

# THE ACT CLUB NEWS

Issue 15

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Welcome to this, the latest issue of the *Advanced Control Technology Club News*. It is filled with details of our forthcoming events and activities, as well as the usual conference reports and other news.

I would particularly like to draw your attention to our latest Special Interest Group initiative which targets the Energy and Power industries. More details about this can be found inside on Page 7. Another new development is the link with a London Centre at Brunel University, see Page 3.

I hope you enjoy reading the Newsletter. If you have any comments (or criticisms!) we will be delighted to hear from you.



Andy Clegg

## *Forthcoming Events for ACT Club Members*

### *4<sup>th</sup> Marine SIG Meeting*

The Marine Special Interest Group activities, continues to be one of the best supported elements of the ACT Club. The 4<sup>th</sup> Meeting of the Marine Special Interest Group will take place at Lloyd's Register of Shipping on 8<sup>th</sup> July. Guest speakers will describe recent developments in Fuzzy Autopilot Design and also Japanese research interests. The ACT Club will also present initiatives that are ongoing within the Marine SIG and these will be discussed and debated in the usual open session.

### *Introduction to QFT*

Over the last few years we have been increasingly impressed by the success of the Quantitative Feedback Theory (QFT) control design method. It is one of the most practical and easy to understand robust control methods and has found many applications. A number of companies have expressed an interest in a training event on this subject.

Therefore we will be organising a one day "*Introduction to QFT*" event, to be hosted by CEGELEC Projects at Rugby, on 9<sup>th</sup> October. The aim of the day is to introduce the fundamental ideas of QFT using simple application examples.

There will be a limited number of places available for this special meeting and early booking is essential. Full details of this meeting will be distributed soon.

## *Expert Systems and Their Application*

We are pleased to confirm that the above event will be held at the British Gas Research Centre in Loughborough on the 27<sup>th</sup> October.

The meeting will concentrate on the application of Expert Systems within many different industrial sectors. The agenda is being drawn up at the moment and will be issued in the near future. If you feel you could make a useful contribution then please get in touch.

## *Hot Rolling Mills Training Course*

ACT Club members should have received an information pack on our forthcoming training course on Hot Rolling Mills. This is being held at Strathclyde University, 13<sup>th</sup>-18<sup>th</sup> September.

Club members are entitled to two free places with additional places at half price. Places are limited and filling up fast, so if you would like to attend or get more information then please contact us at the usual address.

## *Process Control and SCADA Systems Day*

We are currently at a very early stage of planning this event, which will be hosted by Bailey Automation on 9<sup>th</sup> February, 1999. If you have any suggestions about the nature of the meeting or would like to make a presentation, then please get in touch.

*Please turn to Page 7 for Events  
Launching our NEW  
Energy & Power SIG*

**THE ADVANCED CONTROL TECHNOLOGY CLUB**

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### **Recent ACT Club Events**

#### **16<sup>th</sup> ACT Club Plenary Meeting on "Modelling, Simulation & Control Design Tools"**

Our most recent meeting was on software design tools held at Strathclyde University on the 21<sup>st</sup> May. The subject of this meeting was of great importance as, the day was very well attended by Club members. We were able to get the major suppliers of Control System Design Tools to display their wears on the same platform, to enable Club members to decide and evaluate which tool is most applicable for their application.

Copies of the presentations are available to those ACT Club members who couldn't attend the event. Just complete the enclosed reply form, or get in touch at the usual address.

#### **Steering Group**

The Steering Group met on the 24<sup>th</sup> May to determine the actions and directions for the Club over the forthcoming year. Many of our new initiatives were debated and questionnaires will be issued to all Club members to help us prioritise these activities.

The Steering Group of the Club have agreed to the Management's request to increase the subscription levels for 1998/99. This increase is limited to *below* the Rate of Inflation.

#### **Call for New Steering Group Members**

Over the last two years the Steering Group has decreased in numbers. We are keen to hear from any Club members who are keen to help with

guiding the Club and are willing to take part in the Steering Group.

The commitment is not that heavy, as the Group meets twice a year which is usually timed to coincide with other Club meetings. If you are interested then please get in touch with either Mike Grimble or Andy Clegg.



### **Spotlight on new ACT Club members**

#### **British Gas Research**

British Gas were one of the inaugural members of the ACT Club and have contributed greatly to the Club over the years. During a recent reorganisation we lost them from the Club for a period but they are now back and are as enthusiastic as ever. For example they are to host the Introduction to Expert Systems Day later in the year.

#### **BAe SEMA/Yard**

Yard was also a founder member of the ACT Club and during recent changes dropped out for a period. We are very pleased to welcome them back in and we now have an agreed programme of short training sessions that will take place regularly over the next 12 months.

#### **GEC Marine**

This company is a new member of the ACT Club and very welcome since it brings along with it VSEL that build and design Britain's nuclear submarines; Yarrows on the

Clyde that build frigates and other surface vessels and NNC who are specialists in Nuclear power plant consultancy.

#### **Wolfram Research**

This company has sales and marketing bases in Oxfordshire and a research development group in Champaign, Illinois. Each part of the company is linked into the Club activities and their product *Mathematica* is to be introduced to Club members through both an educational note and presentations.

#### **Bailey Automation**

This company is one of the leading world-wide DCS/SCADA suppliers. In fact Bailey Automation were a member of the Club some time ago and have recently rejoined. They bring to the Club hardware support capabilities and an interest in this area of technology, which is useful to all Club members.

#### **National Grid Company**

The National Grid does of course provide an essential service to the UK and the company is responsible for a huge network. One of the major developments of the Club software programme has been a Predictive Control Package, which we believe will be valuable for very large systems. There are few systems which are as large as the National Grid and hence we believe there are a range of ways in which we can support their main aim of improving robustness of supply.

The interaction between different Club members is one of the most beneficial features of the Club activity. It provides a forum for this to occur, bringing together managers or engineers at respective meetings. The increase in the number of Club members is therefore very beneficial, both directly and indirectly.

### ***ACT Club Linked to London Based Centre***

The benefits of membership of the ACT Club will soon be available to an enlarged group of industrialists when the new London Centre opens its doors with a launch-event to be held in November.

New Members joining the Club through the London Centre will benefit from a comprehensive Technology Transfer service made up of the wide range of facilities and activities emanating from the ACT Club enhanced by local activities provided by the London Centre. The initial specialist focus of the new Centre will be on control and information technology for application, particularly in the Process, Food and Biotechnology Industries. These technical areas may be extended in the future subject to sufficient demand.

The new London Centre will provide a convenient link to all of the ACT Club's existing facilities for new Members who are based in London and the South while meeting their specific Technology Transfer needs on a personal and interactive local basis.

The London Centre will be administratively based in the Department of Electrical Engineering and Electronics at Brunel University. Other Institutions (UCL, Universities of Westminster and Reading) will contribute their particular strengths as the programme develops.

The management structure is currently:

- *Manager of the Centre:* Dr Peter Turner, a control engineer.
- *Technical Content and Computational Aspects:* Dr Alan Macdonald, a computer scientist.
- *Provision of finance and infrastructure for the Centre's activities:* Prof. John Stonham, Head of the Department of

Electrical Engineering and Electronics.

- *Liaison with industrial partners and developing the Centre's programme:* Prof. Ron Leigh
- *London Centre Secretary :* Ms Valerie Beeley

### ***What happens next ?***

A major launch meeting will be held at Brunel University later this year to which we shall be inviting a wide range of industrialists to hear their priorities, explain the operation of the Centre and to take suggestions and answer questions. Representatives from Small to Medium sized Enterprises (SME's) will be particularly welcome.

If you would like to receive details of this meeting please contact Valerie Beeley on fax 01895 258728, or email Valerie.Beeley@Brunel.ac.uk, to add you to the mailing list.



**Professor Ron Leigh**, whose remit is to liaise with Industrialists to ensure that the programme of the new London Centre link to the ACT matches their needs.

### ***ACT Club Launch WWW Site***

In a move to provide better services to Club members the ACT Club has initiated its first World Wide Web Internet Site. At present the Site merely contains information regarding forthcoming events, reports, case studies and our general

activities. However, in the future it is hoped that we will be able to extend the functionality of the site to allow it to be used as a decimation mechanism for our deliverables making it more convenient for you to access the wealth of reports and knowledge that exists within the Club.

The Internet address for the site is:

<http://isc.eee.strath.ac.uk/actclub.html>

The site is still in its infancy and any comments regarding its style and content would be gratefully appreciated.



### ***New ACT Club Staff***

The ACT Club is very pleased to announce the appointment of our new secretary *Miss Lorna Fleming*. Lorna will be helping with the day to day administrative duties within the Club and taking a much more prominent role in organising our meetings and mailings.

Lorna will be more than happy to deal with any of your enquiries and can be contacted at the usual phone number and address. Her email address is [lorna@isc.eee.strath.ac.uk](mailto:lorna@isc.eee.strath.ac.uk).

Another recent recruit to the ACT Club is *David Chandrasegarar*. David's background is as a computer programmer, but he also has an avid interest in control and it's application. His main involvement will be with our new software developments, as well as the usual ACT Club events and training courses.

## CONFERENCE NEWS

### *San Diego in Control*

The 36<sup>th</sup> IEEE Conference on Decision and Control was held in San Diego recently. There were 1,020 papers in 18 streams of parallel sessions. The Conference provides the forum to present a number of major awards to control systems researchers and educators. A highlight of this year's awards was the 1997 IEEE Control Systems Award that was presented to Prof. Brian Anderson of the Australian National University. Brian has an outstanding international reputation and a remarkable spread of expertise across control, signal processing and systems engineering subjects. He has also done more than most to foster international co-operation.

It was also a great pleasure to see Prof. Neil Munro (UMIST) honoured as one of the IEEE Fellows for 1997. Only a very small proportion of the IEEE membership become a Fellow and it is awarded for "unusual distinction in the profession".

The Bode lecture prize was awarded to Prof. Ted Davidson (University of Toronto). It was in recognition of his considerable contribution to the field. His lecture, entitled "Control and Automation beyond the Kindergarten Level", was the most prestigious of all the IEEE plenary occasions.

He started his talk with the assertion that there was a gap between theory and practice and most would have agreed that this existed. However, he went on to make the rather surprising statement that "applications were way ahead of theory". It soon became clear what Prof. Davidson meant by this, since he was able to cite applications where the traditional control design procedures did not seem suitable. These applications had controllers obtained by studying the basic physics of the problem, but they did not fit into the usual model-based design framework. The fact

that industry often has solutions which are successful (based on a physical understanding of the process) but where traditional control theory seems to have little to offer, justified his assertion.

Prof. Davidson presented a video of a robotic arm for the International Space Station Project, where again conventional methods seem to have a weaknesses. This project by SPAR Aerospace of Canada provided convincing evidence that there were perhaps shortcomings in existing methods, but where good engineers could provide specialised solutions. He therefore concluded that new methodologies and algorithms were needed, particularly where plants and systems were large. One application he demonstrated involved switching the leads into an intelligent controller so that the multivariable system was temporarily fooled, but later recovered adequately.

Some of the important new areas that Prof. Davidson cited included:

- Complexity Analysis (for large systems)
- Intelligent Control (to cope with unanticipated events occur)
- Very large systems modelling problems (for systems of order  $N > 1000$ )
- Financial modelling
- Biological control systems (learning systems)

A Plenary was also presented by Prof. Lennart Ljung (Linköping, Sweden) on the subject of Identification for Control. Prof. Ljung distinguished between those factors which affect bias in estimated models and those which determine the variance of estimation errors. Prof. Y.C. Ho in his plenary, considered the growing area of computational intelligence.

What appeared to be a very useful practical technique for starting up unstable multivariable controllers

was described by Prof. Jakob Stoustrup (Aalborg University). His methods enable the controllers to be phased in gradually, so that the changeover between conventional and advanced controllers was as safe as possible. A contribution by Dr Michael Johnson and colleagues (Strathclyde University) on the design of controllers which were themselves stable, also had practical relevance. Most advanced controllers for high performance systems are unstable and this can cause commissioning and other problems.

One of the more popular subjects was predictive control and Joseph Bentsman (University of Illinois) discussed the use of  $H_\infty$  predictors within  $H_\infty$  predictive control.  $H_2$  predictors are traditionally used for this purpose, but Prof. Bentsman described the robustness properties of the  $H_\infty$  predictor. Dr Anthony Rossiter (Loughborough University) described his work on constrained predictive LQ control, prompting a lively debate on the considerable advances made in this subject.

A very interesting session was organised by Prof. Bill Helton (University of California, San Diego) on Non-Linear  $H_\infty$  control. Dr Michael Hardt (San Diego) described their work on jet engine control using  $H_2$  and  $H_\infty$ . Significant contributions from Japanese researchers such as Prof. Etsuro Shimizu on the design of  $H_\infty$  controllers for general non-linear systems or possible bi-linear systems were also described.

There remains considerable interest in  $H_\infty$  control and in extensions of standard  $H_\infty$  problems. Liu (Chiba University) considered the problem of  $H_\infty$  control with weighting functions containing imaginary axis poles. Kapila (Polytechnic University) considered an extension of  $H_\infty$  control for systems with transport delay. Another extended  $H_\infty$

## CONFERENCE NEWS (cont.)

control design for solving servo and estimation problems was discussed by Mita (Tokyo Institute of Technology). The trend seems to be to explore all of the possible permutations of  $H_\infty$  design to extend the range of applications considered.

For those who missed this interesting event, in the very attractive City of San Diego, they may like to note that the 1999 American Control Conference is to be held on the 2 - 4 June and the same venue. There remains a year to prepare papers!

### *Mathematical Control Flourishes in Florida*

The 4<sup>th</sup> SIAM Conference on Control and Its Applications was held in Jacksonville Florida, 7<sup>th</sup>-9<sup>th</sup> May, 1998. The Society for Industrial and Applied Mathematics (SIAM) is the leading US institution concerned with Applied Mathematics.

The highlight of this years event was the Special Session on Linear Operator Inequalities and the positive-real lemma presented by Prof. Ruth Curtain (University of Groningen, Holland). Prof. Curtain provided a very simple introduction to the related subjects of passivity, positive-real lemmas and Riccati equations. She began with a simple example of an electrical circuit and finished on the rather advanced subject of the control of infinite dimensional systems. In this latter case system models are represented by partial differential equations, as often arise in control problems. Her presentation which was outstanding in its clarity was very well received.

There has been considerable interest in the subject of smart structures, that is materials that respond to electro-magnetic or electro-static fields or materials have embedded actuators and sensors. Prof. H Banks (North Carolina State University) provided a

review of the subject and described some of the latest results. The interest from industry, particularly in the United States seems to be intense. It appears that smart structures will play an important role in a wide range of applications and will provide control problems involving difficulties such as hysteresis, non-linearity and multivariable behaviour.

The third plenary presentation that attracted a significant audience was by Prof. Petar Kokotovic (University of California, Santa Barbara). Petar discussed recent advances in nonlinear control and also dealt with the subject of passivity. He explained that for certain classes of nonlinear systems the "excess" or "shortage" of passivity would enable the stability of the system to be determined. He also revealed how in some senses passivity acts like the phase property in linear systems. Results from inverse optimal control problems, that were very popular two decades ago, are now being utilised in such designs. Although this approach is only applicable to a narrow range of systems, it nevertheless covers one of the most difficult areas of control; namely, the control of nonlinear plants. This is of great practical importance particularly in grossly nonlinear systems.

Another plenary talk, also concerned with nonlinear systems, was a very practical presentation from Prof. Andrew Teel, (Univ. of California, Santa Barbara) on accounting for saturation in nonlinear control system design. The approach he described was related to many well known empirical methods, but he presented a useful theoretical basis for the approach. The main point of his talk was that his control design method did not necessitate losing local performance. This he illustrated through a convincing example.

This theme of anti-windup was considered by Jonas Ohr (Uppsala

University, Sweden) in a related  $H_2$  optimal control approach. This also provided an method of dealing with saturation and wind-up that was very easy to implement. Maria Celeste (Imperial College) described their work on dynamic optimisation of large- scale systems. In fact these last two papers were poster session which worked very well.

Shankar S. Sastry (University of California at Berkley) talked about so-called Multi-Agent or Hybrid control systems which are now gaining in popularity. In this type of system a "dynamic" part represents changes with time (continuous or discrete) and the "event" part describes the system characteristics depending on the system's "state". A description merging the two parts was presented. The author described the application of this methodology to Air Traffic Control systems.

Camille Brochet (Lab. d'Analyse et d'Architecture des Systems) described a very interesting applications in the use of nonlinear optimisation methods for the station keeping of a constellation of satellites. John Clements (Dalhousie Univeristy, Canada) discussed another important problem in aerospace, namely the optimal control for conflict resolution in air traffic control. Andrzej Ordys (Strathclyde University) described advances in predictive optimal control design that dealt with problems of constraints.

Developments in general purpose optimal control software were described by John Betts (Boeing). It was surprising to hear the wide range of possible applications and the actual results obtained. Ekkehard Sachs (University of Trier) presented a paper on food processing systems. Once again it was interesting to hear real applications of optimal control and in this case in a rather unlikely industry.

## CONFERENCE NEWS (cont.)

Allen Tannenbaum (University of Minnesota, Minneapolis) presented a very interesting talk on Image Processing with applications to movement detection and control. For this purpose it is extremely important to develop fast and efficient algorithms for initial filtration of images to enhance the contrast and edges. Edge detection is the next stage enabling image segmentation and pattern recognition. The algorithms presented, based on the theory of curve and surface evolution, can be implemented in real time and applications range from medicine (cancer cells detection) to military (missile recognition and targeting).

Richard M. Murray (Caltech) gave a survey of recent development in the modelling and simulation of gas turbines. By making use of low order models and control oriented nonlinear analysis, notable progress has been made in controlling fluid instabilities in these systems. The author then described the control system design for avoiding the stall and surge effects and at the same time achieving high efficiency.

The attendance at this meeting was rather disappointing. However, the meeting did bring together some very respected mathematicians and engineers working on real problems. Another successful feature was the plenary presentations or mini symposia. These often involved tutorial material which is very well received by the audience.



## ACT Club Software News

### EASY 5

The ACT Club are pleased to announce that Applied Dynamics International (ADI) have recently joined the Club. This means that Boeing's Easy5 Control Design software is now available for use under ACT Club case studies. Those of you who have attended our recent Plenary Meeting will have seen the presentation on EASY5 and will know that its strength lies within its extensive applications library and speed of execution.

To find out more about EASY5 then please contact either us here at the ACT Club or Jim Robertson at ADI directly (*tel.* 01536 410077).

### Mathematica

As mentioned previously Wolfram Research have recently made Mathematica available within the Club. We are currently developing a tutorial report on these symbolic manipulation packages and their applicability for control system design and this will be issued in the late summer.

We still have a limited number of demonstration versions of Mathematica for Club members to try out. If you would like a copy please contact Lorna at the usual address.

### New Version of UNAC

Dr. Peter O'Kelly from CICS Automation in Australia presented the new version of UNAC (V4.1) at the recent Plenary Meeting this software is also available within the Club for use on Case Studies etc. The new version is particularly powerful in that it allows the seamless integration with traditional process control hardware systems such as,

Allen Bradley and Seimens PLC's and also DCS systems.

Interested parties can arrange for an evaluation license to be issued by contacting either the ACT Club or CICS Automation directly. More information about this product can be found on the Internet site <http://www.cicsauto.com.au>.

## New ACT Club Predictive Control Toolbox

The last issue of the ACT Club News described the forthcoming ACT Club Predictive Control Toolbox for Matlab. Unfortunately there has been a slight delay in issuing this to Club members however, we hope to have it issued by the Autumn of this year.

The new package has been produced as a Matlab toolbox and has evolved from work carried out on previous industrial control projects. The purpose of the toolbox is to provide a user-friendly environment for the design of Generalised Predictive Controllers (GPC) and Linear Quadratic Gaussian Predictive Controllers (LQGPC). The toolbox interfaces to existing linear and non-linear plant models through Simulink. The controller parameters are accessed through easy-to-use dialogue boxes. Consequently, this package is useful for predictive control novices as the underlying algorithms are hidden from the user. For the more advanced user these algorithms are accessible and can be modified as desired.

The toolbox requires Matlab version 5 and Simulink version 2 and operates under windows 95 and windows NT operating systems. Anyone wishing to obtain a pre-release version, when available, please contact Andy Clegg. This package will be subject to a one day training event that will be held later this year.

## **ENERGY & POWER SPECIAL INTEREST GROUP**

As you are probably aware the Marine Special Interest Group is one of the most successful activities of the Advanced Control Technology Club. Recently we have started to develop a Metal Processing SIG and this will be focused around an annual course on hot and cold rolling mills. Flushed with this success we are considering instigating an energy and power Special Interest Group.

The objectives of this SIG would be to bring together companies which have common interest in Energy Systems and Energy Benchmarking.

Sometime ago we distributed a questionnaire asking for your views on this. The responses we received were very encouraging.

Possible areas of activity of the Energy SIG are:

- simulation and control for generation systems
- control of distribution systems
- control of large scale systems
- improving energy efficiency through advanced control and optimisation
- distributed computer control systems
- reliability and fault-robust control
- implementation of algorithms

### **Action Plan:**

- ◆ Tutorial Session "Improving the Quality of Control in the Power Industry" - more details are given below.

All Club Members are invited to participate (*the reduced fee for the ACT Club Members is £40*). Please indicate your interest in this event as soon as possible.

- ◆ The Energy SIG "Kick-Off" meeting will be organised sometime in September. This meeting will decide the topics for Case Studies, reports and training.

- ◆ Following the decision of the "Kick-Off" meeting, the first formal event will be organised possibly in December. This may be a seminar or a training course.

At this stage we encourage all interested Club members to register for the Power Tutorial Session. The information on the tutorial session (and the IFAC Workshop following the session) is enclosed with this newsletter. Please note that you can register for either the whole workshop or just the Power Tutorial Session only.

*When registering for the tutorial session please indicate "ACT Club Member" on the form.*

### **IFAC Workshop on Adaptive Control & Signal Processing**

**Tutorial Session : "Improving the Quality of Control in the Power Industry", 25th August, 1998, University of Strathclyde**

Power generation systems are becoming increasingly sophisticated and diversified. The industry has nuclear, hydro, coal fired and gas plant technology operational. The power market has become increasingly deregulated, competitive and flexible. Power generation costs have to be kept low. Environmental concerns have always been present but highly stringent emission controls have emerged over the last fifteen years or so. These issues have impacted the industry in different ways. Enhanced safety critical controls for nuclear plant, increasingly flexible operation of coal fired plant and the wider use of combined heat and power, combined cycle and gas turbine technology have all been responses to these changes in the power industry.

Control systems and its technology has an essential role in many of these developments. In this Tutorial session short introductory talks on relevant aspects of control and its technologies will be followed by presentations of current applications which are using these methods. The speakers are from the power and control technology industries and also include some academic practitioners; all will be presenting highly relevant applications experience at the session.

**A second parallel Tutorial Session on Gain Scheduling is also planned, and details of this are also enclosed with the Workshop programme.**

For more information please contact:  
*Andrzej Ordys or Mike Johnson*  
*Industrial Control Centre*  
*email: acsp98@eee.strath.ac.uk*

### **Energy Efficiency Meeting for Oil and Gas Industries**

Improved and Advanced Process Control can provide real improvements in profit and energy efficiency and some of the greatest opportunities arise in the energy related industries.

ETSU has asked the Industrial Control Centre to organise a seminar with a general title "Control for Profit and Energy Efficiency", and a particular focus on Utilities and Power or Oil and Gas. The seminar will be joint initiative of Industrial Control Centre, the ACT Club and ETSU. The date for this is 14<sup>th</sup> October, in Glasgow. A tentative programme of the seminar is enclosed. Please reserve this date in your diary if you are interested. More detailed information will follow, closer to the date of the seminar.

## Links with Academic Projects

### European Union Project Success for the Club

The Industrial Control Centre has been recently successful with a number of project applications. The two of particular interest to Club members are international networks supported by the European Union:

- ◆ In-Control (Esprit)
- ◆ Dycomans2 (Copernicus)

In both cases the Industrial Control Centre acts as a project co-ordinator and the ACT Club is formally associated with the network activities. This means that the results of the two projects may be made available to Club members and the meetings of both networks are open for participants from the Club (subject to capacity constraints in some cases).

The IN-CONTROL Project is concerned with the development of tools and techniques that will enable companies to decide whether their process is being controlled well, relative to best practice. This is related to benchmarking studies and also to good tuning procedures.

The DYCOMANS2 network is concerned with dynamic control and management systems in manufacturing processes. The network attempts to bring together the different communities of Manufacturing and Control to cross fertilise ideas and or manufacturing problems to be understood more clearly by control engineers.

### **IN-CONTROL**

The partners for the IN-CONTROL projects are Elsag Bailey (Italy), Deutsche Babcock (Germany), Red Electrica (Spain) and the Universities of Bochum (Germany), Aalborg

(Denmark), Genoa (Italy) and Strathclyde University.

The ultimate aim of the project is to encourage manufacturing and process companies to use improved and advanced control methods, where appropriate. Companies must be able to assess whether their processes are being controlled well relative to best practice. The benchmarking problem would of course be easy if two similar plants could be compared and obvious deficiencies with one or the other determined. In most cases this is not a practical proposition for many reasons. There is therefore a need to develop analytic and simulation methods to aid this process.

A slightly different approach to this problem is to accept that it is difficult to compare different plants and hence to look at methods of assessing how well systems are tuned. One of the other features will be the development of methods which will allow the performance of systems to be determined and then tuned in an optimum manner. In this case optimality does not necessarily refer to a mathematical criteria but simply to good performance.

The working group will be managed by Dr Andrzej Ordys of the Industrial Control Centre at Strathclyde. If you would like to attend one of the meetings please let Andrzej know because he will keep you informed. The working group is chaired by Mike Grimble and Michael Johnson (ICC) is spearheading the controller tuning aspects of the programme.

This project will involve a market survey on advanced control usage and it should be of interest to both control equipment and service providers and to manufacturing and process companies. Register your interest now!

### **DYCOMANS2**

The DYCOMANS Network includes the following partners: Strathclyde

University, Silesia Technical University (Poland), University of Technology Zylina (Slovakia), Patras (Greece), Sofia (Bulgaria), Bucharest (Romania), Computer & Automation Research Institute (Hungary), Institute of Mathematics and Cybernetics (Belarus), Institute of Information Theory and Automation (Czech Republic), Laboratoire d'Automatique de Grenoble (France), Faculty of Electrical and Computer Engineering (Slovenia), START-Engineering (Bulgaria), ADERSA (France), Institute for Organisation of Production Systems (Poland), Department of Recognition Processes MII (Lithuania), Institute of Control Sciences (Russia).

The European Union is keen to facilitate links between Eastern Europe and the West. This is one of the objectives of the network that involves companies and universities around Europe. Once again the Network is chaired by Mike Grimble and is managed by Andrzej Ordys. In the past meetings on the Network have involved specialist events on power systems engineering and also metal processing.

This is the second stage of the DYCOMANS Network. The first three year programme finished in June of this year and the new programme will be for three years from that time. Half of the participants in the meetings are from manufacturing industry or academic manufacturing departments. This is very valuable in broadening the perspective of the control engineering groups and alerting them to the problems significant in manufacturing. Each of the Network meetings involves a programme of talks many of which try to address the interface between these two areas.

Manufacturing companies are particularly recommended to register their interest with Dr Ordys so that future information can be provided. External participation is also encouraged.

## Links with Academic Projects (cont.)

### Reconfigurable Control for Submarines

The ACT Club has recently lent its support to an EPSRC project proposal on reconfigurable controls. This proposal has been submitted with the support of the VSEL, Rolls Royce, DERA and Stirling Dynamics. The main application area will be submarine control but it does of course apply to a wide range of safety critical processes. If the EPSRC proposal proves successful there will be regular reports to Club members on the basic scientific advances, although the IPR on the actual submarine control system developments will reside with the aforementioned companies.

The reconfigurable control systems of interest do not necessarily involve active switching of the control law configuration. One of the techniques to be employed is to use a number of Kalman Filters which are tuned to different, possible system operating states. If there is a fault the Kalman Filter which most closely matches the fault condition is used to provide the state estimates. If there is some uncertainty whether a fault has occurred the state is given as a weighted sum of the various state estimates from the different filters. The resulting combined state is then used for control purposes. Such techniques are now being used in Advanced Flight Control Systems by for example the US Air Force. The application to more general systems is the main focus of this project.

## New Instrumentation Textbooks

The following text books have been made available in the ACT Club Library. If you would like to borrow them, then please get in touch with

our secretary, Lorna. Copies of the books can be obtained by contacting the authors Joe McGhee or Ian Henderson through the ACT Club offices.

### *Data Measurement: Principles and Practice of Digital Techniques Using Correlation by the Frequency Method.*

*Authors:* I. Henderson, J. McGhee, M. El-Fandi  
296 pages

The origins of this book developed in 1984 out of a need for suitable test equipment in a measurement and control laboratory for the measurement of frequency response. Research in measurement taxonomy or classification and information machines made obvious the close symbiosis between machines for measurement and communications. Data communications and information theory have their own philosophy in terms of the source and channel coding theorems, symbols and modulation. The main difference in measurement is that the symbols are used to capture information whereas they carry information in communication. This was a new and original approach to measurement not mentioned in the literature. Because of the close symbiosis with data communications, it was called data measurements.

This book was written principally to introduce data measurement and catalogue all the data measurement signals which have been discovered. A Matlab toolbox is available for use with the textbook.

### *Scientific Metrology*

*Authors:* J. McGhee, I. Henderson, M. Korczynski, W. Kulesza  
422 pages

This book deals with the fundamentals, introductory and intermediate level material on Measurement and Instrumentation. The book is divided into ten chapters

covering the basic and intermediate core material upon which later study should be based. Use is made of a large number of figures, tables and worked examples through the book. A representative selection of end of chapter examples or self assessment questions is also included. The chapter topics are:

1. Instruments as systems
2. Codes of practice, specification standards and physical standards
3. Presentation of numerical information
4. Calculation and treatment of measurement errors
5. Principles of sensors and transducers
6. Temperature measurement
7. Strain gauge measurements
8. Level measurement
9. Information display and recording
10. Digital Measurement

## Continuing Professional Development Schemes

As you are probably aware, the ACT Club is an IEE/IMechE registered provider of Continuing Professional Development (CPD) and all of our training courses and events qualify for points. The other Professional Engineering Institutions run similar schemes and the ACT Club is currently looking at linking in with these schemes as well.

However, at present there are moves to formulate a single common professional development scheme. This is likely to resemble the current IChemE scheme where the individual members is required to assess the suitability of the course/event and keep their professional development records up-to-date.

The ACT Club can provide you with the details of the relevant person to contacts within the various Professional Engineering Institutions for their CPD schemes:

## *ACT Club Control Engineering Training Courses*

The training courses described below are standard courses available through your companies membership of the ACT Club. The courses can be focused on your specific needs and applications and individual modules from different courses can be mixed to form a client specific course. In addition the courses can be aimed at technician to research engineer level.

Should your company require course modules which are not listed then our relationship with Strathclyde University can be exploited to ensure that tuition on virtually any control technique can be provided. Courses are generally run as and when required and can be conducted on your own premises or here in Glasgow.

All of our courses are eligible for CPD (Continuing Professional Development) as recognised by the major Engineering Institutes.

### ***Course 1: Classical Control and PID Tuning Methods (One Day)***

The course covers basic concepts of classical control and provides practical guidelines in implementation and tuning of PID controllers. The course is aimed at technician level.

### ***Course 2: Predictive Control (One Day)***

The course provides overview of Predictive Control techniques and then gives guidelines for analysis and tuning of predictive controllers.

### ***Course 3: Control Theory Fundamentals (Two Day)***

The course provides training on an engineering level in Classical Control Theory and Control System Design. The course presents frequency and time domain analysis of linear control systems. The PID controller and tuning methods are also covered.

This is the most popular training course that we offer. It is especially useful to those engineers who may not have had specific theory teaching during their electrical or mechanical engineering degrees. It also provides an excellent refresher course in basic control engineering for practising engineers.

### ***Course 4: Overview of Modern Control Design Techniques (Two Day)***

The course provides an overview of modern control design techniques ranging from Robust ( $H_\infty$ ) to Predictive Control, Adaptive Control and Fuzzy Logic Control.

### ***Course 5: MATRIX<sub>x</sub> (Three Day)***

This is a basic training course for control design and simulation using the MATRIX<sub>x</sub> family of analysis, simulation and realisation tools. This results orientated course provides knowledge and skills that can be applied immediately.

### ***Course 6: Control Fundamentals for Engineers (Six Day)***

The course starts from basic concepts of signals, systems and computer simulation. The course covers Classical Control Systems Design Methods, PID control, Multivariable Control design, Robust Control

techniques, Adaptive Control, Predictive Control and Optimal Control. The course is focused on use of advanced computer tools to control system design and simulation. The theoretical material is supported with numerous tutorial examples in MATRIX<sub>x</sub>.

### ***Course 7: Kalman Filtering (One Day)***

This course gives a detailed description of Kalman Filter theory and implementation.

### ***Course 8: System Identification and Self-tuning control (One Day)***

This course presents methods for System Identification and design of Self-tuning Controllers.

### ***Course 9: Robust Controller Design (Two Day)***

The basic concepts of robustness of control system are introduced. Those are analysed using classical design methods (for both single-input single-output systems and multivariable systems) and compared with modern ( $H_\infty$ ) approach. Available computer design packages are discussed.



## *ACT Club Services and Deliverables to Members*

The ACT Club provides its members with access to a very wide range of control technologies. This is accomplished through the various services that are listed below and which are **FREE** to members of the ACT Club.

- Regular Plenary meetings, training courses and awareness days on both basic and advanced subjects. *Typically 2-3 per annum, held centrally.*
- An annual training course at the company premises. This can be selected from our standard range covering virtually all topics in control, or tailored to meet your exact requirements. *Typically 1-2 days duration.*
- Case Studies proposed by members are undertaken to investigate the usefulness of new technologies. *Typically 3-4 case studies are undertaken per annum.*
- Special Interest Groups (SIGs) that focus our efforts onto particular sectors of industry. *Typically 1-2 meetings per annum.*
- Annual visits to provide consultancy advice at company premises.
- Instant access to consultants is available over the telephone, fax or email.
- The ACT Club's own range of user friendly software packages and toolboxes designed to make advanced control more accessible.
- Access to commercial software and hardware rapid prototyping systems.
- Detailed technical reports and easy to understand educational notes.
- Regular conference reports from most of the major events world wide on latest technology and results.
- Regular mailings and newsletters.

### *Case Studies*

Case Studies investigate the applicability of advanced control technologies to specific industrial problems as proposed by the ACT Club members. These studies usually take the form of a 1-3 month study, which can be either simulation based or use real hardware to interface directly to the members plant.

The following Case Studies have been carried out and the associated reports can be made available to Club members.

**ROLLS ROYCE:** Control of a Gas Turbine Engine (CS01/1992)

**BRITISH GAS:** Self Tuning Control of a Furnace Temperature (CS02/1992)

**BRITISH AEROSPACE:** Pitch Control of a Generic Canard Delta Aircraft (CS03/1992)

**BRITISH STEEL:** Control of Reheat Furnace (CS04/1993)

**BRITISH STEEL:** Gauge Control for Cold Rolling (CS05/1993)

**ROCHE PRODUCTS:** Non-linear Model Based Control for pH (CS06/1993)

**MARINE SIG:** Design of Robust Ship Positioning Systems and Advantages of Feedforward/ Feedback Control (CS07/1995)

**BRITISH AEROSPACE:** Classical versus Modern Control Design Methods for Safety Critical Control Engineering Practice (CS08/1995)

**BRITISH STEEL:** Multivariable Decoupling Control of Collector Main Pressure on Coke Ovens (CS09/1995)

**ROCHE PRODUCTS:** Roche Vitamin C Modelling Report (CS10/1995)

**BRITISH GAS:** British Gas Maintenance Reduction (CS11/1996)

**BRITISH PETROLEUM:** Introduction to Predictive Control with Application to a Hydrogen Reformer (CS12/1996)

**T&N TECHNOLOGY:** Gauge Control of Cold Rolling Mill (CS13/1996)

**ROYAL ORDNANCE:** An Operational Planning Tool for the Royal Ordnance Nitro-Cellulose Process (CS14/1995)

**BARR & STROUD:** Control of a High Resolution Laser Scanner (CS15/1996)

**MARINE SIG:** Implementation Problems and Design of Ship Autopilots (CS16/1996)

**MARINE SIG:** Advanced and Classical Control of Non-linear Ship Positioning Systems (CS17/1996)

**ROYAL ORDNANCE:** Expert System Based Training Simulator : Picrite Process Application (CS18/1997)

**SCOTTISH NUCLEAR:** Control Room Alarm Analysis Toolkit (*On Going*)

**UNILEVER RESEARCH:** Control of Supply Chain Dynamics (*On Going*)

### Technical Reports

Technical Reports provide a detailed theoretical description of specific advanced control techniques. These notes are written to be a concise and complete source of information that any engineer working in that particular field will find invaluable.

The following list gives all the ACT Club Technical Reports:

Application of Expert Systems in Industrial control (*ACT Report 1/1990*)

A Tutorial of Polynomial LQG/ $H_\infty$  Optimal Control for Industrial Users (*ACT Report 2/1990*)

A Tutorial of Digital LQG and  $H_\infty$  Self-Tuning Control for Industrial Applications (*ACT Report 3/1990*)

$\mu$ -Analysis and Synthesis (An overview of an Optimisation - Based Methodology for Multivariable Control Design) (*ACT Club Report 4/1990*)

Weighting Functions in  $H_\infty$  Control (*ACT Report 5/1991*)

Introduction to Non-linear Self Tuning Control (*ACT Report 6/1992*)

An Introduction to the Control of Non-linear Processes (*ACT Report 7/1993*)

Mathematical Notations and Glossary (*TR07/1993*)

On the Performance of Generic Model Control (*TR09/1993*)

An introduction to Neural Networks (*TR10/1994*)

Long Range Predictive Control: A Review (*TR11/1994*)

Introduction to the Benefits of Controller with Several Degrees of Freedom and the Use of Feedforward Control (*TR12/1995*)

Applications of Fuzzy Logic Control (*TR13/1995*)

Tutorial Introduction to  $l_1$  Analysis and Synthesis (*TR14/1996*)

Comparison of the Design of a Marine Autopilot using  $H_\infty$  Design and Quantitative Feedback Theory (*TR15/1997*)

Advances in Autotune Methods (*TR16/1998*)

### Educational Notes

Educational Notes are a simple introduction to the various control subject areas that are becoming increasingly prominent and relevant to industry. These introductory texts are aimed at engineers with no prior knowledge of the subject described and provide a basic understanding of the techniques involved.

The following list gives all the ACT Club Educational Notes:

What is  $H_\infty$  Optimal Control ? (*EN01/1990*)

What is Robustness ? (*EN02/1990*)

Typical Robust Control Design Problems ? (*EN03/1990*)

What is Self-Tuning Control ? (*EN04/1990*)

A Note on Smith Predictor for the Control Process Plants with Significant Transport Delays (*EN05/1993*)

Tutorial on Variable Structure Control for Industrial Users (*EN06/1995*)

Simple Introduction to Kalman Filtering (*EN07/1996*)

An Introduction to Discrete Event Simulation (*EN08/1997*)

### ACT Club Software

The software packages listed below provide intuitive user friendly tools for many of the common control design laws. Comprehensive manuals and examples are provided and complementary training courses often exists.

**4 DoF Non-linear Ship Modelling Package for MATRIX<sub>x</sub>**

**EASY\_KIT Toolbox for MATLAB**

**Self-Tuning Control Software**

**Nonlinear Self-Tuning Control Software**

**Multivariable Robust Control Toolbox for MATLAB**

**Robust  $H_2$  Feedback/Feedforward Control Design Toolbox for MATLAB (Polynomial Approach)**

**$H_\infty$  Robust Control Toolbox for MATLAB**

If you require more copies of **The ACT Club News**, then please complete the form below and return by to Andy Clegg at 50 George Street, Glasgow, G1 1QE. *tel.:* (+44) 0141 553 1111, *fax:* (+44) 0141 553 1232, *email:* actclub@isc.eee.strath.ac.uk.

Please send \_\_\_\_\_ more copies of this newsletter.

Name: \_\_\_\_\_

Company: \_\_\_\_\_