WGS Report 97-1

Results of the NICONET Questionnaire

1 Introduction

The Commission of the European Communities has given an exploratory award to WGS[1] in order to set up a thematic Numerics in Control network in the field of Industrial and Applied Technologies, entitled NICONET (contract number: BRRT-CT96-0038). The aim is to formalise and extend our current collaboration into a European network to coordinate the development of robust numerical software for control systems analysis and design. Such software is an essential ingredient in modern computer aided control system design (CACSD) and thus for the future of high-tech European industry in a wide variety of applications. This network enables WGS to extend its activities in the area of numerical methods and software for control to a European level and to act as an information center. The intended benefits of NICONET include:

- The establishment of industrial links to ensure that industrial requirements are being met, and to keep industry informed about developments and availability of software;
- The establishment of an information centre on numerics in control software for industry, researchers and software developers;
- The establishment of electronic mail reflectors, world wide web pages, electronic repositories and an electronic journal to allow ready information exchange, up to date sources of information and software, and a means to publish and make available important software and results;
- The coordination of the development of software, including test software, benchmark problems and industrially relevant examples.

The partners of NICONET are:

1. **KUL-SISTA** Katholieke Universiteit Leuven, Department of Electrical Engineering, Research Group SISTA, Leuven, Belgium.
   Contact and Coordinator: Prof. Sabine Van Huffel
2. **UCL-CESAME** Université Catholique de Louvain, Centre for Systems Engineering and Applied Mechanics, Louvain-la-Neuve, Belgium.
   Contact : Prof. Paul Van Dooren
3. **TU Eindhoven** Eindhoven University of Technology, Eindhoven, The Netherlands :
   (a) Department of Mathematics and Computing Science.
   Contact : Drs. Aloys Geurts, Mr. Ruth Kool
   (b) Department of Electrical Engineering.
   Contact : Dr. Ad van den Boom

[1]WGS means Working Group on Software. For more information, see the WGS web site http://www.win.tue.nl/wgs/wgs.html

4. **TU Delft** Delft University of Technology, Delft, The Netherlands, Department of Electrical Engineering, Systems and Control Engineering Group.
   Contact : Dr. Michel Verhaegen

5. **DLR** Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V. Oberpfaffenhofen, Germany.
   Contact : Dr. Andras Varga

6. **NAG** The Numerical Algorithms Group Ltd, Oxford, United Kingdom.
   Contact : Mr. Sven Hammarling

7. **TU CZ** Technical University Chemnitz-Zwickau, Numerical Analysis Group, Chemnitz, Germany.
   Contact : Prof. Volker Mehrmann

They have a proven record of collaboration on the development of reliable and robust software, expertise in the many aspects of numerics in control and control applications, and have a number of existing links with industrial users. NICONET will enable this collaboration to continue and to expand in order to make the much needed software available to European industry in a timely fashion. A major outcome from NICONET will be the production of a library for numerics in control (called SLICOT) which is mature with respect to size, completeness and quality. This library will be developed on modern computing platforms and made available through the information centre.

In order to evaluate the proposed network, WGS has set up a questionnaire[2] for obtaining:

- an inventory of existing research activities in the area of control software;
- a list of potential partners ready to contribute actively to the collaborative effort and NICONET aims,
- an assessment of the relevance of the NICONET objectives and network activities.

This report presents the results of this questionnaire, which consists of the following 3 parts:
1. General questions,
2. NICONET objectives and network activities,
3. Inventory and evaluation of Control software.

The NICONET questionnaire was sent out by ordinary mail on October 15 and 16, 1996, to 285 people, selected from:

1. the WGS address list (only addresses within Europe),
2. the KUL-SISTA address list of contact persons within Europe,
3. the list of industrial partners attending the European Conference on Control (ECC),
4. addresses of a related EC project coordinated by Prof. Ackerman and provided by Dr. Andras Varga,

[2]available by anonymous ftp at wgs.esat.kuleuven.ac.be in the directory pub/WGS/NEWSLETTER

5. the NICONET proposal (all partners and potential new academic and industrial partners mentioned in the proposal).

In addition, the questionnaire was announced via the WGS and NICONET home page and also via an announcement in the November issue of the E-LETTER on Systems, Control, and Signal Processing (editors: Anton Stoorvogel and Siep Weiland from Eindhoven University of Technology). Interested persons had the possibility to retrieve the questionnaire either by anonymous ftp[3] and then send their answers via e-mail to the coordinator, or to fill in the questionnaire directly via World Wide Web (WWW)[4] which was then sent automatically to the coordinator.

We received 72 answers back, 7 of which were sent via e-mail (through the use of ftp) and 17 via WWW. So, most answers reached us via ordinary mail. Below follows a detailed report of the answers on all questions.

2 Answers to General Questions

1. **Identity, Affiliation, Country**
   The results of this questionnaire are based on 55 answers from people working at Universities or research institutes and 17 answers from people working in industry. They came from the following countries: Belgium (7 persons), Bulgaria (2 persons), Canada (1 person), England (9 persons), Finland (1 person), France (4 persons), Germany (17 persons), Greece (1 person), Hungary (1 person), Italy (2 persons), Poland (1 person), Portugal (3 persons), Romania (3 persons), Slovakia (1 person), Spain (6 persons), Sweden (3 persons), Switzerland (1 person), and The Netherlands (9 persons).

2. **Access to Internet**
   70 persons have an e-mail address, while 27 persons also gave their URL address.

3. **Computer type and operating system used**
   The following computers and operating systems are used (between brackets you can find the number of people using the corresponding computer or operating system).

Type:	workstation (47)	Operating system:	Unix (46)
	PC (59)		Windows 95 (36)
	supercomputer (4)		Windows NT (16)

   It should be noted that 33 people use both workstation and PC. Furthermore, 2 persons use a VAX as computer. Other operating systems in use are: Mac OS (3), Windows 3.11 (5), Windows 3.1 (7), Parix (1), Finder (1), DOS (4), OS/2 (1), Linux (1), VMS (3), and MVS (1).

4. **Standard mathematical software used**
   The following software is used (between brackets you can find the number of people using the corresponding software).

[3] at wgs.esat.kuleuven.ac.be in the directory pub/WGS/NEWSLETTER
[4] http://www.win.tue.nl/wgs/niconet.html

EISPACK (19)	IMSL(10)	LAPACK (22)	LINPACK (21)
Maple (23)	Mathematica (19)	Matlab (71)	NAG (15)
Numerical Recipes (8)			

Furthermore the following packages are also used: SIMULINK (2), HARWELL (2), MUPAD (2), PVM (1), MPI (1), ScaLAPACK (1), PLAPACK (1), FeH(1), Gregpah (1), ACSL (1), SDIFAST (1), SLATEC 3.1 (1), STARPAC (1), GRAPHER (1), SURFER (1), ODEPACK (1), OPTDES (1), FFSQP (1), DSSI2 (1), DSTOOL (1), LOCBIF (1), Visual Basic (1), OFFICZ (1), and Geometric Bounding Toolbox (1).

Note that all but one replier use Matlab which is mainly due to the user-friendliness of the product.

3 Network Activities: Evaluation, Comments, New Suggestions

A list of 10 proposed network activities to be coordinated through NICONET has been given. Each activity had to be evaluated by giving a number from zero (no interest) to five (high priority). In addition, comments could be added to each proposed activity. Below follows the list of proposed activities. For each activity, the sample mean score is given together with the sample standard deviation (after the ± sign), as well as a list of all comments raised by the repliers.

1. In the past, WGS essentially relied on the expertise and software developed by its own members. Each contributor had its own focus, so that the present library only covers part of the whole field. Therefore the participants list should be expanded and a **European network is ideal** for this purpose.
   Score: 3.7569 ± 1.2390
   Comments:
   World-wide would beat European.
   Such activities can only survive if a network is installed.
   The core of WGS should not be increased too much. Perhaps some type of hierarchical structure could be installed, containing WGS, contributors, NICONET partners, etc. But I think this is already one of the aims of NICONET.
   Feedback from others than the developers is absolutely necessary to get SLICOT widely used.
   We are interested in participating to such a group.
   Expansion of the list can yield overleap.
   I believe that this is the only path to the development of a complete library for solving control problems.
   Too ambitious and too big, may be disadvantage.
   The creation of NICONET should be accompanied by a serious research work for development of numerical methods and algorithms corresponding to the current standards (e.g. LAPACK).
   It would be interesting to put questions forwards of lacking software: e.g. is someone interested in developing a GSVD?
   It is important that the network has a group of active members in order to have some

efficiency.
It is not clear why a European network should prevent each member from focussing on its own interests.
The efficiency of large discussion groups will be decreased.
What about people in the U.S.A. and Canada?
must be clearly arranged, no redundancies. Connections/links between the packages.
Two levels are required: low (Fortran, C) for binding to packages like SPEEDUP, and high (matlab, Xmath) for implementation as user functions.
Why not use netlib?
The establishment of a European network for control systems analysis and design software is of primary importance for both the software developers and users. It provides the opportunity to enlarge the areas covered, and to fulfill better the users' requirements.
A network is useful for communication and for a wider base of software developers. However, quality control on the software made available must be imposed.
It will become impossibly cumbersome unless very clear and simple rules and roles are established.
Contributions from outside Europe could be interesting, but the creation of a European network is certainly a major step.
Why not world-wide?
It is important that any other significant activity is included which results in new algorithms.

2. The main aim of WGS is to see the library be used by as many scientists and engineers in industry as possible, so that the careful efforts of the contributors bear fruit. This requires a wider distribution, and in order to guarantee this, **a better integration of the SLICOT library in a user friendly environment** is needed.
   Score: 4.0556 ± 1.1855
   Comments:
   Good software is only guaranteed to be used if embedded in a user-friendly environment.
   We live in a world of software environments, not of libraries.
   Some tools as mentioned under 3. are certainly desirable. Still I think that SLICOT itself should be kept as a subroutine library rather than a click-on-the-icon software environment. I believe that many users want to use SLICOT subroutines in a larger program. Some kind of a SLICOT-workbench could be developed to complement the subroutine library as a 'pure collection of subroutines'. Also driver routines, like, e.g. those in LAPACK should be developed for certain control problems. Another important aspect might be the design of an online tutorial to teach users the use and possible applications of SLICOT.
   It is more important for WGS to focus on algorithm.
   This is vital. If it is not user friendly only a few people will bother to work out how to use it. If it is not easy to use it will not be used!
   Is there no risk for a monopoly ?
   From the point of view of the introduction and use of this library in the industry the user friendly environment is an important issue.
   User-friendly seems nice, but people should always be aware of restrictions on the problems solved by software. It is already user-friendly.
   This seems to be a difficult task.

in Matlab?
Matlab seems to me more or less a de facto standard. A Fortran based library would be quite cumbersome to use.
We do not use SLICOT so far, but a user friendly environment is a prerequisite for a wide distribution of software.
An easy-to-use bridge/link to other commerical software tools and programmes seems to be necessary for SLICOT being more widely accepted.
Focus on integration in an existing environment such as Matlab is viewed as of primary importance.
Most software users want to have flexible and powerful, but easy to use tools. Therefore, an integration of the SLICOT library in a user friendly environment is desirable and it could increase the number of its potential users from both academia and industry.
Only user-friendly code will be used to any significant extent.
I have no experience with SLICOT.
Useful if well documented and reliable.

3. A first step in this direction could be the **use of a compiler that automatically passes the function parameters** from the CACSD environment, such as MATLAB, to any FORTRAN routine of the SLICOT library and back (e.g. the NAGWARE Gateway Generator, developed by NAG), which clearly makes the routines of a FORTRAN library available to a broader group of users.
Score: 3.9931 ± 1.2740
Comments:
This is strongly encouraged since most people in control only use Matlab and refuse to use SLICOT because of a lack of userfriendliness.
Too many computers do not have Fortran installed. Moreover most people in control are not very experienced in Fortran. These people depend on programs like Matlab. However, the routines in Matlab beyond Eispack/Linpack are often quite bad. Therefore I feel many people would appreciate it if the routines of SLICOT are available in a package like Matlab. Often people accept the low speed given a much easier interface. However, people do want reliable answers. For this you certainly need reliable software.
See also 2.
Compilers from Matlab to C should be considered as well (commercial product).
Good interfaces to userfriendly tools is the best to do: SLICOT acts as a "back engineering work bench", compare to the back office of Microsoft.
Only parts of the SLICOT library needs to be interfaced, the other ones may be simply and efficiently written using interpreted language. The most important thing is to develop new high quality algorithms and promote them as de-facto standards.
Also, consider including a DLL library to eliminate the dependence on the FORTRAN compiler.
This is the way to go, for a completely integrated package.
The numeric library should be designed in a way such that it could be used like any Matlab toolbox.
Would it be too drastic to write software directly for matlab?
Isn't it possible to rewrite SLICOT into another programming language than the good old Fortran?
Multiplatform orientation would be appreciated, e.g. NAGWARE does not exist for

Macintosh.
Not exclusively!
Good if it works!
The approach proposed above is very appealing. Another, more expensive approach would be to develop a fully interactive, stand-alone package having the SLICOT library as support.
This is of course important if the user needs code which is implemented in different languages. One, single, homogeneous user-interface is of high importance.
We do not have the appropriate tool to accomplish this goal.
This activity should closely relate to developments of Matlab/SIMULINK.
Why not ensure the existence of a library for common packages and platforms, aside from the Fortran version?
Also, a C++ version should be included here.

4. **Software engineering aspects** have to be further elaborated and **tested in the context of a practical industrial application**. This should allow us to evaluate and benchmark the SLICOT library on end-user problems and will be a more realistic validation of the user-friendliness of the product.
   Score: 3.8542 ± 1.2260
   Comments:
   I think that the design of any subroutine library should use software engineering knowledge as far as possible, regardless of industrial applications.
   This activity will follow the activity of question 5.
   SLICOT programs must be validated by systematic testing on a wide range of applications. This is more important than the user-friendliness of the product.
   The use of the library will be guaranteed if it meets the industry requirements. In this sense end-user problems are very important to validate the library.
   The methods implemented in SLICOT seem more appropriate for research work. The practical industrial applications may need other methods.
   The focus should be on numerical aspects and the general user-friendliness at one time.
   Generally, industry is not particularly willing to use packages without good support, but for which support can be expected for many years to come. Thus, packages like Mathematica, Matlab, ACSL prove popular, while those, developed in a more academic environment, such as FACSIMILE, are not really widely used.
   Having a practically relevant test case and feedback from its provider is mandatory for any successful new software development!
   The real-world applications are the ultimate means for validating any theory, design, or software product. Moreover, these applications provide useful suggestions for extending the scope of the SLICOT library, for improving the efficiency, robustness, and usefulness.
   In industry the SLICOT library is most likely to be used in a research department, not in actual manufacturing. The research departments of small companies may not have researchers of a high level, so the software has to be user-friendly. A small study could be made of the possible research environments in which SLICOT will be used.
   Need not necessarily be industrial. More important is to build up experience with many different applications and guide the user to the best possible routine for his use.
   The range of applications and areas have also to be defined.

5. The further evolution of the library should be assessed by real industrial applications with respect to its performance, reliability, versatility and so on. In particular, SLICOT should be turned into an **efficient package for large scale applications**.
Score: 3.5278 ± 1.2330
Comments:
I think SLICOT should be at first kept as a subroutine library for standard problems without having large-scale applications in mind. First of all, there will always be the need for the numerical solution of standard problems. Second, not all control problems have also large-scale counterparts. Moreover, large-scale problems are often very different in nature and therefore require different programming models/computer environments. The design of a library for large-scale applications should complement SLICOT, but first there is a need to define the problems where large-scale problems arise. The approach could be similar to the extensions of LAPACK: there is a basic subroutine library, and then there are several subroutine libraries for several large-scale applications, e.g., ScaLAPACK, PLAPACK,...
Work for the industrial partners, maybe with help.
Has the interest of industry been tested ?
The efficiency could be used in smaller scale applications as well as to promote the use of these methods.
In this context I think that high performance computer tools are appropriate (software packages like BLAS, LAPACK and new parallel packages should be used).
Why not?
It seems important to include a library for high performance computations (e.g. for MIMD computers).
What will be the relation with existing packages, toolboxes?
Some application areas (like ventilation systems or treatment of waste water) have their own dedicated package. It does not seem pertinent to substitute those.
Many real world problems are large scale. Therefore it would be very helpful to avoid the usual model reduction and to use the large scale model directly.
I don't believe that all industrial applications, which are relevant and interesting, are of large scale type. They may be complicated in another way.
For an industrial large scale application the mathematical subroutine level should (and can) as a rule not be questioned and tested against other software!
I do not like too many packages, integrate into Matlab for instance.
The conversion of SLICOT into an efficient package for large scale applications is an objective of paramount importance. One approach for achieving this goal, which is already in progress, is to resort to the components of the state-of-the-art linear algebra package LAPACK. This enables the potential parallelism of many modern computer architectures be exploited. In addition, this also provides the latest algorithmic and software advances in numerical linear algebra, which has a special impact on control systems related software.
Large scale can be interpreted in several ways. The problems of a large industrial process are better handled by modeling techniques rather than by numerical methods. In hydrology there are models with very high state space dimension for which appropriate software can be developed.
I think of optimisation of MINLP problems.
Large-scale applications are likely to raise problem-specific difficulties. It is difficult to

identify a generic application which is large scale.
The nature of large scale applications has to be defined since this may have a considerable impact on the performance of algorithms.

6. We will not only implement our software in applications of industrial partners of the network, but also **try out more advanced control strategies** that were developed by academic experts and proven to perform better than the conventional methods.
   Score: 4.0833 ± 1.0714
   Comments:
   Here I believe that it is of major importance to develop demonstration programs that prove that the academic approach has significant advantages over the approach the engineer uses which may be well-known, robust, used for years, and much easier to understand. The proof should be such that applied engineers having only a basic mathematical/numerical knowledge can easily see that the new approach saves them time and money. (This is based on personal experience.)
   The industrial partners should provide technical examples.
   Of course, necessary for scientific advance.
   Was this proof done on real-time benchmarks?
   Again, these are probably the methods for the future.
   Results should be spread through control scientist community.
   It will be good to include routines for H_∞ design.
   This will be necessary in the near future if competition among industries will further increase.
   Please, avoid examples where highly academic control strategies were tried for a short time only (under supervision of the researcher) and switched off after then for ever.
   Clear arrangements and applicability are more important.
   Cooperation with toolboxes or solution providers (Aspentech, Mathworks) is more important than direct cooperation with companies as my own.
   The use of more advanced control strategies is a scientific objective with high practical relevance.
   Such software may also be useful to determine whether the method performs better than conventional methods. The answer is often dependent on the industrial application.
   This would be the opportunity to reduce the gap between research and applications in the real industrial world.
   This will be difficult for many strategies. To embed a performant controller in an application is expensive and riskful. More is needed than only better performance.
   There exists activity, which is not yet integrated.

7. In order to guarantee a proper distribution of the SLICOT library, we are convinced that the product ought to be made **freely available**.
   Score: 4.2917 ± 1.3577
   16 persons are interested in commercial support, 38 are not interested and 18 persons didn't answer this question (some of which found the question too unclear).
   Comments:
   Free availability is great but a commercial version with support is for another group of people the best choice. Optimally, both should be available.
   I think there is a difference between academic and industrial users. In academia, one is

happy if we have freely available software. For industrial users, it can be of major importance that there is an address where they can ask for support/troubleshooting. Often, people trust software only because it is commercial rather than public domain.
Free availability seems very important for software of item 6.
We are academics. Support may be for installation and initial use.
This policy allows to use most of the NETLIB programs. GNU or GNU like distribution policy is necessary for a good protection against commercial vendors and acknowledgement of the origin of the code.
Any practical application would need support staff to answer questions and solve problems in a short period of time (probably including e-mail support). This support probably should be paid, so a small annual contribution to maintain the support staff in the long term should be considered.
The commercial support could be very important for industry.
Depends on its usefulness.
This is essential for academic environments; students are great multipliers!
Of course you know the widespread opinion (in industry) that every really good thing has its price! I am sure that persons from industry would pay a moderate price.
It must be findable by Alta Vista!
Maintenance? etc.
There has to be professional support for the package. Companies will not want to base their research and development on something that is not properly supported.
Making SLICOT freely available will clearly contribute to increase the segment of users, from both the academia and industry. In order to achieve this, SLICOT itself should be built on freely available components, such as those provided by LAPACK.
The goal should be the quality of the product. If good quality can be obtained and the contributors can be properly compensated for their work without charging money then that is good. One can, however, charge a lot of money for a good product and most industries are willing to pay for quality.
The development of software involves a cost. These costs should be charged to the users even if it is small.
Support is necessary if it is to be used in practice, commercial or not, not only for software or numerical problems but also for selection.

8. We want to start an **electronic journal for control and systems software**. The rationale for this is twofold. First, we expect that software submissions to this journal will be valuable additions to the SLICOT library. Secondly, we wish to try to collect evaluations and comparisons of software for systems and control theory.
   Score: 3.8750 ± 1.2775
   Comments:
   There is a new electronic journal of control that was just started by INRIA. Could this be combined ?
   A fast publication of software articles together with a fair refereeing process is certainly desirable.
   It should be appended to e-letter or other widely used news distribution channels.
   It should be an integral part of the publication actions. There are enough scientific journals etc. on control and software.
   The electronic journal should include a reviewing process.

Risk for errors and overleap.
Definitively, this is the most appropriate way to develop tuned efficient codes.
If the review procedure is fast this is a very interesting way to spread results fast (in many journals it takes about 2 or 3 years).
Put benchmarks in it (control benchmarks).
Personally, I would prefer not to set up a new journal, but to book in on an existing one.
An open electronic form is a good idea, no matter whether it is an electronic journal, a newsgroup or whatsoever.
The number of journals already existing is rather high and the time to read the most relevant of them too short. I don't expect many industrial readers outside universities.
Why add one more journal in the field of numerics?
Starting an electronic journal for control and systems software is a very good idea, and the sort of submissions proposed above are to be welcome. I consider that this journal has also to be freely available.
A journal may stimulate the research community. Evaluations of software and new software is best distributed on WWW pages.
Not another journal!
It is a good idea that may help in enriching the library.

9. The **use of electronic means** is most appropriate in setting up our network: the newsletter (electronic version) and the WWW home page, the software repository of the SLICOT freeware and a new electronic journal will be major assets for the participants of the network to be established.
Score: 3.9861 ± 1.3479
Comments:
In particular, people can get a quick assessment of SLICOT without investing much time.
The software repository is, I believe, the most essential. The WWW page and newsletter are advertising that are helpful to keep activities alive.
Efficient modern way!
Outside of universities the use of electronic means is not standard, or sometimes an expensive standard.
Most people now have access.
You can get what you want, no more, no less.
In my opinion Web servers are the most flexible and friendly channels and should be preferred.
This way is modern. However, the amount of information is huge and it is a hard job to manage it under typical limitations of time.
Advertisement and announcement are very important.
Do not underestimate the care and cost to keep an electronic system going. I rather have paper (that somebody has read and tested) than "experimental quick and dirty" software by wire.
Papers are out!
The use of electronic means as described above is clearly most appropriate in setting up the network. These will also provide the needed communication between the teams working in the control systems domain, either in academia or industry.

Use of CU-see Me software from Cornell University for Videoconferencing (Quick Cam needed!)
A network requires more than electronic means.

10. **Regional workshops** around the topic of control algorithms and software with emphasis on **industrial applications** will be organised.
    Score: 3.6736 ± 1.2366
    Comments:
    Best in connection with existing conferences.
    Could this be combined with existing conferences ?
    Of major importance would be to find people that really solve control problems in industry in order to see if SLICOT is steering in the right direction.
    The focus on industrial applications is important to convince people in industry to move forward. However, both sides should keep an open mind.
    Good idea; It is complementary with the publication activities on the WWW. Thus it might reach industry better!
    Why not?
    Industry will be interested if the cost is low.
    Is this not possible to organize through existing conferences?
    Not only regional but international workshops too.
    Special interest in real-time implementation issues.
    Costs could be prohibitive for us.
    Assure first industrial participation (at a rate of 50% particpants).
    Interesting, maybe it can be combined with existing activities.
    Not necessarily regional, will depend on the interest.
    With respect to workshops I would prefer low costs (only travel and hotel - if possible).
    Why add another workshop?
    Evaluation of good and better algorithms must be a key point.
    I very much like to meet applied people.
    The organization of Regional workshops having the thematic mentioned above is an important objective. They will promote the recent advances in the field of control algorithms and software and will strengthen the relationship between researchers from academia and industry.
    Distribution of software should probably be supported by workshops or courses how the software should be used and the theory behind it.
    The first or second workshop must adopt a common methodology in the software engineering process in order to achieve a certified status,i.e. conforming to ISO 9001.
    Separate workshops are needed for the 2 intended audiences: (1) researchers in industry and (2) researchers at universities. Short courses for researchers in industry may also be valuable. Check with industry.
    International (European) conferences could also be organized occasionally in order to stimulate exchanges and collaborations.
    Good idea for the dissemination of results and proving or indicating the relevance of the work.
    Presentations and demo's should be organized at major control conferences.

In addition, the following **additional network activities** have been proposed.
NICONET should grow to a network of excellence. Questions from industry are directed to-

wards the most knowledgeable and skillable group. Compare this to the NoE being set up by SiE: Simulation in Europe.
Dissemination of results in specialized journals.
The transfer of Automatic Control Technology and Tools from one region (or country) to another could also be an important topic for the network.
Courses for industrial users to bring them up-to-date on new control software and technologies.
a C++ and a Fortran 90 version of all is desired.
In my feeling the network should be started small. There are a lot of other things and the response rate might be rather weak.
Adress book is desired and electronically available e-mails.
I think that a related objective of the network could be to facilitate the effective cooperation between teams and individuals involved in control systems analysis, design and implementation. Providing some financial support, for instance for participating in Regional workshops, could be necessary for some individuals, especially from Eastern and Central European countries.
In order to have a good financial support, NICONET could submit proposals to different European Programmes which promote East-West collaboration.Complete information and application forms can be obtained from:
i)NATO Scientific Affairs Division,B1110,Bruxelles,Tel(32-2)728 4111, Fax(32-2)728 4232.NATO offers different kinds of Grants (linkage grants, ASI,expert visits,collaborative research grants) in priority areas (e.g.Information Technologies, Materials Science) to be carried out between Scientists in NATO countries (e.g.Belgium,Germany,England) and Cooperation Partner Countries(e.g.Romania)
ii)In the period 1990-94 EC launched ESSI(European System and Software Initiative) aimed to promote software development process in industry so as to achieve greater efficiency, higher quality and greater economy, Contact:Commission of The European Communities,DG XIIIA,ESSI Proposals Office,BU 31 3/80,200 Rue de la Loi,B-1049,Bruxelles,Noelle Tracey +32-2-2993575,Fax +32-2-2968364.ESSi offered grants between 100KECU to 500 KECU.
iii)Phare Programmes (Commision of the European Communities, PHARE, Montoyerstraat 34 3/80 Rue Montoyer,B1040, Brussels, Tel(+32-2) 299 16 00 /299 14 14/299 15 55
The above activities are extensive, we better concentrate on these before trying to expand further.
Groups around specific themes in the algorithms development area have to be organized, such as: algebraic computations, computations on inaccurate models, large scale computations, etc.

Nineteen **people expressed their strong interest** (by means of the highest score 5) **in contributing actively to the network and also specified their possible contribution.** The NICONET kernel is currently selecting the most appropriate partners for the extended network according to the above specified needs.

Finally, we summarize **further remarks and suggestions.** Some people think that the WGS initiative to set up a thematic Numerics in Control network in the field of Industrial and Applied Technologies (NICONET) will have a strong impact on increasing the European industry competitivity. But other people are sceptical of the value of networks, except as a means of bringing together no more than 2 or 3 groups with strong shared interests, and do not see which role SLICOT has to play in developing things not already available in excellent commercial packages.

4 Inventory and Evaluation of Control Software

4.1 Availability of Software

The following control libraries and packages are used (between brackets you can find the number of people using the corresponding software).

Library:	SLICOT (8)	Package:	scilab (2)
	Matlab toolboxes (65)		Matrix-X/Xmath (6)
	RASP (3)		ANDECS (3)

Furthermore, the libraries LISPACK, SYSLAB, 20-SIM and program CC were mentioned once (used by one person), as well as the packages CADACS, CONOISSEUR, SMCA, DMC, and DMC+ . The average number of full-time equivalent persons available for control related software development in the group of the repliers to our questionnaire is 1.7306 persons (the standard deviation is 2.2435). Observe again the large number of Matlab toolbox users, mainly due to their ease of use.

4.2 Description of Other Research Activities

Other relevant research activities are: the organisation of courses and workshops in the area of control, the publication of research papers and books, the development and extensions of software packages in modelling, systems and control, and the development of a design environment. In addition, several people mention involvement in other European networks, industrial collaboration, and research in related areas such as process simulation and mechatronics.

4.3 Need for new software and RTD topics

The following **needs for new software and/or RTD[5] topics (in order of priority) have been specified** (between brackets the preferred programming language is mentioned).

1.Model reduction techniques for large scale problems,
2.Periodic discrete-time systems,
3.Optimization techniques for control (this is rather broad and general, though),
for robust control design (Matlab).

In order to make the usage of SLICOT as simple as possible, tools are of major importance. Also, driver routines should be designed *to simplify the usage of SLICOT for users (Fortran 77).*

- application of group theory to algorithm design,
- inclusion of physical principles (lossless transformations),
- algorithm analysis by computer algebra,
- control system design for linear and nonlinear systems with behavioral approach,
- software support for the above mentioned course,

for research and education (preferably in matlab or mathematica).

[5]i.e., Research and Technological Development

New RTD topics: interfaces to CAD tools and connection to a library for convenient storage and retrieval of models are necessary. Furthermore, integration with other tools producing software is important *for applications in mechatronics (preferred programming language: none, however coupling like OLE, DDE).*

Identification tools and simulation of hybrid systems are needed *for research (C, Fortran).*
Software needed *for sensor array signal processing (in Matlab, PV-WAVE, C++, Fortran).*
Control system design is needed *for research (aerospace vehicle design) (in matlab script).*
We think that the developed systems must be robust, reliable, friendly environment, with good technical support and documentation *for research/production/education (in Matlab or C++).*

At the end of 1996 Bulgaria is in a full financial collaps and we need any available free software as well as RTD matters *for research and education (in Matlab or C++).*

Topics of interest: 1. real-time implementation of control software in embedded systems and 2. implementation of control algorithms with integer-based arithmetic *for the development of automotive control systems (in C).*

Need for software in control of large scale problems and singular control problems *for research (in Fortran or matlab).*
Software needed for portable extended precision for basic matrix-vector operations and for interval arithmetic approach *for research and education (in Fortran 77 or matlab).*
Tools for learning in control systems and tools for automatic modelling of physical systems are needed *for research and education (in C, C++ or matlab).*
Algorithms and software with condition and accuracy estimates with quality comparable to LAPACK are needed *for research and education (in Fortran).*
Software needed for analysis and design of periodic systems (including multi-rate), for uncertainty modelling (LFT) and for H_∞ control and controller reduction *for use in production and research (in Fortran).*
Need for symbolic control system package and LQ H_∞ design *for use in education (in Maple, Mathematica or MUPAD).*
Model development in chemical engineering and optimisation of differential-algebraic equation systems (large scale) are needed *for use in research and education (in Fortran).*
Software for minimization of cost functions is needed *for use in research (in Matlab).*
Need for reliable software for dynamic simulation (good integrators for stiff nonlinear systems, mixed continuous and discrete event systems) *for use in production and research (in C, C++ or matlab).*
The major need is the application of mostly existing or new advanced control algorithms to industrial/practical problems. Any software that assists this activity is welcome *for use in production (in Matlab or C++).*
Need for software for highly stiff systems *for use in research.*
Need for a variable structure control support package.
Need for application integrators (modelling to control), nonlinear parameter estimators and optimisation and data validation tools (dynamic) *for use in production (in C or C++).*
Need for software for solving minimax problems *for use in production and research (in C or Fortran).*
Relations between modern identification and control methods (bridge routines) needed *for*

use in research and education (in Matlab or C).

1. Need for software tools that increase the efficiency of developing process control applications;
2. Need for user friendly interactive software packages for control systems analysis and design;
3. Need for high-performance subroutine libraries in the mentioned area.
for use in research (in Fortran).

Need for user interfaces and the presentation of system data for evaluation purposes *for use in production (in visual C++).*
Software needed for combined numerical symbolic tasks which is sufficiently robust for "real" problems.
Software needed for the control of discrete event systems (automated approach) and hybrid systems, also for system theory and system identification of positive linear systems *for use in production/research/education (compatible with Matlab).*
Software needed for simulation, nonlinear identification, model reduction, nonlinear control *for use in research and education (in Fortran).*
Software needed for system identification, descriptor systems, frequency response *for use in production and research (in Fortran).*
Specification tools and tutorial tools on new methodologies are needed.
No need for new software but an effort to group existing software into a user-friendly package available on any platform is necessary *for use in research (in matlab).*
Need for user-friendly software *for use in research and education (in Fortran or C).*
Need for fast numerically robust optimization routines for large scale (many inputs and outputs) identification (both parametric and nonparametric) and MIC problems *for use in production and research (in C or C++).*
Need for (1) robust algebraic computations and approximate solutions to problems with model parameter uncertainty, (2) large scale problem computations, and (3) a user-friendly environment.
Need for a comprehensive collection of algorithms, a graphical user interface and a detailed help *for use in research and education (in Matlab or C).*
Need for software for discrete event and hybrid system analysis *for high level control (in C++).*
Need for OOP languages for control *for use in education (in Java or C++).*

Here follows a list of **further remarks and suggestions:**
It should be discussed if in the future, FORTRAN 90 or C are more appropriate programming languages for software development. It might also be worth considering tools for multi-language programming in order to use the language most appropriate in the several areas of programming.
More emphasis should be put on education.

4.4 Development of control related software

Finally, 31 persons filled in the **appendix describing control related software developed within their group** (university/research institute/industry). Software contributions were reported for the following areas (between brackets you can find the number of contributions reported in that area).

System Identification (13)	Adaptive Control (7)	Time-varying Systems (3)
Optimal Control (9)	Nonlinear Systems (7)	Descriptor Systems (3)
Model Reduction (8)	Periodic Systems (4)	Neural Networks (3)
Time Response (8)	Fuzzy Systems (4)	Deadbeat Control (2)
Frequency Response (8)		

In addition, the following areas were cited: nonlinear optimisation (2), time reduction (2), forecasting (2), SVD (1), bond graphs (1), qualitative model (1), prediction (1), controller synthesis (1), controller reduction (1), eigenvalues for structured problems (1), Lanczos methods for control problems (1), singular values in control problems (1), pole assignment (1), linear least squares (1), time series (1), signal processing (1), systems analysis (1), dynamic optimisation (1), robust control system design (1), and system monitoring and control (1).
Programming languages are Fortran 77 (for 22 contributions), matlab (for 19 contributions), C (for 9 contributions), and C++ (for 7 contributions). In addition, the use of the languages Ansi C, Labwindows, Prolog, flex, PWXPCE, Mathematica and Maple is mentioned for just one contribution.

5 Conclusions

The results of the questionnaire show that the control community has a high interest in all proposed NICONET activities. The expansion of the present WGS network (NICONET partners in the exploratory phase) to a European level is strongly encouraged in order to obtain a wider base of software developers and potential users. The network should focus on the development of numerically reliable and efficient control related software which should be freely available and embedded in a user-friendly environment such as Matlab in order to guarantee its widespread use in both academia and industry. In addition, the library should be benchmarked and validated by means of real industrial examples. Commercial support should be provided too, especially for industry. Finally, the use of electronic means is the most flexible and user-friendly way to enhance information exchange and collaboration within the network.