the IT departments of state and private enterprises,
- software developers working in other organisations (government, universities, etc.),
- unregistered software developers.

Estimates from other countries (Heeks 1996) would lead us to estimate that the actual number of software developers in Romania for 1996 was somewhere in the region of 6,000; and nearer 10,000 in 1998.

Reported wage levels in the Romanian IT industry are a little above the national average (see Table 5).

**Table 5: Average Monthly Earnings in Romania (1996)**

<b>Category</b>	<b>Average Monthly Earnings</b>
Overall Average	US\$85
Finance, Banking & Insurance	US\$155
IT Industry	US\$96
Education	US\$78

Source: National Commission for Statistics (1996a:8-10)

Field research suggested that real earnings may be somewhat higher, at least in software, since even the former ECRCs and Calculus Centres reported wage ranges from US\$80 to US\$200, and an average monthly wage ranging from just over US\$100 to nearer US\$150. Wages in the IT departments of major enterprises were higher still, averaging at least US\$240. Wages in foreign-owned IT firms were yet higher, with reported averages of well over US\$300 per month. The differential between IT and overall average wage levels therefore seems higher in practice than that portrayed in Table 5.

Comparisons with IT wage levels in the West are hard. Basic salary figures often ignore additional payments (e.g. for pensions) and subsidies for housing, transport, etc. However, one can say that salary costs for Romanian IT staff are around one-tenth of Western costs. This makes Romania, at least potentially, an attractive site for offshore software development.

The majority of the IT workforce is between 23 and 38 years old. Most have a higher education computer qualification, and most have an expertise in at least one foreign language (typically French, German, English or Russian). This all helps to make it easy for Romanians to communicate whilst working on export contracts, to receive technical training overseas (or from foreigners coming to Romania), and to keep up with IT developments via the international media.

## **4c. The IT Industry in Transition**

### **Former R&D Institutions**

As noted above, these institutions now have budgetary autonomy and must earn all their income in order to survive; a few have been partially privatised. They have changed to focus on more modern, global information technologies. They also focus more on niche rather than general applications development.

However, in some ways their work remains quite similar to the pre-1989 pattern. For example, they are still involved with a mix of research, development, consultancy and systems integration, with the emphasis on practical and applied development work for paying user organisations. They also continue to depend heavily – either directly or indirectly – on the Romanian state.

To some extent, state funding has enabled these organisations to retain and maintain their existing technological capabilities. However, pay is low and so is morale. There has been a dramatic exodus of staff; in some cases of the most capable. Staff losses range from 20% of staff in the case of RII to 75% or even more in the case of the SISs (former ECRCs and Calculus Centres).

A substantial number of these staff have joined the post-revolution brain drain, particularly to the US. The brain drain is not entirely negative. Through remittances home, it offers a source of foreign exchange. It can offer an overseas 'shop window' to Romanian software talents, encouraging foreign firms to consider Romania as a site for offshore software development. Romanians based overseas may themselves be in a position to sub-contract work back home.

However, the brain drain also represents a serious loss of technological capability from the country, and a loss of investments in education and training. Worse, this Romanian talent ends up working for foreign enterprises (some of whom may be competing with Romanian enterprises) rather than helping local organisations.

Less adventurous IT workers have stayed in Romania but drained from the public to private sectors in various ways:

- to work for multinational subsidiaries in the case of the most fortunate (given the much higher wages paid),
- to work in the IT departments of large local enterprises, or
- to set up on their own.

Many in the last group set up small software firms (see below), while others moved into PC trading and assembly. For a couple of years, between the revolution and the arrival in force of hardware multinationals, small fortunes were made by those who bought second-hand micros from the West, cleaned them, loaded them with software, and sold them on in Romania. Some 'screwdriver assembly' operations still remain, but now address a much smaller market, leaving software to overtake hardware as current 'flavour of the month' for entrepreneurs.

Finally, a small minority of staff have drained right out of the IT sector into other work that presented greater opportunities for income generation. These represent the severest loss of IT capabilities. They form part of an 'internal brain drain' of Romanian IT specialists to other economic activities, that must be set alongside the 'external brain drain' of specialists who go overseas.

The staff who are left in the public sector typically survive by taking on additional outside work, with or without official sanction. RII staff, for instance, work as IT trainers for training companies and on short-term contracts for software exporters and other development firms. Coupled with the financial autonomy of former R&D institutions, this creates a significant 'grey area' of the IT industry that blurs the boundaries between public and private sectors.

#### *Research Institute for Informatics*

The Research Institute for Informatics is the successor to the main work (and staff) of the former Central Institute for Informatics. As noted above, at least 20% of the former CII's staff have left in the years since the revolution and RII now has some 360 employees, of whom roughly 300 work directly on IT. However, it remains both the largest R&D institution for software in Romania and the largest software-producing enterprise.

RII is sub-divided into three divisions:

- The Software Tools division, which has a general remit for software, particularly work that combines development or use of relatively 'leading edge' technologies with their practical application. It has been responsible for the development of expert systems, object-oriented systems, mathematical modelling systems, multimedia systems, and specialist relational database management systems (RDBMS).
- The Management Information Systems division, which is more application-focused and which works particularly on economic and financial applications of management information systems (MIS).
- The Industrial Informatics division, which specialises in the development of applications for use in manufacturing production processes such as computer-integrated manufacturing systems.

The RII has strong links with government. It is state-owned and is seen as the principal mechanism through which national IT strategy should be catalysed and, to some extent, implemented. To take just one example, through its 'technology transfer centres' it acts as a main conduit for IT awareness-raising throughout the public sector (Filip 1996).

RII has been able to retain many of its pre-revolutionary resources (especially staff and buildings), but has had sufficient income/investment to allow the build-up of a formidable set of new IT resources (formidable, at least, in comparison with that available to most other software enterprises in the country).

The hardware base of the Institute has been updated to run a local area network of Unix-based workstations and over 200 IBM Windows-based PCs. The mainstays of Romanian programming have been supplemented with relatively more recent languages such as C, C++ and Lisp. In addition, a range of Case (computer-aided software engineering) tools is available plus RDBMS/fourth generation programming languages (Oracle, PowerBuilder, etc.). Finally, the omnipresent Microsoft Office has been widely installed and used for some development work.

This range of foreign packages and tools reflects the changes that have taken place in RII and in the industry more widely. Before 1989, everything from operating systems to development tools to databases would have been custom-built in Romania. Now most of these basic or horizontal programs are imported. The work of Romanian organisations like RII is confined more to niches and vertical market segments.

RII's income comes from three main sources:

- Approximately 40% comes from government R&D contracts, especially via the Ministry of Research and Technology, with which RII has a close relationship.
- Another 40% comes from contracts from other European countries, particularly money from the European Union, much of which relates to work within the public sector. There have also been a few examples of export work, such as work for the Siveco group (see below).
- A final 20% comes from other Romanian clients.

RII has a relatively secure position because of its government links. It relies heavily on state direction and support and, for example, has no formal marketing operation since government and other pre-existing contacts provide all major contractual work.

The contract work undertaken by RII includes:

- Romanian public sector projects, such as development of an information system to optimise petroleum extraction, an IS to calculate privatisation assets, and an MIS for the population register.
- Regional projects, such as development of an information system to monitor traffic patterns of shipping in the Black Sea, and a communication system interconnecting the Black Sea ports. These typically involve collaboration with foreign institutions.
- Bilateral projects, such as the development of a communication system linking Romania and Germany, undertaken with a German partner.

R&D contracts are either awarded direct in the case of work of a sensitive nature (e.g. work for the Ministry of Defence) or via a bidding process advertised in the national media in the case of other applications (e.g. standard public administration developments). RII is the only viable contender for the direct contracts. However, it also wins a lion's share of the bid work.

It is easy to complain that RII benefits unfairly from its relationship with government since some members of the panel evaluating R&D contract bids will have close working relationships with RII staff. However, a number of points are worth making here:

- Business and other transactions in Romania (and, of course, in many other parts of the world) still rely far more on personal contact and the trust which that brings than on formal criteria. This is especially so in a small industry like Romanian IT, where many people know each other.

- Whatever happens behind closed doors, the RII would tend to win out anyway on formal bid criteria because of its track record and resources.
- RII acts not only as a focal point for the public sector but also as a seed-bed or catalyst for much private sector activity. There are thus good arguments for trying to maintain a single centre of excellence in IT for the country, rather than dissipating expertise by spreading an already small pot of money even more widely and thinly.

### *New R&D Institutions*

Given the continuing importance of state funding in support of the Romanian software industry, some software R&D enterprises have been created since 1989 to try to tap into such funds. Although the enterprises are new, the founder members are often ex-employees of the old R&D institutions. They are likely to be involved in a varied portfolio of work, but to have a key focus on winning R&D contract projects from or related to the government.

These projects arise in three principal ways, most of which are related to government, including the Ministry of Research and Technology. First, enterprises may bid for Romanian government/public sector contract work to develop software. Second, the bid may be for work connected with European integration, often involving development for government agencies. Third, companies may submit proposals and feasibility studies to MRT for the development of information systems to meet a need that is perceived by the company.

One such enterprise is Informatics Services, based in Bucharest, which was set up in 1991 by former RII staff. It employs a staff of 16 people and has invested in a local area network of Windows-based PCs for its development work. This work – some state/EU funded, some resourced internally – has included:

- A career guidance system that uses a database to match job/profession requirements with the skills, qualifications, and personality of individuals seeking guidance.
- A guidance system for the young unemployed that matches either available training courses or job vacancies to the skills and qualifications of individual unemployed applicants.
- A set of computerised personality tests for use in recruitment and selection.
- A set of self-paced computerised tutorials relating to total quality management in manufacturing production processes.

The main problem for all these enterprises is that most of their applications remain essentially in demonstration form only, without being tested and validated in a real user environment. In part this arises from a lack of market demand for what is being produced: potential user organisations (e.g. government labour offices in the case of some Informatics Services systems) have a preference for manual rather than computerised systems, or do not perceive a need for the particular application available, or lack the financial and other resources necessary to computerise.

Secondly, commercialisation failure arises from lack of financial incentives for the software enterprises themselves. Where applications have been funded via MRT, the application is owned by MRT and any sales income must first be used to pay back MRT's investment. In this situation, enterprise effort is better focused on trying to win the next government contract rather than trying to commercialise and market existing applications. The arrival of the Agency for Technology Transfer should help to rectify this problem.

In order to supplement state-funded R&D, these enterprises have turned to other work. Informatics Services, for example, had recently completed a systems integration project for one local government division, funded by European Union money. This involved integrating an imported geographic information system with imported hardware and then installing the system.

Many companies, though, have had to turn to non-developmental work in order to survive, such as desk top publishing, word processing, and IT training. These activities have tended to be far easier and far more lucrative than software development.

State funding and state-oriented EU funding for software R&D work therefore remains essentially a jobs subsidy that keeps this part of the Romanian software industry going and prevents software technological capabilities from atrophying. Programmers would otherwise be likely to leave the country or metamorphose into DTP operators or IT trainers.

#### *Other Institutions*

The Societies for Informatics Services have had less close links with government and have therefore had to fight more to cover their costs. Many of these enterprises only

just survive on a 'hand-to-mouth' basis. Employees have struggled to keep some of their old clients and have taught themselves new PC-based operating systems, applications and programming languages in order to gain new clients.

Typically, their main services since 1989 have been writing small software applications and giving training courses in MS-DOS, Windows, Microsoft Office applications, FoxPro, dBase, Lotus and so on. Initially the quality of the applications they developed was not high because the programmers were self-taught and lacked the experience or time required to master the new languages. There has also been some potential loss of technological capability for those who moved from custom-building applications to customising imported packages.

### **Representation of IT Multinationals**

One highly visible change since 1989 has been the arrival of foreign IT products and multinational IT firms in Romania. IT imports for the years 1990-94 are estimated at US\$250-300m, and have risen steadily since (Filip 1996). This is a model repeated elsewhere in Eastern Europe (Horten 1993), but multinationals have been more cautious in Romania than elsewhere, partly because of continuing political uncertainties.

In the case of both hardware and software, actual capital investments have been quite limited, but there are differences between the two technologies. Software companies such as Microsoft, Novell, SCO and Oracle are all represented in Romania but, as has been the pattern in a number of other countries, hardware multinationals have been more active and more visible than those in software. Hardware firms have tended to have their own local subsidiaries whereas software firms have used existing local firms as authorised resellers and distributors.

This difference derives from the fact that the local market for software packages is very much smaller and less profitable than that for hardware. There are two main reasons. First, the high rates of software piracy in Romania – sometimes estimated at over 90% of software in use – decimate the package market. However, it should be noted that piracy (at least in relative, if not absolute terms) is declining. The 1996 Copyright Law may have something to do with this as may the 1997 creation of a Romanian office of the anti-piracy Business Software Alliance, but so has growing market maturity and the force of competition. At least in some business sectors, enterprises want access to the latest imported applications with adequate vendor

support in order to keep ahead of, or just keep up with, competing enterprises. Piracy cannot offer this and the legal market for packages is therefore growing.

Second, the low cost of locally-produced software makes imported software appear very costly. In part, Romanian software is cheap because local software wages are low. The pricing of local applications can be reduced further by firms willing to accept a 'loss leader' or to cross-subsidise from state-funded/state-related projects.

Multinationals have sometimes hit back. One firm's Romanian subsidiary, for example, failed to sell a single package despite a substantial advertising campaign. It then negotiated a special deal with the parent company allowing charges to Romanian customers to be reduced by up to 75% from global prices. This, and a more concerted focus on personal contact rather than general marketing, led to sales of their management information systems to 14 Romanian businesses.

The work of the local hardware representatives includes consultancy on equipment acquisition, installation, maintenance and training. One major component is software-oriented, involving systems integration to put locally-relevant software onto the parent company's hardware platforms. Rather than writing software from scratch, this has often involved the provision of Romanian interfaces for existing applications and some customisation. IBM, for instance, has been customising Western computer-integrated manufacturing systems for Romanian enterprises.

The main hardware focus of sales has been microcomputers or workstations (IBM, Sun, Compaq and Apple are present) and related peripherals (Epson and Hewlett-Packard are both represented). Given the high price of hardware relative to Romanian wages, the target market is not the home or small enterprise but:

- large multinational enterprises (such as Coca-Cola) which have set up Romanian subsidiaries,
- major infrastructure projects, typically funded by sources such as the International Finance Corporation or the European Bank for Reconstruction and Development, and
- major public sector (or recently ex-public sector) organisations and enterprises, funded from internal or EU programme sources.

IBM is the major hardware player and is perceived as having a major part to play in the future of Romania's IT industry. It has spread its presence throughout the country and now has a network of some 70 representatives. Soon after the revolution, it began donating computing equipment to different educational institutions. Its main state

sector reward to date was a US\$3.5m order placed in 1991 by the Ministry of Education and Science (whose Minister was a former IT professor). This involved the supply of PS/2s and networking technology to a number of universities and polytechnics.

Public concerns are expressed from time to time about the potential dominance of foreign IT multinationals (Palade 1996), and about the limited influence of Romanian partners on expenditure and investment decisions. Nevertheless, the multinationals are there to stay, and increased regulation of their activities seems unlikely, particularly in the wake of Constantinescu's election.

### **Hardware Producers**

Hardware-producing enterprises have fared badly in the transitional era. As Western hardware began to become available, comparisons with Romanian-produced computers and peripherals were unflattering. Romanian hardware was seen to be slower, lower capacity, harder to maintain, energy-inefficient, costlier and generally out-of-date. As state funding for mainstream computers also dried up, demand for local hardware consequently imploded and the firms were forced to diversify. Although nominally autonomous, their survival has relied on state contracts for mass production of items such as cash registers, electronic scales, and telecommunications equipment. ROMCD, for example, saw its joint venture lapse and it then merged with other companies to form Romanian Cable Systems, focusing on production of telecommunications equipment.

Some of the technological capabilities created prior to 1989 have been retained, but many have not and many skilled staff have also left these enterprises to go overseas, to set up their own company, or to work for the locally-based subsidiaries of IT multinationals.

### **Systems Integrators**

There are a number of private sector systems integration firms, with the larger ones typically employing 10-50 staff. One example is Infocib which won a contract to computerise Bucharest's Victoria Superstore. Infocib analysts worked with client managers and IT staff to develop a set of information systems requirements. Infocib's integration work then consisted of:

- purchase of the required hardware items: Compaq PCs, a network infrastructure, and point-of-sale terminals;
- purchase of a number of retail packages covering accounts, purchase, inventory, sales and MIS reporting functions;
- installation of hardware systems;
- creation of customised links and a Romanian interface for the software packages;
- installation of software systems;
- client staff training; and
- continuing support.

The work of such firms has tended to be more software- than hardware-focused, and they represent an important pool of Romania's current software capabilities.

### **Software Firms**

In addition to a few medium-sized (10-50 employees) software firms, Romania has a very large number of one- and two-person software firms with low turnover. These are often set up by IT professionals who have left one of the R&D institutions, or by recent IT graduates. Their work ranges along a capability continuum:

- from custom-building software to meet the needs of PC users in the small but growing market of smaller enterprises and home users,
- through customising existing software packages for the same market (building databases and spreadsheets, using application programming languages like Visual Basic, and/or adding a Romanian interface to the package),
- to simply trading imported software packages, which has been and is a growth market.

As noted in Table 2 and Box 1, the first of these activities is relatively skilled; the last requires few, if any, software skills; and the second lies somewhere in between.

The Romanian language and the specific requirements of Romanian legal, government and business practices provide a continuing 'natural protection' for the local software industry in a way that does not apply in hardware. Western packages cannot be transferred directly to work in most Romanian settings. The same issue has arisen elsewhere in Eastern Europe. The Western firm Bull, for example, ran into a number of difficulties in trying to install Western-origin information systems for tax processing in Poland and for the banking system in Hungary (Horten 1993).

In some ways, then, this has been a learning process for Romanian clients, finding out that Western information systems are not the answer to their prayers:

"Now they have learned that western computers in themselves are not necessarily what they need. They need systems which cater for their own unique national requirements, and suppliers which will work with them to design those systems." (Horten 1993:20)

The process of economic transition contributes to natural protection since it creates an ever-changing legislative environment in which benefits, tariffs, taxes, etc. keep altering. Information systems must therefore be constantly amended in order to keep up, and this requires continuing local input. Piracy also helps to reduce the incentives for software multinationals to establish a major presence.

Nevertheless, with the influx of some software multinationals, growing awareness of foreign software standards (largely driven through piracy), and a growth in the use of English, the Romanian software market has undergone – and continues to undergo – a process of commoditisation. That is to say, where once the entire market was for custom-built software, consumption is increasingly dominated by software packages which, at best, have been customised to some extent.

The consequential outcome – less dramatic than with hardware, but present nonetheless – has been a suppression of higher-level local technological capabilities in favour of the foreign capabilities incorporated into imported products. This is also seen in the creation of software packages by Romanian firms. Since the revolution, there has been no serious development of operating systems, databases or complex applications as there was before. Locally-produced packages now only exist in dwindling vertical or niche markets, and trading or supporting imported packages is more profitable and more attractive.

Vertical market applications, such as accounting or medical or manufacturing information systems, have the natural protections described above. They are likely to survive for some time. However, it will become increasingly attractive for multinational producers of vertical applications to collaborate with a local partner who can customise the foreign package to local needs and practices.

Romanian niche market products include anti-virus and communications packages. Apart from their interface, these are not Romania-specific and foreign analogues exist

which can potentially compete. In earlier days, markets and profits were seen as too small to attract foreign products. However, as the overall IT market grows, such niches come to the attention of Romanian entrepreneurs who seek to find an imported product that will fill the niche, and for which they can act as the distributor. Although new niches may continually emerge, the larger ones will increasingly be filled by imported products.

In some other ways, though, opening trade barriers can help to preserve existing technological capabilities where these are recognised and harnessed by foreign firms. The vast majority of Romanian software firms are focused on the domestic market. A few, however, address the global software market.

One such is Siveco (Romania), which began operations in 1992 and now employs around 50 people. It is a joint venture owned 10% by a group of Romanian businessmen and 90% by Siveco (France). Siveco (France) is, in turn, a subsidiary of the global Siveco Group together with Siveco (UK) and Siveco (Switzerland).

85% of the Romanian subsidiary's US\$200,000 turnover (1995) consists of export work. This work is contracted from other members of the Siveco Group and includes custom-building, customisation and conversion work. It has focused on computer-aided maintenance systems running on PCs.

Where exporting firms also bid for local contracts, there will be a cross-fertilisation of export-developed capability to the domestic market. In Siveco's case there is only a limited direct involvement with local contracts but a more significant indirect involvement because Siveco is a prime example of the blurred public:private boundary in Romania. Although part of an IT multinational, Siveco (Romania) was set up by staff from the Research Institute for Informatics and has an ongoing co-operation agreement with RII (Filip et al. 1997). As a result RII acts as Siveco's access route to Romania's scientific and technical community, and also provides staff for secondment to Siveco projects.

This can therefore be seen as a successful model for software exports since it:

- builds on Romania's existing domestic capabilities and provides a channel for these capabilities to bring foreign exchange earnings into the country.
- persuades skilled software professionals to remain in the country and to remain coalesced around the country's main software institution, and

- helps maintain and develop Romanian software capabilities through exposure to foreign trends, ideas and collaborators.

The only concern may be that these capabilities are principally used to improve the information systems of organisations overseas, instead of being directly harnessed to the needs of Romanian organisations. However, given that many staff will return to apply their capabilities to domestic projects via RII or other routes even this should be only a temporary concern.

### **In-House Capacity**

Prior to 1989, only the very largest state enterprises had their own IT departments. Now, all large and some medium-sized organisations have an in-house IT capacity. In a few cases, this in-house capacity will only be involved in installing, troubleshooting and maintaining foreign hardware and software.

In a greater number of cases, staff will customise packages to meet in-house needs. In perhaps an equivalent, though declining, number software will be custom-built, either because the organisation cannot afford a package or because in-house needs are so particular that no package can meet them. In either of these situations, staff are kept busy by the continuous process of change in the legislative and economic environment, forcing constant updating of organisational information systems.

This in-house capacity represents a substantial, growing, yet largely hidden site of IT capabilities in Romania. The overt IT industry taps into these capabilities largely through the process of staff turnover, if in-house staff move to a software firm (which high in-house salaries dissuade them from doing).

### **Training Companies**

There has been a rapid increase in the number of Romanian IT training firms in recent years. There are two main types: those that focus on training almost exclusively, and those which use training as a way of making ends meet when their other activities (often software development or selling foreign software packages) fail to do so. IT training courses are in high demand, particularly among school and university leavers, because they are seen to increase one's chances of getting a job. Parents are therefore willing to pay the high charges levied in the hope that it will give their child an advantage in the crowded labour market.

New Systems is one of the many companies in Romania providing both basic and advanced courses in IT and IT-related areas. Their IT offerings are typically PC-oriented and cover package skills (especially use of MS Office) and programming courses (e.g. FoxPro and Turbo Pascal). Other PC-related skills courses are mounted according to demand. They also provide related courses in 'management' topics such as MIS and systems analysis and design.

Rather than using in-house staff, companies like New Systems typically contract outside lecturers and IT specialists to deliver the training, thus providing the latter with a source of additional income. All the courses come with some form of certificate or accreditation at the end, and all are well attended, despite the cost. Course charges range from US\$60 for a two-week, four-hours-per-day MS Office course to US\$150 for a three-week management programme.

As already noted, there are honourable exceptions, such as New Systems, but most training companies provide a poor return on the training investments being made.

## **5. Conclusions and Recommendations**

### **5a. Liberalisation, State Intervention and Technological Capability**

Technological capability is a key measure of industrial development. According to this measure, Romania's Communist-era policy of isolationism had a positive effect of creating IT capabilities. However, this build-up came at a high price – particularly in constraining local IT consumption – and the government of the time failed to use the capabilities as a base from which to create a strong, innovative IT sector. Quite the reverse, in fact, since capabilities were atrophying and policy was directionless during the final years of the 1980s.

The period of transition and gradual policy liberalisation since 1989 has seen much of the country's hardware capability lost or corralled into specialised niches.

Liberalisation has also caused a loss of software technological capabilities through both external and internal brain drains, through the conversion of some software developers into software traders, and through the conversion of some software custom-builders into software customisers. Nevertheless, greater retention of software TCs has been possible than was the case with hardware skills.

Liberalisation has led to the suppression of some existing higher-level technological capabilities. However, it cannot be just 'painted black'. Liberalisation has led to a significant expansion in local IT consumption. This has drawn in the multinationals but it has also encouraged a large number of new local entrants into the IT industry. Within these local entrants, there has been widespread creation of at least low-level technological capabilities in areas such as IT consultancy, IT installation, IT maintenance, IT training, and software customisation.

The use of computerised systems is still seen mainly as the preserve of IT specialists. As liberalisation helps IT to spread out of these enclaves into homes, schools, managers' offices and the like, demand is likely to increase for localised systems created by local software developers. Secondly, Western spreadsheet, database and other packages are no more than shells which must be customised to particular organisational needs. As these packages spread, demand will increase for customisation work undertaken by local software developers.

The benefit for local IT production of liberalisation-stimulated IT consumption depends, obviously, on the degree of linkage between the two. In the sphere of

hardware, there is little linkage. Stimulating microcomputer use in Romania, for example, will benefit hardware multinationals, not local producers. That is not to say that all benefits flow overseas since local import, distribution, installation and maintenance capacity will all reap rewards. Nevertheless, the spin-offs for local production are much greater in software.

In summary, whilst liberalisation has suppressed some *existing* capabilities, it has simultaneously created a pool of *new* (albeit lower-level) capabilities. The difficulty for any nation is to build from this base to higher things rather than being confined to a prison of secondary skills.

On the other hand, Romania's retention of existing capabilities has not been the result of liberalisation and of market forces – quite the opposite, in fact. Retention of software TCs has, instead, been based on two factors discussed below: 'natural protection' and government intervention.

### **'Natural Protection'**

The natural protection that protects software capabilities is based on unique Romanian user requirements. These derive from Romania's particular organisational practices and social, economic, political and cultural environment. Elements of this already identified include:

- the Romanian language,
- the importance of personal contacts rather than mass marketing, and
- the process of transition and the continuous changes it demands.

Protection also derives from the high cost of imports in an impoverished economy. Economic and political uncertainties afford a further measure of protection because legal purchases of larger foreign packages represent a long-term investment that many enterprises cannot risk.

These protective factors mean that local software consumption is – to some degree – delinked from the global marketplace. This ensures that – piracy notwithstanding – while Microsoft may have been the main beneficiary of growth in Romanian software consumption, there have been plenty of opportunities created in local package customisation, in training, in support, and even in the custom-build arena.

However, this will only remain true if the natural protections remain in place. At the time of writing, there are clear signs that they are being eroded by three factors:

- Western European languages are increasingly part of educated Romanians' skills portfolio. They are both willing and able to use packages that lack a Romanian interface.
- Romanian organisations are facing a choice in their use of software. On the one hand, they can have a program custom-built by a local firm to meet their particular needs and way of working. On the other, they can adapt their working methods to match what is provided by an imported package. The latter route may be quicker, cheaper (especially where the package has been pirated), and more in tune with ideas of modernising the Romanian economy by rejecting the 'old ways' and embracing Western methods. It may also produce a higher-quality, better-tested application.
- The major software multinationals are themselves investing in software localisation to match their packages to the languages and practices of individual country markets. Some multinationals are also 'localising' their prices. Both trends are visible in Romania.

These factors particularly affect software demand from business enterprises. The Romanian public sector is more likely to remain a redoubt of unique needs met by local software developers. As noted below, then, state intervention via its procurement strengths may be critical in sustaining the local software industry.

### **State Intervention**

In addition to the natural protections, continuing state intervention is helping retain software capabilities. Direct funding for the state IT industry has fallen considerably and steadily since 1989. Nevertheless, state funding of R&D and public sector procurement of information systems (often via EU funding) remain important props that support Romanian technological capacity in IT.

The Romanian government has been criticised for not liberalising policies as much as neo-liberal blueprints would require, and the roots of this are seen to lie in inefficiencies or the protection of personal and political interests by one section of society. However, government's actions can be viewed in a more positive light. The IT industry – like the whole of the Romanian economy – is being opened up to the forces of market capitalism. If undertaken suddenly, such a process can create a shock

that, in economic terms, is potentially lethal. Whether by luck or judgement, changes in Romanian state policy have created a process of manageable transition that has provided access to up-to-date technology for some Romanian *consumers* without (as yet) destroying all the technological capabilities of Romanian IT *producers*.

It is therefore argued that the process of transition in Romanian IT has not been managed perfectly, but neither has it been a disaster. Both IT industry and IT policy-making institutions continue to exist and there are two future directions to be chosen. First, the future direction for the IT industry and second, the future direction for state IT policy. These will now be discussed in turn.

## **5b. Future Directions for Romania's IT Industry**

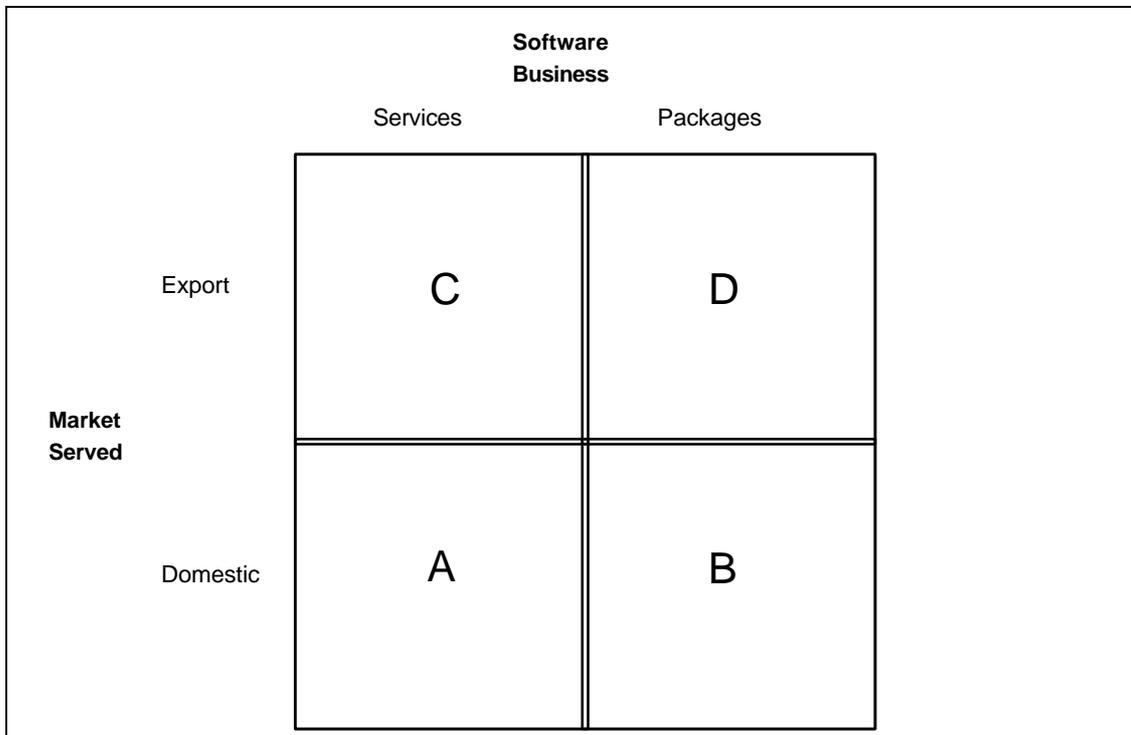
The future for Romania's hardware industry seems limited, at least in terms of mainstream computer production. The best it can hope is for some arrangement with an existing IT multinational. This might be assembly work for the local market or, just possibly, some peripheral role within the globalised production network. It seems unlikely to break through to higher levels of technological capability from either of these situations. Mainstream markets are likely to remain dominated by existing production locations.

Production for Romania-specific hardware niches (i.e. individual vertical markets) should continue. However, even this is unlikely to be sustainable in the long run without joint ventures and foreign partners to inject new technologies and new techniques.

The future in software seems somewhat brighter and offers greater opportunities for the country. Compared to hardware, Romania has built up and retained a greater depth and volume of software production capabilities. Development of new capabilities is also easier since software has much lower entry barriers than hardware production because it is less capital-intensive, more labour-intensive, with a lower rate of obsolescence, and (at least for certain types of software) it has far fewer economies of scale. All of these factors work in Romania's favour given its particular macroeconomic circumstances. In addition, software has long been forming an increasing component of overall value within information technologies and "has become the 'lifeblood' of business, industry, and government." (World Bank 1993:58).

Experience shows that there are four strategic positions that could be taken within the Romanian software industry, as shown in Figure 3.

**Figure 3: Strategic Positioning for Romanian Software Firms**



### **Potential for Software Exports**

At first sight, an export-oriented strategy seems highly attractive. Romania has been successfully exporting software and has the advantages of a cheap and skilled workforce, virtually all of whom speak at least one foreign language. Software exports have also brought a number of developmental benefits. However, there are serious barriers that will constrain Romania's ability to become a major player in software exports.

The barriers include:

- *Lack of infrastructure.* The software export trade increasingly demands a sizeable installed computer base; reliable and pervasive telecommunications links both domestically and internationally; and reliable electricity supply. With hand on heart, Romania cannot yet claim to provide this except, perhaps, in parts of Bucharest.
- *Lack of market information.* Exports are based on understanding your export market and having trading contacts in that market. Such information is not readily available within Romania.
- *Domestic market limitations.* The present state of Romania's domestic market for software constrains exports in two ways. First, a sizeable and demanding domestic market can be the springboard from which to launch into exports by providing a base of relevant skills, experience, user feedback on products, and track record. Second, a sizeable domestic market will draw large numbers of IT multinationals into collaborative relationships with local partners in order to serve that market. As these relationships deepen, an export component often emerges. Unfortunately, Romania's domestic market cannot yet be described as either sizeable or demanding.
- *The business environment.* There are still a number of factors within the business environment that make exports difficult in some way or which put off potential clients. These include regulatory barriers, legislative deficiencies, problems of arranging finance and financial transactions, and perceptions of Romania's political context. Whilst all of these have improved immensely since 1989, with a boost since 1997, they still fall down in comparison to other potential Eastern European sources of software exports, such as Hungary.
- *Being a late-comer.* A number of developing countries – such as India and Singapore – arrived on the export scene many years ago. So, too, some of the other transitional economies – particularly Hungary and Russia – have been software export bases since the early 1990s. These countries have already built up contacts, policies, infrastructure, working methods, track records, etc. that Romania is yet to develop. As a result, these more established players are likely to continually consolidate their position whilst squeezing out late-comers like Romania.

This is not to argue that Romania should abandon hopes and efforts to win a share of the software export market. Government policy should ensure that software exporters are assisted, especially those following a Siveco-like model. However, the main focus of attention at present should realistically lie elsewhere.

### **"Plan B" – The Software Package Market**

If export-orientation is currently difficult, should Romanian firms, instead, be aiming for the production of domestic software packages? In the general applications market (e.g. word processing software, spreadsheets, databases, operating systems), they certainly should not.

Imported packages have that market wrapped up, and entry barriers for local firms remain formidable:

- *High development costs.* Any low labour cost advantage in development is quickly eroded because of the huge advertising and marketing budget required for a successful package. Many major software multinationals spend 40-50% of annual revenue on sales and marketing, and Microsoft spent around US\$1.5bn annually in the mid-1990s. Even research and development is becoming costly. The main firms spend 14% of revenue on this and, for example, Microsoft spent US\$60m developing its Access database. Aside from these costs, experience suggests that only about 1-5% of products succeed, thus providing very little return on most package investments.
- *Foreign software preference.* Irrespective of price, quality and features, Romanian consumers appear to prefer foreign rather than local software.
- *Piracy.* High rates of package piracy squeeze an already small domestic market, thereby rendering unit costs for marketing and distribution even higher.
- *Dearth of market information.* Information on the domestic market is lacking, making it very hard to plan, design and market a new package. Distribution channels through which to collate such information and sell locally-produced software are also few and far between.

Narrow, vertical package markets do exist in Romania, in public administration, manufacturing, health administration, hotel management, insurance, accounting, etc. Local software firms are addressing these markets but their 'packages' are often just a set of menu or window interfaces that are used as a marketing or development platform for further customisation. In addition, the growing competition from multinational imports (both legal and pirated) increasingly threatens even these local developments.

### **Mastering Strategic Position A**

Most firms therefore need to aim for strategy A by providing software services for their local markets. This is the easiest market segment to enter and it is here, as we have seen, that most Romanian software firms sit. In the longer-term, the firms can seek to follow strategic development paths such as A -> C or even A -> B -> C. However, this can only come about once strategic position A has been successfully mastered.

A cold, hard analysis of firms' performance in this strategic sector shows that all is not well and that position A has yet to be fully mastered. In Table 2, the scale of software technological capability was presented, and existing software producers were seen as representing a moderate level of technological capability.

However, we can analyse this single dimension of capability into some component parts. A fairly simple classification would identify three main categories of skills that are required for software production: programming, analysis, and project management.

Although one may criticise them for being often self-taught in new programming languages, Romania's programmers remain its main strength, providing a solid base of technical expertise. Where software development in Romania starts to fall down is in the shortage of information systems analysis and design capabilities, especially an understanding of human and organisational requirements. There are also difficulties bringing software developments in on time, on budget, to the required quality because of limited software project management skills.

The US Software Engineering Institute offers a five-point scale against which Romania's software project management processes may be classified:

1. Initial: *ad hoc* processes.

2. Repeatable: basic management practices are defined and followed.
3. Defined: technical practices are defined and enforced.
4. Managed: fully defined process is measured so that performance can be controlled.
5. Optimising: measurement results and error prevention activities are fed back to identify areas for improvement.

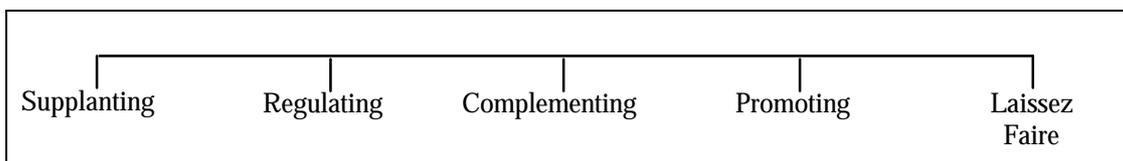
The vast majority of Romanian firms fall into category 1, with only the smallest handful finding their way towards categories 2 and 3. It is little wonder that customers are turning to imported packages, with their guarantees of quality, reliability and longevity, and trying to keep local customisation to a minimum, even if this means that they do not have their needs fully met.

The way forward is clear enough and involves actions such as more staff training, a more professional approach from software company management, and greater customer orientation. Yet such things are far easier to describe than to implement, partly because firms face external constraints which they alone cannot overcome. Higher authorities must therefore become involved.

### 5c. Future Directions for Romania's Software Policy

The obvious higher authority to involve is government, but not all commentators support this. Many US-based companies and development organisations, for example, claim that the best development path is that provided by reliance on market forces and 'rolling back' of government intervention. Out of the possible responses of government to private industry (see Figure 4), many of these commentators therefore favour 'laissez faire'.

**Figure 4: Possible Government Responses to Private Industry**



These advocates of the free market approach are suffering selective amnesia. America built its IT industry on government money pumped in during critical early growth years in the 1940s, '50s and '60s. Those preaching market forces today do so only because their industry is now fully-established and because the market-only approach

means more sales and less competition for US software products. Yet state promotion continues at home, with ARPA (the Department of Defense's Advanced Research Projects Agency) having poured hundreds of millions of US dollars into US IT industry research and development during the 1990s.

Advocating a 'minimal state' approach also flies in the face of Romania's historical experience of state-supported industrial development. Selective liberalisations may play a part in future developments but further liberalisations may well bring diminishing returns. The recommended focus for government should be more on supporting and sustaining the capabilities that are left rather than washing them away in a further flood of market forces.

One may conclude that the argument should no longer be one of 'state vs. market' but a question of how to achieve the most from state and market working together. The recommended role for the Romanian government today is therefore that of a 'promotional state'. What does this mean in practice?

Before doing anything else, it means that there should be a comprehensive survey of the current status, trajectories and needs of the Romanian software industry. Having done this, a menu of constraints that need to be addressed is likely to emerge. Some of these – already identified in this paper – can be addressed by government promotional interventions. They include:

- *Finance.* The Romanian government needs to stimulate the supply of working and venture capital to software firms. Existing financial sources are too bureaucratic and find it hard to incorporate software's intangibility. The government itself would do well to consider changing some of its direct financing in order to provide its contractors with a greater incentive to commercialise the products that have been developed. Some form of profit-sharing arrangement could be used.
- *Education and training.* Although it needs to work alongside other providers, the state is likely to remain the prime source of fundamental skills relevant to software industry development. It needs particularly to try to target the analytical and managerial skills that Romania's software industry lacks. In addition, some accreditation scheme for private training firms, or the use of international certification schemes for skills should be introduced.

- *Research and development.* Government investment in Romanian software R&D has been a major bulwark against the loss of technological capabilities from the country and against the growing concentration of innovation within multinationals. R&D investments should focus particularly on Romania's software market niche: that of customisation to meet local needs.

Funding needs to be invested in at least equal measure in the commercialisation of existing skills and applications. The government recognises this problem, as shown by its creation of the Agency for Technology Transfer. Studies of R&D in almost every country in the world bemoan the problems of commercialisation. Nevertheless, Romania could well learn from the experience of Western countries which have been much more successful in reaping a return from public R&D investments. Part of this will involve improved links between R&D institutions and commercial enterprises.

'Reinventing the wheel' can develop local technological capabilities, but it may be more efficient in some areas to co-operate with a foreign institution which already has the TCs and work on a means of collaborative capability transfer. It may also be more effective: some Romanian software development in innovative areas has involved reading a textbook on the topic and then floundering around trying to build a relevant application. Collaboration would cut through this type of problem, and would also increase the likelihood of attracting funds both within Romania and from overseas.

- *Marketing and market information.* The Romanian government can reap the benefits of scale economies in both these areas. Local software producers need information on markets and on potential collaborators both within Romania itself and outside, particularly in Western Europe. Subsidising attendance of Romanian firms at overseas IT exhibitions should also help.
- *Intellectual property rights.* Piracy has more to recommend it as a strategy for development of software capabilities than is often admitted. However, the maturation of a software industry goes hand-in-hand with a legal framework that only the state can provide. Romania has made a good start on this and a steady strengthening of implementation is likely to emerge.
- *Infrastructure.* From Singapore's intelligent island concept to the US' data highways, the state is seen to have a vital part to play in the creation of a

telecommunications infrastructure. In this field, the role of the Romanian state is likely to be liberalised somewhat, to allow greater infusions of much-needed foreign capital whilst still underpinning some basic services.

- *Procurement.* Because of its large purchasing power, the state can be the most important consumer for emerging software industries and can use its power to significantly influence the direction of industrial development. This has very much been happening in Romania, as described above. However, there has been no strategic purpose to this procurement and no sense in which externalities are sought from procurement decisions.

Centralised procurement offices have gained a bad reputation and certainly Romania should avoid anything that introduces red tape or compulsion into software procurement. Nevertheless, if the government were able to make use of scale economies, for example by putting together consortia of public sector purchasers who required similar custom-built or customised products, this could lever significant benefits for both purchasers and local producers. EU funding and funding criteria could also be brought in to support this process.

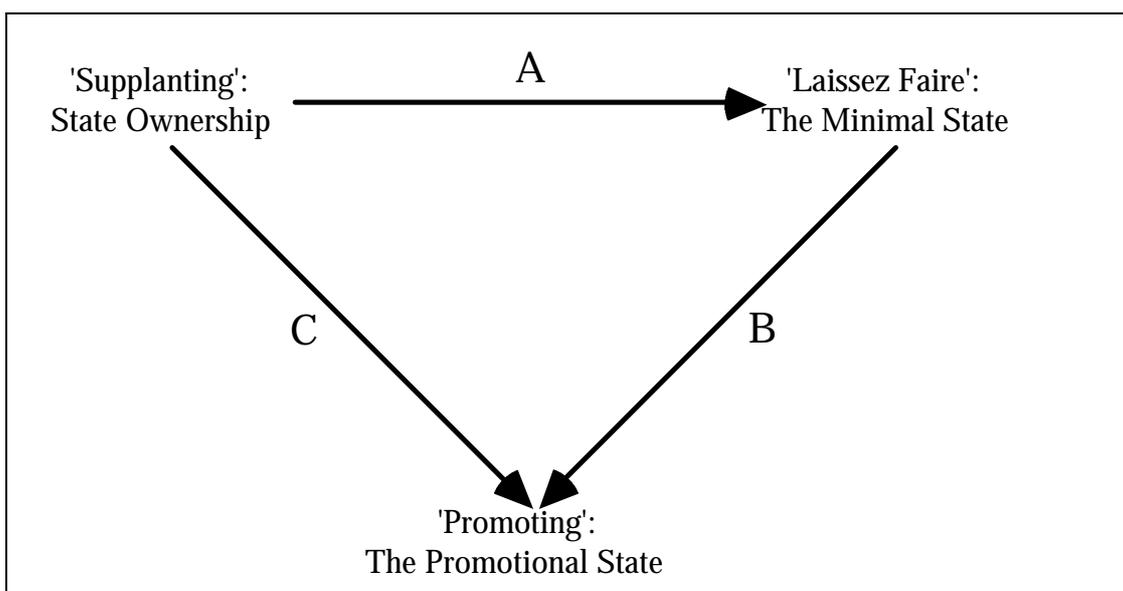
- *Spread of best practice.* Even in a mature software industry, the state can use its purchasing power to lead in requiring best practice from its software suppliers. The Romanian government (again with EU funding assistance where possible) should therefore focus on some means of demanding and assuring product quality standards from all its software suppliers. Acting as a communications link and business adviser, the state can also help best practice to spread within an industry. Subsidies for advice from software quality consultants can also provide a mechanism for this.
- *State-run organisations.* The fashion for privatisation has cast a shadow over public sector software firms in many countries, but this is not justified. In the long-run, the Romanian software industry is likely to develop primarily through private ownership. In the medium-term, however, capabilities could also be sustained and developed through reform of the remaining state-run organisations. For example, spinning off a cluster of small, more commercial enterprises from the present institutions may be a useful way forward.

In summary, then, neither a completely state-owned nor a completely market-led approach will create the conditions required for long-term software industry

development in Romania. One would never seek to deny the importance of sound financial management and of markets in the development of software production, but there are more than enough organisations and consultants around the world reminding everyone about this. What this paper wishes to reinforce is the much less fanfared message: that the state continues to play an essential role in the process of industrial development. However, the state's role needs to be one of promotion, not the old extreme of supplanting the private sector nor the possible new extreme of ignoring the private sector and leaving everything to market forces.

The proposed transition path for the Romanian state is therefore path C as indicated in Figure 5. Current signs are that this path is being followed – at least to some degree. The past constraints of public ownership and regulation are gradually being removed, yet the state retains a vital role in sustaining Romania's software industry.

**Figure 5: State Roles and Developmental Paths**



There are two dangers. First, that the Romanian government reverts to a supplanting and regulatory role. Despite the relatively measured pace of liberalisation in Romania, this seems most unlikely. Liberalisation has already progressed too far in the country, and internal and external pressures for liberalisation are too great, to imagine any serious reversion to past form.

The second danger is that Romania will be pushed along path A. This danger arises because of Romania's past and the associations of state activity with negative aspects of the Communist era. Government intervention comes to be associated with

inefficiency, delay, failure, and political interference. Logically, a shortcoming – even a failure – of government intervention in the past is not an argument for recourse to the market. It should, instead, be an argument for improved intervention next time.

In Romania, though, there are some pressures for policy to flip from one ideology to another: from overactive embracing of the state to overactive embracing of the market. Some industry managers are reacting to liberalisation and the lifting of what they see as the 'shackles of state interference' by seeking a future devoid of state intervention. They often have a genuine psychological block about viewing government as anything but an encumbrance. Unfortunately, this would create a long and wasteful process before Romania recognises the need to change once again and move along path B.

At present, though, this also seems relatively unlikely (though less unlikely than the first scenario). Romania has now had almost a decade of transition in which this danger has not emerged. The government machine has been able to resist pressures for an end to intervention and – due to its own self-preservation urges and the political support from those whose livelihoods depend on government funding – the state has been keen to find a continuing role. The role of promotional state provides this and, indeed, can be the basis for a renewal of confidence in the role of the Romanian state.

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## Glossary of Romanian Institutions

The English name is given first, together with the acronym used in this paper. The Romanian name and commonly-used acronym are provided in brackets.

- AHDC: the Autonomous Headquarters of Deva Copper (Regia Autonomă a Cuprului Deva: RACD)
- CII: Central Institute for Informatics (Institut Central pentru Informatică)
- CTI: Calculus Techniques Institute (Institut pentru Tehnică de Calcul: ITC)
- ECRC: Electronic Calculus Regional Centres (Centre Teritoriale de Calcul Electronic: CTCE)
- ECRO: Electronic Calculus Regional Offices (Oficii Teritoriale de Calcul Electronic: OTCE)
- HEDN: Higher Education Data Network (Rețeaua de Date a Învățământului Superior: RDIS)
- ICTI: Institute of Calculus Techniques and Informatics (Institut de Tehnică Calcul și Informatică: ITCI)
- IPI: Informatics Perfection Centre (Centrul de Perfectionare în Informatică: CPI)
- MRT: Ministry of Research and Technology (MCT)
- NCI: National Commission for Informatics (Comisia Națională de Informatică: CNI)
- NCN: National Computer Network [for Research and Development] (Rețeaua Națională de Computere: RNC)
- RII: Research Institute for Informatics (Institute de Cercetări în Informatică: ICI)
- RO: Regional Offices (Fiiliale Regionale)
- ROMCD: Romanian Control Data
- SIS: Societies for Informatics Services (Societăți Servicii Informatică: SSI)