Roboteers in Residence: an evaluation for the BBC

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1 The Brief

1.1 Background

Modelled on Artists in Residence and Poets in Residence, Roboteers in Residence is a NESTA funded pilot project in which Expert Roboteers planned 30 one-day workshops in Further Education colleges across the UK between September 2002 to April 2003.[1] Roboteers were also allowed 20 days preparation in July and/or August in the lead up to the residency so that any building activities for the workshops could be planned ahead. This pilot project was intended to test the Roboteers in Residence model in 5 host FE colleges with a view to encouraging other parties to adopt and sustain the model in years to come.

The FE colleges were located across country	*the assigned roboteer*
St Helens, Merseyside [2]	Mike Franklin
Richmond, London	Ian Swann
Ballymena, Co Antrim	Peter Redmond
Newtown, Powys	Adrian Marshall
Kirkcaldy, Fife	Ian Watts

The idea stems from NESTA funded work carried out by the BBC project management team over the past year. A series of inspiration workshops in schools, exhibitions, a CD ROM for teachers and other activities have provided many school children with a taste of robotics. The programme of residencies comes from a desire to explore deeper opportunities for learning about robots - primarily with the 14-18 age group - for fun and in real life.

[1] Subsequent events led to a change of time-scale, extending it to Dec 2003
[2] This centre withdrew before work commenced and was replaced by a Northamptonshire Centre

It was planned that the Expert Roboteer would work with FE college D&T staff to help student residents construct a competitive robot for BBC Techno Games or a prototype robot for other outcomes (e.g. local industry, education, local community) through hands-on training and guidance [3]. The plan was that residential sessions would be scheduled by the Expert Roboteer in consultation with staff at each FE College where residencies were held. Finished robots were showcased at end-of-residency events in the regions, including exhibitions of drawings, computer generated images, working diagrams, models, prototypes and finished robots. The winning teams from these regional events were subsequently showcased at the Young Scientist and Technology Exhibition in Dublin in Jan 2004.

A prize was awarded for the most successful residency, in terms of collaboration and overall achievement of the robot projects. This was judged by the steering and advisory group and jointly awarded to the college and Expert Roboteer to carry out further work together beyond the formal period of the residency.

1.2 Project aims

The explicit aims of the project were

To show how to deploy the skills, energy and ideas of expert roboteers so as to ...

i) initiate a deeper interest and involvement in robotics among Design & Technology and Engineering students in the 14-18 age group, and

ii) deliver a high-quality face to face learning opportunity for Techno Games robot builders throughout the year.

1.3 The evaluation

The evaluation was conducted by Prof Richard Kimbell of the Technology Education Research Unit Goldsmiths University of London. The geographic spread of the FE colleges raised logistic problems for the evaluation, and to deal with this problem Prof Kimbell appointed a team of experts in design & technology - each located within reasonable distance of the four colleges outside London (the Richmond college was dealt with by Prof Kimbell). Three experts were therefore appointed: in Scotland, in N Ireland, and in Shropshire (to cover Powys & St Helens)[4]. The experts are either Local Education Authority advisory staff or HE lecturers in design & technology and not only brought appropriate experience and expertise to the evaluation, but also sought to contribute to the smooth running of the project.

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[3] In the event, the BBC withdrew the Techno-Games series and the target for robot building became regional 'heats' leading to the winners showcase at the Young Science & Technology Exhibition in Dublin in Jan 2004.

[4] Following the withdrawal of St Helens, the Shropshire evaluator concentrated on the Powys centre.

The evaluation team met at the start of the project to debate the data that needed to be collected and appropriate modes for collecting it. It was assumed that these data derived from:

- questionnaires to roboteers / FE staff / students
- interviews with roboteers / FE staff / students
- systematic observation of working sessions with roboteers / FE staff / students
- photographic and other recording of work by roboteers / FE staff / students

One of the key procedures underpinning these approaches was to identify in advance the questions that the BBC / Nesta needed to answer, concerning the effectiveness of the RiR programme. For example “is the roboteer working within or outside the formal college curriculum?” and in either event “to what extent and in what ways does the roboteer impact on the normal curriculum of the college?” These questions (and many more) then became the focus of the questionnaires / interviews and enabled the evaluation team to provide the BBC / Nesta with appropriate answers at the end of the project.

Following the preliminary meeting of the evaluation team, local contacts were made with the FE colleges and roboteers, and the plan was for each evaluator to make three visits to their designated college, to interview the people and observe the practices. The distribution of the visits was agreed with the college/roboteer.

At the end of the data gathering process, each evaluator prepared a report on their local college and these reports were assembled into a full project report by Prof Kimbell. It was originally planned that the report would be prepared by the end of July 2003, but the revised schedule agreed between the BBC and Prof Kimbell has resulted in a final report being requested at the end of Jan 2004; ie after the Dublin event.

2 The evaluation team

The evaluation team was constructed in the light of the geographic constraints of the proposal: ie the need to visit St Helens, Merseyside; Richmond, London; Ballymena, Co Antrim; Newtown, Powys; and Kirkcaldy, Fife. It was necessary to have all members of the team as design & technology specialists, and accordingly the following team was assembled:

Wesley Hamilton	Lecturer in Design & Technology	Stranmillis University College, Belfast
Susan McLaren	Lecturer in Design &Technology	Strathclyde University, Glasgow
Paul Clewes	Advisor for Design & Technology	Shropshire LEA

The original plan was for Wesley to visit Ballymena, Susan to visit Kirkcaldy, Paul to visit **both** St Helens and Newtown, and Richard to visit Richmond.

The team met in the TERU offices at Goldsmiths College for a planning day on Thursday 7th Nov. At that meeting the evaluation was planned in detail; the data to be gathered was determined and the data gathering instruments were developed and printed.

3 Issues emerging in the field

3.1 Setting up the project

• the selection of FE colleges and schools

From the outset, FE Colleges were seen to be the hubs at which the roboteers would be based to make contact with a number of school students. The plan involved an FE College using it's contacts to a small number (4-5) of local schools – each of which would release a small number of students to attend robot building sessions run by the roboteer at the 'hub' FE College. The starting point therefore was to identify excellent FE Colleges, and the BBC did this through it's 'Learning Link' advisers in 4 regions (Scotland, Wales, N.Ireland, and England [Merseyside + London]). The project was then centred in the most appropriate department of the Colleges; for example in Richmond it was the 'Technology' department that incorporates Design & Technology, Engineering, and Built Environment.

The selection of schools was largely in the hands of the head of department in the College, or the person designated as the project manager in the department.

• the link between Colleges and Schools

The link between schools and FE Colleges ought to be strong, since the former are frequently 'feeder' schools that supply 16+ students for A level, GNVQ, National Diploma and other courses of study at FE Colleges. But these links are not always good, and even if they are, it is NOT common for pre-16 students to be released from schools for a short time during the week to attend curriculum (or extra curricula) sessions at College. The logistics of this – for a school – are potentially complex. How would they be transported? Who would be responsible for them? Do parents have to sign consent forms? Who is responsible for Health & Safety? Does a teacher have to go with them? What happens to others in the same group?

In all but one of the centres this link was less than good and resulted in real problems. In Richmond it resulted in the roboteer having to by-pass the College and go through the Local Education Authority channel to find four possible schools. And having found them, they didn't want (for the reasons suggested above) to have their sessions at the FE College.

> Many of the schools were strongly opposed to going and working away from their normal environment, especially on a Saturday, and of course the college could not work on week days. Going to the schools individually has allowed me to tailor my approach to their particular abilities as well. (int Richmond Roboteer) [5]

> The college as a base is a waste of time. This is for many reasons. The schools themselves are very reluctant to go to the college to work. The college and the schools have very different timetables and it was, in my case, impossible to reconcile these to get the groups all together. (Richmond Roboteer interim report)

In Powys these problems were compounded by the local geography. Whilst the majority of schools were represented at an inaugural meeting at Coleg Powys it was apparent that schools would not release students to attend the College to take part in the project. This area of mid - Wales is very rural and there are considerable distances between almost all of the schools and the college and the time taken to drive from one location to another is considerable.

In Ballymena, the link between schools and the college was made even more difficult by the fact that the N Ireland Grammar schools in particular have almost no contact with FE Colleges.

> Contact between the Institute and the post primary sector seemed to be at a formal level and by means of a circular only. The impersonal nature of the relationship was not conducive to getting an immediate and welcoming response from the schools.

> As a result, schools were poorly informed in June 2002 about a new project commencing soon after the holidays. This was much too late for teachers to get involved, and for them to begin reorganising classes, timetables and resources for a project that they knew very little about. (Ballymena evaluator)

In Ballymena therefore, the ideal of having school pupils and further education students attending the NEI Centre on a particular day or on two afternoons during a school week was impossible to achieve.

This meant that there – as in the London and N Ireland centres – the roboteer had to visit the schools individually, rather than focus his teaching on the College. Such individual attention was of course very demanding on time and resulted in the roboteer seeing the students less frequently. The reciprocal advantage however was that (as the roboteer points out) his sessions could be more tailored to the needs of the students in the schools.

The case of the St Helens (Merseyside) centre is a special case illustrating this problem. So poor were the connections between the FE College and the local area schools that student groups were never properly identified, and never taken ‘on-board’ with the project. After months of vacillation, the centre was eventually ‘written-off’ by the BBC, and the Merseyside area was abandoned for the purposes of this project.

In contrast to these examples however, the Scottish centre had no such problems. Kirkcaldy Institute of Applied Technology is the largest IAT in Scotland and is involved nationally in the ‘Young Engineers Club’ initiative. For

over two years it has been involved in hub and spoke/outreach and has good working relationships with students from 5 years to 18 years old and runs a schools programme in which students come into the Institute for teaching and activities. The opportunity to have a roboteer to enhance and develop various aspects of current work was appreciated, and capitalised upon.

• the selection of roboteers

The posts for roboteers for this project were advertised nationally, but the network of known professional roboteers was also exploited, in part through the auspices of the FESTA team at UCE Birmingham. Selected applicants were interviewed and chosen on the basis of their roboteering track-record and their suitability to this educational venture.

> ***Richmond Roboteer***: A non–graduate, self taught in terms of robotics. Worked in 'remote measuring' of strip steel – then ran his own company doing control software. Worked on Robot Wars; twice UK winner with 'Chaos 2' (the flipper). He really enjoys working with children and has done so regularly with top juniors (11-12 years old) and at school fetes ("their enthusiasm is terrific") – showing them how they can achieve far more than they think they can. He has a particular soft spot for the ones who have been 'written-off' by formal education. He believes that engineering is under-promoted in the UK and sees roboteering as a terrific vehicle to enthuse youngsters.
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> ***Kirkcaldy Roboteer:*** Well known by those involved in Robot Wars, he has worked for the BBC for many years. . He has been involved in teaching and training at HNC/HND and university level for over 10 years. He has great and genuine enthusiasm for getting youngsters involved and works through a very student centred approach. 'Even the toughies at the back did air punches and exclaimed YES!' when he introduced the project. His attitude was that everyone involved should have fun and get a kick out of taking some risks. He had no expectations of any serious engineering, but hoped to raise interest, and expectations. 'Ultimately it doesn't matter about winning….it's about dealing with failure, takeaway and improve, understand that it is a prolonged slog and learn how to persevere.' What is important is that students 'learn how to lose and how to win and learn how to learn from losing.'
>
> ***Ballymena Roboteer***:
> Enthusiasm and a passion for things mechanical and electronic were key qualities in the choice of Roboteer. He is an Aircraft Engineer and teaches apprentices aeronautical engineering. He has experience of avionics, has an engineering degree, and is currently completing his M.Sc. Anything that is mechanical and moves, he is keen to interact with. He loves problem shooting and fault-finding and gets a real kick out of getting young people involved in this way of thinking and operating. In particular he enjoys working with disadvantaged groups enabling them to experience success and to get fun from manufacturing mechanical things and making things happen. His enthusiasm and practical know-how causes others to want to join in and get involved.
>
> ***Powys Roboteer:***
> He is personable, a good communicator and is enthusiastic about the field of robotics. His previous experience of providing problem-solving engineering solutions within industry (including a cake icing machine for Mr Kipling), his involvement as a competitor with 'Robot Wars' and 'Techno-games' and his experience of providing fun robotics activities for groups of children at his daughter's primary school provided him with an excellent background to work as a roboteer in residence.

The roboteers were invariably the real strength of this project. They were all personable, highly skilled and ingenious with robotics, very engaging with youngsters in schools, and they brought with them a huge level of credibility with schools.

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[5] It should be noted that the interviews throughout this report were not recorded, and the resulting "quotations" are not direct transcriptions. They are reconstructed from detailed notes taken during the interviews. Whilst they reflect both the

> "Because they have seen him on TV - XXXX has got real 'street cred' with these lads". (Head of Engineering - Coleg Powys)

• the link between students and roboteer

The selection of roboteers was undertaken separately from the selection of FE colleges, which were seen as the hubs around which this project would revolve. Accordingly there was no pre-planned geographic 'fit' between the selected roboteers and the colleges in which they would work. As examples, the Fife (Scotland) roboteer travelled from his home in Brighton, the Richmond (SW London) roboteer from his home in Ipswich, the Powys (mid-Wales) roboteer from his home in Buckinghamshire, and the Ballymena (Northern Ireland) roboteer from his home in Southern Ireland.

Not surprisingly, this geographic dislocation created many headaches.

> I think the amount of time, and mental energy, I spend travelling is very wasteful of resources. It would be far better if my residency was local to me. Not only would I spend less time travelling but also this time could be spent with the students (Richmond Roboteer interim report)

A related problem was the increased dependency of the project on the teachers in the schools who had to maintain the energy level of the project.

> It has been a matter of 'out of sight-out of mind'. If I could have been at hand then it would be much easier to keep the momentum and interest going (Richmond Roboteer interim report)

• the selection of students

Student identification for the project was a matter for the schools, but was predominantly based on students volunteering to take part. Where there were more volunteers than could be managed, the selection process was commonly based more on the ***attitudes*** of students than on their skills, knowledge or experience. Qualities of determination and 'stickability' and ability to work in teams appear to have been at the heart of teachers' selection processes, particularly as this was a long term project that had to be seen through to the end.

The project has drawn from a wide variety of student groups – from primary schools (age 10 years) to further education college students (up to age 23 years), and the following are comments from the students about why they volunteered for the project.

> ' I enjoy technical stuff - that sort of thing…I want to do dentistry' (Greg)
> 'I enjoy archery, joinery and I've worked in industry but not with metal…. It will be best if theoretical maths is not so important.. I like trial and error and I'm interested in moving into research' (Jamie)
> 'My only experience is in LEGO Technic!- but I'm not afraid to show ideas and be enthusiastic' (Michael)
> ' I enjoy playing about with computers….like programming robots' (Russell)
> 'Dad got me into fixing things and IT, has own business, not engineering, mind!' (Sean)

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facts and the tone of the comment, they are not the verbatim words of the interviewee.

The gender groups - as suggested by this list - have not been evenly distributed. As an illustration, in the Richmond centre, of the four school groups + the college group (ie 20+ students), there was only one girl. The exception to this rule was provided (not surprisingly) in the primary schools (Scotland & Wales) where the gender groups were evenly represented.

A number of schools in Scotland, in addition to the daytime input from the roboteer, ran the project as extra curricular through Young Engineers Clubs (YEC). The organising teacher of one YEC in Fife (a probationary technology teacher) comments as follows about the gender factor.

> 'We haven't got a tech studies class this year. I get paid through supported study for 1 hour and add a voluntary half hour to the YEC meetings. 4-5.30. It's attended by between 15-20, all boys. Girls were initially interested from the talk, video and demo provided by Ian but only boys turned up to the follow-up meeting with me and Ian.
> (St Columba's School)

In Powys, one of the groups was based at Coleg Powys. It was offered to all the students on an engineering course but some had rejected it, and by the time of our first visit the group was composed of 4 (all male) students who were 16/17 years old and were following NVQ L2 Engineering courses (Performing Engineering Operations).

> "We have found that the older/mature students are not interested in Techno games" (Acting Head of Engineering – Coleg Powys)

In Ballymena, pupils in schools were all taking Technology and Design at GCSE level. What they had in common was an interest in this type of activity and they saw it as a challenge that was real and exciting. They liked the idea of working with a Roboteer who had a proven track record in the field and they very quickly got to know about him.

> "They needed no convincing when XXXX arrived in the school playground with his weaponry."
> (Ballymena evaluator)

• the emerging links between schools and roboteers

The logistic difficulties created by the disconnection between schools and the colleges, and the dislocation between these and the roboteers' home bases has resulted in some uncomfortable and inefficient arrangements. The common denominator of these problems is that the FE College is typically NOT being used as a hub but is just another independent centre along with the 3, 4, or 5 schools that were supposed to be attached to it. So the roboteer rotates around the student locations – doing separate visits to each – rather than seeing them collectively. Given that each roboteer's contracted time is finite, this has the effect of reducing the time that he can spend with any particular group of students. The following examples illustrate the situation.

> Richmond roboteer: Operates Tues after school (3.30-5pm) in school 1; Wednesday 2.30-3.30 in school 2; Thursday lunchtine (1-2pm) and after school (3-4.30pm) in school 3; all day Friday in school 4; and at the FE College on

Saturday 10-3pm. He typically sees the schools every 3 weeks and by doing this is significantly overrunning his contracted time.

Fife roboteer: Traveled to Scotland from Brighton (approx 450miles) in 3 day blocks every fortnight up to Christmas 02. This involved working with IAT College students on Monday pm and YEC Monday evening. St Columba's High School on Tuesdays. Balwearie High School students and college students on Wednesdays at the IAT. After Christmas the scheme was extended to include locations as far flung as Orkney, Montrose, and Peebles to roll out the roboteering and technogames challenge to schools beyond those working with the IAT centre in Kirkcaldy.

The Ballymena roboteer operated somewhat differently, with more groups in fewer centres. He ran two groups of roboteers in Ballee High School and both were involved with solarbots. Two groups were also identified at Ballymena Academy – a rope climber, and a swimming duck, whilst at the North Eastern Institute, three robot groups were underway with National Diploma students.

The Powys Roboteer established one of the most devolved arrangements, with groups operating in five high schools; Llandindrod Wells, Llanidloes, Buith Wells, Welshpool and Newtown, There were also groups set up at Llandinan Primary School and at Coleg Powys.

Devolved (school centred) arrangements were therefore used throughout the project by all roboteers. The original plan of using the college as a hub to draw in school students did not work anywhere. Whilst the scale of devolution varied across the regions, school centres were seen to be the only realistic plan.

There were at least three connected consequences of this devolved form of operation (across many schools, colleges and campuses) that was universally practised by the roboteers. First the roboteer was crucially dependent upon the staff in the schools to maintain the project during his relatively extended absences. Second it was more difficult for the students/staff in those schools to maintain students' enthusiasm and commitment to the project. Third the arrangement was inconvenient not only in terms of roboteers' 'other' lives, but crucially in relation to their immediate access to the known resources of their home base. When asked the question 'what would you do differently next time?' a common first reply was.. "Keep it local".

- ***the schools/sessions observed***

The evaluation plan required that each of the centres would be visited three times to observe the robot building operations. The three sessions were designed to gather data at key points in the development of the project:

visit one (Nov/Dec '02) - background data (on the College, the schools, the roboteer, and the students)
visit two (Feb/Mar '03) - interim data on the progress of the work
visit three (May/June '03) - concluding data on the outcomes of the project

This plan was thrown into some disarray (i) by the unevenness of the start times, and (ii) by the lack of good communication between the roboteers and the evaluation team at the outset of the project. The communication problem was sorted out by the BBC in early '03, but Scotland was already underway by that time. The evaluation team improvised arrangements to observe as much as possible and to gather as much data as possible in a format that made the centres as comparable as possible. The arrangements made in the regions are outlined below.

Richmond: Visit 1 was to the FE College to meet all the staff. Schools had not at that time been identified, so we were unable to meet school staff or students. Because of the devolved arrangement that emerged in Richmond, visits 2 and 3 were to a school to observe a particular group of students working through to completion. The school was chosen because the roboteer described it as his 'very best' and 'most committed' school, and we judged it to be important to see how the project worked in the best centre available. We recognise of course that because of this selective approach it is not possible to generalise the comments about the project in this school to the other schools (and the FE College) in Richmond.

The Richmond centres were:
- Orleans Park School
- Sheen International School
- Gray Court School
- **Hampton Community School (yr 10)** [6]
- Richmond on Thames College

Fife: The project got off to a very fast start, since the roboteer wanted finished robots for the Nov 2002 filming of Techno-Games. Intensive visits were therefore arranged to the following centres. After the filming, the roboteer developed a different approach – essentially 'rolling out' the programme to a much wider number of centres including the west coast and Scottish Islands.

The Fife centres were:
- Balwearie High School.(5 advanced level students)
- **IAT College team, (5 students aged 17 to 23 years)**
- Young Engineers Club from IAT, (incl Claire Motion, 11 years old)
- **St Columba's Secondary School Young Engineers Club. (12 S3 students [13 years])**

Powys: There were two groups of students observed during design and construction as well as all of the groups seen on the day of the regional final. One of the observed groups was based at Coleg Powys, and the other was based at Builth Wells School.

The Powys centres were:
- Llandindrod Wells,
- Llanidloes,
- **Buith Wells, (y9)**
- Welshpool
- Newtown,
- Llandinan Primary School
- **Coleg Powys. (NVQ L2)**

Ballymena: The roboteer ran two groups of roboteers in **Ballee High School**, and another two groups at **Ballymena Academy**. All these school groups were with GCSE 'Technology & Design' students. At the **North Eastern Institute**, three robot groups were underway with National Diploma students but operating from different campuses with a minimum 90 minute drive between them.

[6] Schools in **bold** were observed on multiple occasions – typically 3 times

3.2 Roboteering in the schools

• the first contact

In every case that we observed or had reported to us, the initial contact in schools between the youngsters and the roboteers was immensely engaging, motivating and enriching. It was frequently organised as a 'showcasing' event at which the roboteers brought along some of their robots and demonstrated them. Since some of these robots have become household names (at least with followers of Robot-Wars) and some of the roboteers themselves have become familiar faces, this showcasing was invariably a 'wow' event.

At one Richmond centre, the school hall was the venue, with 200 youngsters packed in to watch the roboteer do his stuff. It created huge interest and lots of associated 'street cred' for the design & technology department.

In some centres the first 'taster' session was itself a hands-on experience. The following observation was not untypical

> XXX gave a basic introduction to the system of control and the component assembly required. XXX got them curious by showing them the bits and saying what they are and then wiring them up and testing the servomotors.. He introduced (using chalk board) the components, their names and functions. He provided clear instructions for handling the servos and transmitters. He encouraged early fiddling and wiring up capitalising on the curiosity of the pupils. Then he gave advice about the control of servos and the use of the control sticks etc. He then explained the task and basic design specification for their robot i.e.build a robot which has to be good at
>
> - Sumo - pushing ability
> - Assault - fast, nimble and negotiate obstacles
> - Football - fast and kicks/ pushes.
>
> The pairs of pupils worked with his support and advice when required. He asked prompt questions to encourage students to review their own ideas, work and prototypes. He asked them to give names to the robots and tests were carried out as a knock-out league. Boys and girls were equally engaged for the full duration. He was keen to have the students ask themselves 'why ' if the robot lost its race/ fight. Why did our robot fail and how can it be improved?' Pupils were very willing to modify and change and even rebuild totally. Working fast, thinking things through and accepting the need to alter. They were obviously enjoying the competition element as a celebration of the whole achievement. There was time for fun with Sumo, obstacle and class football before the robots had to be taken apart. (Fife evaluator)

• staffing/teacher issues ?

The importance of teachers support in the schools was made time and time again. The devolved nature of the programme in which roboteers were working with groups in separate schools, inevitably created longer interim periods of no contact. It was at these times that the role of the school staff became critical. At one school in which the project was working very well, the roboteer drew attention to the importance of the teachers.

> The two teachers here are extremely committed to the project and have the backing of the school. They are prepared to stay long after school hours and are able to be there for the group when I can not be. (Richmond Mar 03)

In this case the roboteer saw the students for a whole Friday every 3 weeks, and in the two intervening weeks the teachers ran a lunchtime technology club to keep the work progressing and the youngsters engaged.

This level of staffing commitment was not always so evident. At one FE college the staff were not prepared to work over hours and this made working arrangements difficult for the roboteer. Towards the end of the project the staff "pulled out completely" and this meant that the students were not taken to the regional finals and their robot was taken for them by the roboteer. The sadness of this circumstance was underlined by the efforts of one of the students to make his own way to the regional event by motor bike.

In the schools, the demands of the national curriculum and the GCSE examinations sometimes (ie in some schools) permitted little flexibility within teaching timetables for what was being regarded as 'something extra'. Staff could not be released from their timetable commitments and pupils could not be released during normal class time. Consequently the projects in such schools were organised as an extracurricular activity.

A big and recurring issue was teacher ***confidence***. From several centres we had reported to us the idea that having done this project once under the direct tutelage of the roboteer, they (the d&t teachers) would now be able to take on a similar project for themselves in the future. In one Richmond centre, the teacher reported that his year 7/8/9 after-school technology club …

> … would be moving away from "making" and engaging more in technological and robotic projects. We will start with simple motors, gearboxes, and radio control and I think we'll have … something like… a robot football competition. (Richmond teacher)

It was frequently reported that the further they went into the project, the more confidence they had with the project – and with their own ability to lead it. They were drawing on knowledge that had not been used much to date, and were learning more about the appropriate technologies, but the essential approach to the project was very comfortable for them (much more so than for science and maths teachers). It is not surprising that this confidence tended to show later in the year (from Easter onwards) as the teachers increasingly realised that they could do it.

This is a great compliment to the project – and perhaps it's greatest enduring contribution to the schools.

• *resource issues*

Three resource issues are worthy of comment here.

First concerning the ***technical*** resources; the cylinders and clips and connectors, and control boards and all the other technical paraphernalia that are central to robot-building. The project provided a budget for each centre for the purchase of such resources, but it was frequently the roboteers themselves who were the key suppliers. They have access to all sorts of componentry through their network of contacts and suppliers, and we frequently

observed their generous support of the school projects through these means. As an example, one roboteer has developed a control board that he uses for his own robot-building, and he presented one of these boards to each of the schools he was working in. Furthermore, the connections between the roboteers and their suppliers often encouraged the supplier to be equally generous with the schools.

> They (the students) have made very good use of my Robotics XI board and have learned how to programme it to make their robots move to their commands using Delphi programming language which Borland UK have very kindly donated to all my schools (Richmond roboteer interim report)

There were some difficulties with compatibility however, since the excellent opportunities provided by the roboteers sometimes extended the 'in-house' resource demand beyond the capabilities of the equipment in the schools.

> "No (school) computers will let us use the programming software" (Y9 student Powys)

The second resource issue concerned running expenses, which the schools found difficult. Not infrequently, teachers found themselves funding purchases on their own credit cards, in good faith that they would be recompensed either through the roboteer/BBC or through the school.

> A budget allowance would have been good. Each school getting something up-front and then it would be easier to see what was possible/ available' (Fife teacher April 2003)

Third, it is important to note the characteristic ingenuity (and scavenging instinct) that d&t teachers brought to the resource issue. The concept of 'found' materials was taken to new heights as old desks, deconstructed bits and pieces, cardboard waste, blue-tack, masking tape, bottle tops and pen casings were recycled into robots.

• *teaching & learning issues*

Invariably we saw excellent approaches to teaching and learning being deployed by the roboteers. Since they are not primarily teachers, we assume that their approach is ***intuitive***. In any event, their approach centred on them seeking to engage youngsters interest – and through that interest to encourage them to participate in the 'harder' bits of robot design and development. The following observation is typical of the initial approach adopted.

> "XXX placed a dancing ant weight robot on the carpet and let curiosity gather the students. He then placed another robot type on the table. He then started to pose questions…. 'What happens if the robot hit something?' then ' What could we add, to help this robot so it doesn't get stuck against the wall…? and so on. "(Fife Nov 02)

It was also noted that this open questioning approach that characterised the roboteers performance throughout the project was in some contrast to the approach adopted by other staff.

> "XXX approach contrasted greatly with that of the engineer helper at the Young Engineers Club, who was working with XXX on the rope climber. He tended to use technical vocabulary and **told** or **showed** or actually **did**, rather than engage and involve the youngsters in the work. (Fife Dec 02)

Commenting on this apparently intuitive pedagogy, a roboteer commented

> I treat them like my own children – we all do what we can to build on their inquisitiveness (Richmond Roboteer Mar 03)

There are two other features of the roboteers intuitive pedagogy that is worth noting.

First, the issue of knowledge selection. There is inevitably an awful lot of technology that **might** be useful in building robots. So how does one decide what to teach and what not to teach? In just about every case observed, we noted that the roboteers formal teaching input was organised on a 'need-to-know' basis. That is to say that the youngsters had reached a point where they could not make further progress without more technical understanding – so the necessary input was decided and provided.

The project does not therefore lead us towards a 'robot curriculum', specifying this or that content. But rather it leads us towards an intelligent, responsive, project-centred approach to teaching and learning. The decision to base the project within design & technology is therefore fully justified.

Second, the issue of *concrete* learning. We have already drawn attention to the natural inquisitiveness that the roboteers were seeking to exploit, and this draws in part from the concrete handling of real objects (the robots) and engaging with them in a concrete task (making it do x, y, or z). The working models that the roboteers frequently used to demonstrate and explore ideas with the groups were excellent teaching resources and provided inspiration for the students to try things out. This concrete-ness was observed at many levels and even in formal technical input sessions.

> They do not give the pupils the answers to their problems but instead make them think about what they are doing by asking questions and probing them: how about using that instead of….; is that the best way to go about ……; do you think that is a good idea ……; what would happen if ….; there must be a better way of …… . what did you learn from doing that… The roboteer gently nods and prods the pupil in the right direction. They are excellent role models for practical problem solving, very knowledgeable and highly verbalised about their work. (Ballymena evaluator)

We observed a group that had reached the point at which they needed to grapple with pneumatic cylinders. They needed one to (a) initiate a rolling action – and then (b) to stop the rolling action. How big a cylinder is needed? How much pressure is required to drive it? How big a throw does it need? These 'need-to-know' questions were the basis of a formal input session in which the students were introduced to the basics of choice-making. And central to this session was students 'feeling' the kick of different cylinders – really holding them and sensing the amount of kick that this one or that one can deliver with a given pressure.

> "They need to get a **feel** for it … what does 20 lb pressure feel like, or 30 lb ?" (Richmond Roboteer Mar 03)

So the initial choice (for the 1st prototype) was not based on maths and formulas about pressure and area, but was rather based on the feel of how much force was needed to do the job that they had in mind. Subsequently

this moved on to calculations about pressure and area – but only after the initial concrete engagement with decision-making.

This intuitive concrete pedagogy - almost universally adopted by the roboteers – has been a real strength of the project and the following observation was very similar to that noted by all of the evaluation team.

> Pupils were challenged to think for themselves, and learning was real and evident in their progress. When problems and difficulties were experienced these were resolved with a minimum of fuss. In most cases XXX would probe the pupils' understanding and through careful questioning, hinting and prompting point them in an appropriate direction.
>
> XXX is a problem solver and he models this approach in his teaching. He is able to communicate easily through sketches and with the aid of materials and components. Pupils at no time felt on their own or on a mission that was impossible. The content was very appropriate to National Curriculum demands and the learning process pointed up those skills and qualities much needed in developing resilience, resourcefulness and reflectiveness. (Ballymena evaluator)

Two other related issues are also important to note concerning the responsibility for and management of learning within this venture. On many occasions pupils were working in pairs, or 3s, and some teams were as big as 5 or 6. There was clear evidence of peer support between team members with much sharing and listening to advice between members. Tasks were typically subdivided and co-operation, communication and encouragement were frequently witnessed by the evaluators. The teams were eager to improve their robots performance even in situations where it had already performed well. We should note however that teamwork does raise some problems for schools – particularly concerning assessment.

> The Roboteer project is refreshing because of its emphasis on collaboration, and on pupils working and learning together. Unfortunately current assessment patterns are driving the curriculum and the teaching methodology in the classrooms. This places a stranglehold on initiatives such as this one and confines them to extracurricular activity at the end of the school day.. (Ballymena evaluator)

Nonetheless, the strengths of teamwork are universally acknowledged by teachers, and alongside this teamwork there was also ample evidence of students taking considerable responsibility for their own learning. They had the aim (often a group aim) of making their project work and that provided not only significant motivation but also seemingly empowered them to take autonomous decisions and steer the project along paths that were agreed between them.

• *competition issues*

The Fife centre was the only one to have started sufficiently promptly to be engaged in the 2002 techno-games filming, and there emerged an issue of the apparently changing rules for 'Technogames' as the work progressed. Detailed questions (eg about safety clips for the rocket cars) were not answered properly and this resulted in the cars not being permitted to race on the day. The teacher thought it unfair since the safety clip that had been devised by the team was, he thought, far superior to the one the BBC safety officer was wanting. This

was merely one example of details that remained un-clarified and rules that were unconfirmed. It didn't help that the printed rules were different from the www. site rules.

> '..Likewise with the exploding haggis - the pupils had even programmed the haggis robot to go off away from the others to explode safety… they even offered no explosion just smoke – still not allowed.' (Fife teacher)

One team was particularly despondent but kept bouncing back when the rules changed and their initial game (sumo) was removed, and then their second choice (tug of war) was also removed from the competition. They finally (just two weeks before the event) designed and built an entry for the assault course.

> 'So important that the details and the information is available well in advance and doesn't shift. H&S stuff critical. I would have liked the roboteer to have been more definitive in his answers after all he was to be the communication link between techno-games and the school. XXX provided the necessary momentum for getting things kick started, but then tended to lack focus when the techno-games entry progressed. He was very open when he introduced the games to the pupils - all categories seemed to be open for choice to them… I would have preferred maybe two games being focussed on.. after XXX left we had 4 games to cope with!' (Fife teacher)

The filming experience also raised the issue of mis-match between big expensive entries and inevitably low-budget school entries. Some form of handicapping system might permit the obvious value of exciting, expensive, tele-visual entries whilst offering realistic hope to low budget novice groups. If robot competition is seen to be open to all - It is important not to dispirit school team members.

Having said this however, it is important to emphasise the positive aspects of the competition. In one centre a lot of effort went into the preparation of the rocket cars. The students found the tasks exciting and developed significantly enhanced practical skills whilst making the entry cars. As the cars tend to be destroyed during each run, fresh re-makes were the order of the day providing plenty of skills practice and an opportunity to apply new designs based on practical experience. The students also particularly enjoyed watching their own rocket cars outdo those of their teachers.

Many of the students involved in the original Technogames selected Technological Studies Standard Grade as a result of their roboteering experience. For the schools involved there has been a discernable increase in interest in YEC and numbers have gone up. Students returned to 'compete' in the regional Technogames event the following year with the additional schools who had been courted by the Centre through the YEC network and the Roboteer showcase visit.

• *the link to school curriculum*

It might be assumed that there is a strong link between robot-building and the formal curriculum, particularly of maths, science and design & technology. For perfectly sound reasons, when the projects were based in curriculum settings (as opposed to after-school clubs) they were typically located in design & technology settings. This generally worked well and capitalised on the project-based strengths of d&t.

> The project activity was highly relevant involving design and communication, materials and components, energy and control concepts. The teaching and learning sought to ensure that pupils had a good grasp of the concepts involved and that their understanding was complete. (Ballymena evaluator)

But the decision to base the project in design & technology departments ("Technology & Design" in N. Ireland) does leave open the question of how well the project reached out from d&t into the science and maths curriculum.

The observations suggest that there was no formal arrangement in the schools to make this happen, and generally it didn't happen except on a casual convenience basis. Where some calculations were required (eg of pressure or mechanical movement) the roboteer might ask "how would you work this out", and might seek to create a link into the youngsters learning through the formal curriculum. But these links generally arose through happenstance.

> There is no natural fit to the curriculum, but the technology teachers are the key and the link to other teachers (Richmond Roboteer Mar 03)

One demonstration of this link between the roboteering and the special needs and interests of the school arose in one of the Richmond centres – which was seeking Specialist School status in relation to the Performing Arts. The roboteering group looked on their task as an opportunity to exploit this connection and designed a gymnastic robot.

Frequently however there was a curriculum rub-off in the schools. As an example, whilst some of the Powys schools already had the teaching of 'systems and control' (within d&t) established in their curriculum, some did not and this project provided the opportunity to rethink that gap.

> "It supports the daytime curriculum (and specifically) the development of control systems as a subject. This is not done presently. Electronics is taught within physics" (Technician - Powys School)

• *the attitudes of the schools*

It was repeatedly brought home to us that the whole venture relied upon the support of the wider school community and specifically of the head-teacher. The educational value of the project was clearly evident and important to teachers, but so too was the PR value of a project of this kind, with TV potential and much public exposure. The teachers frequently drew attention to the increased kudos that the d&t department had attracted with students, staff and parents. And at a whole-school level the head-teachers were very aware of the benefits to their school in terms of recruitment and awareness within the community. They invariably threw all their support behind it and in one case the Parents Association volunteered £500 for additional resources.

The benefit of this support was not lost on the roboteers. When completing their post-project questionnaire, several drew attention to the need for high level support in the schools

> "Senior management in schools need to be on board"
> "Enthusiasm and commitment by schools as well as direct participants"

As with the schools, it proved crucial that the appointed centre manager responsible for the project was given full support from the Principal of the college. Support in respect of the initial requirement for outlay of substantial monies, on the promise of project funding, as well as giving encouragement and recognition of worth of the initiative as a learning, recruitment, liaison and PR opportunity .

The Fife centre manager was noted for his quiet 'behind-the-scenes' enthusiasm and energy, although no additional time was given for the management of the project. The role the centre manager played in terms of networking, promotion, paperwork, organisation, the provision of equipment, the additional financial backing provided etc was recognised and appreciated. Teachers and roboteers commented on how important this was to sustain the project.

> "The Institute of Applied Technology coordinated, arranged trips, accommodation and so on and held the funding. Very useful link, although sometimes communication was less good." (Fife Teacher)

> "Without the tireless pursuit of a focused individual the current crop of paperwork hurdles and time frames would bury the project before it got started. There is an important distinction to be made between two essential roles; namely the Centre Manager and the Roboteer in Residence. For the entire project to have the desired impact it must be divided to succeed. The CM works away to achieve all the necessary arrangements whereas the roboteer sweeps in as the celebrity to give prestige to the entire activity." (Fife Centre Manger)

• *emerging strengths and weaknesses of the structure in schools*

The great strength of this Roboteers in Residence project has been in the way in which the roboteers have engaged the enthusiasm of youngsters in schools with the potential of systems & control in technology. Specifically it has taken an area of the design & technology curriculum that is under threat in many schools – through lack of students opting to study it – and has transformed it through the development of robot-building.

Many schools in England, Wales and Scotland (N.Ireland is the exception) do not take such studies as an option choice post 14 years old, effectively reducing important areas of technological understanding in fields such as electronic, mechanical and structural systems and control. Those schools that have been involved in this roboteering project have found it has re-invigorated youngsters (and teachers) interest in what is generally seen as a 'hard' area of the design & technology curriculum.

We have already noted (above) that one of the keys to this development is teachers own confidence level. But with this expanding confidence grows their knowledge base in 'roboteering', and the roboteer provided the

stimulus to make this happen. It undoubtedly proved beneficial to have an outside expert, in a school situation, who has the technical skills, personal skills, the vision and the enthusiasm to 'make it happen'. The roboteers showed ways in which robots could be introduced and knowledge progressively built upon. It was not done without much effort and application on the part of the teachers and students as well as the roboteers, but it has been a notable and important outcome.

> "It has raised our sights … what is possible … and our confidence that we can do it on our own" (Richmond teacher)

The weaknesses of the project did not so much 'emerge' as appear right at the start. They concerned problems of location (of the roboteer, the colleges, the schools and the students), and specifically the difficulties of integrating the needs of the schools/colleges with the possibilities of the roboteer. We have raised these organisational issues at the outset and will return to them below.

• *what did the robots do?*

A wide range of robot types was built during the project, and the following examples illustrate this range.

shot putt / trebuchet : .. involving computer simulation to establish construction dimensions and details

gymnastics / dance : several teams developed this theme and it encouraged the 'artistic interpretation' element of robotics. In two cases the gymnastics was set to music.

rocket car : much excitement was generated by the racing and repeated re-building

relay race : imaginative roof rack mechanisms were developed to allow the baton to be passed from car to car throughout the race.

solar challenge : sourcing appropriate cells (even from the US) provided it's own challenge

cycle race : with a highly imaginative cycle frame

basket-ball thrower : with combined pneumatic/mechanical throwing system

rope climbers : including one based on a radio-controlled Mini with Meccano backup: the "Mecca-Mini".

assault course : a very challenging problem and in more than one centre was done very well, including the 'best engineering' award at one regional heat

high jumper : which did not perform quite as planned

uni-cycle : an exceptionally challenging design with all the motors, control steering & power systems contained within a bicycle wheel rim.

rugby ball kicking machine : a simple lever but with a flicking system to replicate a leg and ankle movement.

maze explorer : some of these had excellent programming and were highly imaginative

crab walker : which won an innovation award at the regional heat

solarbots : to control a buggy

swimming duck : the mechanism enabled the duck/boat to tread water without putting its feet down

sumo: *antbots* and *football antbots* for stimulus, familiarisation, build experience and immediate competition.

• the regional and final showcase events

There is no doubt that the project took a big hit when it became known that there would be no new techno-games series, and that - as a consequence – the students would not appear on television. Inevitably this was a seriously de-motivating moment in the project and the roboteers in particular felt exposed on the matter. They had 'sold' the idea to youngsters on the understanding of a TV finale and anything short of that was bound to be a serious let-down.

The re-configured conclusion for the project involved a series of regional 'events' organised by the roboteers at venues that were appropriate to their setting. As an example, the London event was at Imperial College beside the Science Museum. All participating student groups were invited to these events – though (for various reasons) they did not all attend. The events were typically stage managed by the roboteer and involved high profile (and very engaging) judging activities for the various classes of robot. Additionally however there were typically master-class demonstrations by the roboteer (sometimes with other roboteering colleagues) at which the well known robot-wars characters (panic attack – razer and the rest) made an appearance and strutted their stuff much to the delight of the youngsters and their teachers. The 'winning' team from each region was then invited to the national showcase event at the Young Scientist and Technology Exhibition in Dublin in Jan 2004. In the absence of techno-games filming, the regional and final events were very important for teachers and students alike. Teachers in particular like to meet up and see what others have done and meet with other roboteers to see how things have been done elsewhere.

There were therefore three noteworthy dimensions to these regional and national events: a) the celebration of students work, b) the sheer 'theatre' of robot demonstrations, and c) the professional networking of teachers

> 'The roboteers are super heroes'- that is the message from the pupils. They are in a league all of their own. They come to the schools with a wealth of experience, accumulated from industry, tinkering with motorbikes and go karts, and from playing with all sort of mechanical gadgetry. They have an intuitive feel about components and how they can be used within projects. They know from their twenty or thirty years experience what components are compatible and what can go together, what materials are the most suitable and for what reasons, and what pressures and sizes the cylinders and pumps should be to make things work well. They just know this stuff and they are full of it.
> (Ballymena evaluator reflecting on the Dublin final)

3.3 Impact on and attitudes of participants

• views of the roboteers

Along with the informal and 'soft' data emerging from our observations and discussions with the roboteers, teachers, and students, we collected some 'hard' data that informs this section of the report. In a questionnaire

we asked the roboteers to comment on a number of factors – listed below - that might bear upon the success or otherwise of the students. Which did they think would be important?

teamwork & cooperation skills
technological awareness
enthusiasm & motivation
modeling & prototyping skills
communication skills
creativity & imagination
persistence & stickability
maths skills & understanding
science skills & understanding
competetiveness
independence
awareness of robotics
open-mindedness & flexibility

Interestingly the roboteers judged that personal and human characteristics (eg teamwork, enthusiasm, stickability) would play a far more important role than subject-based knowledge and skills (eg in maths and science) in the success of the project

To underline the importance of these human characteristics, we asked the roboteers – in free-response mode - to identify the 3 things that they thought (in advance) would be most important to the success of the venture and the 3 things that would most inhibit it. They identified "persistence" as likely to be the most important of the supportive features, and "personality clashes" and "loss of motivation" as the most likely inhibitors. All very human / personal qualities, and remote from the conceptual (maths and science) 'stuff' of the curriculum.

When we asked the same questions at the end of the exercise an interesting shift had occurred. We presented the same list of factors as at the start, but asked the roboteers to say (after the event) what had ***really*** proved to be important. There was virtually no change in their response. It was still the human qualities such as persistence, teamwork and communication that dominated their thinking. But in the free-response section there was a change, and we might describe it as a change that recognised the importance of the **pragmatics** and specifically the **logistics** of running the project.

So, for example, their judgement of the things that were *most important* for the success of the exercise included:

- sufficient funding
- commitment by the school (other than those directly involved)

And their judgement of the things that had *most inhibited* the success of the exercise included:

- travelling
- lack of (local) promotion
- lack of access to the schools (electronic media doesn't always help!)

• views of the students

At several points during the project we asked the students to tell us what they thought of the project – and specifically what they liked and disliked about how it was going. There was generally very strong support for it, with most students "strongly agreeing" with statements like:

- it's fun so far
- its good to work with a robot expert
- our team is working well together
- robot building is creative/exciting

When we asked students – in free-response mode – to tell us the best and worst things about it, there were some recurring comments. The best things were typically that they realised what a great opportunity they were being offered.

"good to have an opportunity to do this"
"it's a great opportunity as I want to go into design"

They then identified what it was about the opportunity that most impressed them, and two things emerged. First it was working with *other people*, specifically the ***roboteer*** that they valued.

"to work with people you wouldn't normally"
"working with Ian" (the roboteer)

Second they valued working in a team with their peers. This is a sadly undeveloped feature of practice in secondary schools, and they clearly valued the learning potential of working collaboratively.

"we all work together well"
"improves teamwork skills"

Intriguingly, their views about the downside of the project reflect a concern – almost paranoiac – that has developed in recent years over the demands of coursework assessment. They are worried that the project has distracted them from their assessed work.

"falling behind in exam revision"
"losing out on time for coursework"
"missing coursework"

Despite this potential difficulty however, it is worth reporting that students in more than one centre had their career aspirations transformed by this project. An example is the student who was able to submit his project as part of his Higher National Diploma coursework and who was so inspired by the activity that he subsequently

sought and gained a place on a University Honours degree course in Mechatronics. Among his comments, is the simple, telling, endorsement that the Roboteer will 'never be forgotten'.

At the final showcase events the teams were pleased with the final outcomes, referring to them as "great achievements". Pupils spoke of the opportunities for teamwork and how they had to work together in order that the robot would work for them. Frequently, some bits of the projects were difficult to work out and some aspects didn't go according to plan. Nevertheless the projects were fun though sometimes they struggled with them. The pupils enjoyed the opportunities for manufacturing a real project with real components. They especially liked it when they could see it coming together, and getting a feel that it was going to do what they wanted it to do. This was not easy at times, and there were many anxious moments, but 'we got there.' The roboteer helped to make them feel more independent and capable of doing it.

> 'He never once told us that what we were doing was too hard or that we wouldn't be able to do it.'

And inevitably, pupils were engaging in reflective inquiry to show what they would do differently next time, and revealing in the process all that they had gained in getting to the point they had reached. The roboteers too were full of the project and its potential for stimulating pupils into worthwhile creative activity.

> Working with practical things is not abstract, it is real hands on learning activity. Pupils like that, they can see it and they can work with it. Young active minds need to be stimulated and fed with a relevant teaching input that engages their interests. (Ballymena evaluator at the Dublin final event)

The challenge for these roboteers lay in providing pupils with just enough information to get them started and to keep them going.

• *views of the teachers*

There was also unequivocal support for the project from the teachers, who really valued the contribution that it had made to their d&t department.

> "It's such a good thing for the school.. and the department" (Richmond teacher)

> "A new rector arrived in schools in June 2002 and we had to fight our corner to keep Technological Studies. We used this project to get high profile and since the process was supported we won the head teacher over. We did this initially for the high profile, but now we're keen to do it again.." (Fife teacher)

They also valued the contribution to students' learning. They spoke enthusiastically about students' work and about how much they valued the 'hands on, informal' learning approach adopted by the roboteers. They recognised that the pupils were motivated and did not have to be told to keep at it; that they wanted to be there and that they had a certain confidence that even though the challenge was not an easy one, they would eventually get there.

> 'The challenge was real and they went for it' (FE tutor Ballymena).
> The project has had an influence on course choices: almost three quarters of the groups involved at S2 have selected Tech. Studies for S3. Really pleasing." (Fife teacher)

There is always a danger with projects of this kind that they work once and then disappear leaving no lasting impact on the school beyond the first event. This is the 'flash-in-the-pan' phenomenon of curriculum projects. There is evidence that this project has started to build teachers confidence and capability in taking it on themselves into another phase.

> "It's been great to rely on the expert – but yes my confidence is much better"
> "I'm moving to another school in September, and I'll set it up there"
> "It's raised our sights – and our confidence that we can do it"

> "The teacher from Ballymena was most supportive of the project and intends to start up a techno club after school for interested pupils. He plans to build on this over a period of time and to have one 'spectacular' event in the school calendar where pupils could strut their stuff. He was also quite taken with the facilities at the North East Institute and intends to keep in touch with that Centre of Excellence now that he has made the staff contacts. (Ballymena evaluator)

• would they do it again?

Students

The almost universal response was "Yes – definitely"

Teachers

> "Yes we would do it again… the opportunities for all areas of d&t are invaluable"
> "Yes – even though there is a heavy workload/time commitment"

The exceptions to this general rule applied more to the colleges than to the schools. More than one of the colleges (the supposed 'hubs' of the project) reported that they would probably not do it another year – even if it was offered.

Roboteers

> "Yes – it's important to all – and to the country in terms of the value of engineering"

The roboteers were universally enthusiastic about the project and would certainly do it again. But they would like to have more control over where they did it, and with whom – so as to iron out the worst of the resource (mainly time/travel) wastefulness that they all perceived.

3.4 Key factors *supporting* the project

- the enthusiasm, skill, personality and teaching style of the roboteers
- the opportunity for students to work in teams
- the concrete approach to teaching and learning
- the engagement that comes with robots that do things (and that we can control)
- the challenge of designing one from scratch and making it work
- the contrast with 'normal' school work

- working through prototypes and incrementally improving them
- the sense of fun that was encouraged
- being given responsibility to make their own decisions and go with them
- the commitment of teachers
- the support of the school / college

3.5 Kay factors *hindering* the project

- the assumed model of implementation (FE college hubs) was flawed
- the physical dislocation of the key players (schools/colleges/roboteers)
- the resulting devolved arrangement was a 'best-fit' but very wasteful solution
- where staff (in a school / college) were not committed it foundered
- the need (in some centres) to 'fit' the activity to inflexible school / college timetables
- the confusion regarding the technogames competition specification and rules
- the mismatch between project schedule, technogames event dates, and school year timetables

3.6 Conclusions concerning the aims of the project

The aims that launched this project were outlined in the opening section

> *To show how to deploy the skills, energy and ideas of expert roboteers so as to ...*
> *i) initiate a deeper interest and involvement in robotics among Design & Technology and Engineering students in the 14-18 age group, and*
> *ii) deliver a high-quality face to face learning opportunity for Techno Games robot builders throughout the year.*

We have no doubt that both these aims have been met. Moreover we are confident that a great deal more than this has been achieved in this project.

We have seen the enthusiasm of young students grappling with highly complex technological challenges and making their robot work. We have seen experienced teachers extending their knowledge and skills into new areas that will support the future development of design & technology. We have seen roboteers supporting youngsters learning in the most sensitive and thought provoking ways. We have seen students change their career aspirations in response to the experience of the project. We have seen head-teachers overflowing with enthusiasm about the impact of the project in their schools. And we have seen the roboteers themselves drawing great satisfaction from the work, and enthusing about the successes of their student groups.

There is no doubt that with the 14-18 student groups that the project has touched, it has created a far deeper interest and involvement with robotics than hitherto. And there is equally no doubt that the learning opportunity that these groups experienced was – by any standards – a high quality experience.

However, this obvious success should not blind us to the shortcomings of the project, and to the ways in which it might have been even better. Accordingly, in the spirit of further development, we offer the following recommendations.

4 Recommendations for the future

The biggest problems with this project were implicit in its organisational structure, and accordingly our biggest group of recommendations address this structure.

4.1 Concerning the organisational framework of the project

The idea of arranging for roboteers to work with groups of students was extremely valuable, but the mechanism for achieving it was deeply flawed. It seems as though the approach was chosen *without* direct knowledge of how schools and FE colleges operate. This is not surprising – since there is no reason why the BBC should have this knowledge. However, before committing themselves to the plan, the BBC would have been wise to consult those with direct experience of wide-scale curriculum development projects involving the active participation of students eg. LEA advisers, Teacher Education specialists, the Young Engineer Clubs network, the DATA professional association. Any of these would have been able to advise on the plan, and in our view would not have suggested the structure that was used.

Recommendation 4.1.1 *We therefore recommend that future projects involving direct contact with schools and work with school students should be discussed at a very early stage with specialists who have detailed understanding of the working practices (and the interrelationships) of schools and colleges.*

The key to the success of this project lay with the roboteers. They were well chosen and - without exception - they were excellent. Their excellence was not just in robotics but included their personal relationships and their 'teaching' with the students. They are gifted and rare individuals. Colleges however are commonplace. They exist in all major towns and several will exist in all cities in the UK. Because of their ubiquity, (set against the relative rarity of the roboteers) we believe that it was a mistake to cherry-pick individual colleges and to make **them** the centre of the project. The roboteers (rather than the colleges) **could** have been the organisational hub – and then colleges and schools could have been found near where they lived and worked. We recognise the need of the BBC to have the project in locations in England, Wales, Scotland & N.Ireland and this might have required some optimising. But in this project, **every** roboteer has been severely dislocated from their home base and their normal networks of resource, and moreover they have all wasted countless hours of project time in travelling.

Recommendation 4.1.2 *We therefore recommend that in future projects of this kind, the BBC identifies the key resources (the scarce resources) of the project, and devises a project structure that facilitates the optimal use of those resources. By prioritising the plentiful resource (the colleges) over the scarce resource (the roboteers) the working of the project was made far more cumbersome than it needed to be.*

The timescale for this project has been significantly extended due to the slow start of the project. As we pointed out in part 1, this project was initially planned to run through the academic year finishing in July 2003. The slow start to the project – which was evident in all but the Fife centre – was attributable to two principal factors. First the initial contact to schools was sent far too late for teachers to accommodate a September start, and second they were typically sent from a place (the FE college) that the schools had little knowledge of and no direct attachment to. Moreover the person sending the letter from the college did not know the schools or the staff to whom s/he was sending it. None of the normal networks (particularly the LEA, or [in N Ireland] the Library Boards) was used. The huge authority that the BBC carries was barely used to leverage and facilitate co-operation. Some of these issues could have been ironed out through recommendation 4.1.1, but additionally….

Recommendation 4.1.3 *We recommend that in future projects of this kind, the BBC ..*

(a) uses existing local education networks to ensure good communication

(b) facilitates profile-raising events (eg at a local college or teachers centre) that enable the network to spark enthusiasm and commitment that will kick-start the project

(c) does (a) and (b) well in advance of the projected start date of the project.

4.2 Concerning roboteering in schools

We have been very impressed by the quality of the roboteering that has been generated in the schools and colleges and have become increasingly aware of the things that have supported and inhibited the project. The roboteers were clear that it was the **teachers** that were central to the continuing success of the venture during their extended periods of absence. Moreover, we would suggest that the teachers are the key to ensuring that this project is not just a one-off 'flash in the pan'. If the enthusiasm for roboteering is to be sustainable in schools, then it must be through the extent to which the teachers were empowered to develop their practice.

Recommendation 4.2.1 *Accordingly we recommend that in future projects of this kind that bear directly on the development of practice in schools, the BBC should have an explicit aim of supporting the development of teachers. Had that aim been in place, then some explicit mechanisms and networks for teacher development could have been tapped into and exploited.*

Finally, we are absolutely convinced that the BBC should be encouraged to run the project again taking on board the points made above. The power of the roboteers to inspire and enliven students' learning is so profound that it goes well beyond a 'normal' teaching event or project. For many of the students involved in this project it was quite literally life changing. Major decisions about courses in schools and even degree courses to be embarked upon were transformed by this experience. The BBC is to be applauded for bringing together professional roboteers with youngsters in schools. The difficulties to which we have drawn attention are principally organisational and do nothing to undermine the concept of Roboteers in Residence. It is an entirely good concept and, as one of the evaluators noted …. "It shouldn't end here"

Recommendation 4.2.2 *Accordingly we strongly recommend that the BBC should consider re-running the Roboteers in Residence project. Ideally this would be attached to a TV/film output, but even without this the benefits of the project are profound for schools, for teachers and for students.*

End.