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Original Article

A major contribution to practice and to the education and training of practitioners in radiotherapy; an interview with Professor Andy Beavis, Consultant Clinical Scientist and Head of Radiation Physics at the Department of Radiation Physics, Queen's Centre for Oncology and Haematology, Castle Hill Hospital, Hull, UK

Venue: Queen's Centre for Oncology and Haematology, Castle Hill Hospital, Hull, UK on Friday 21st August 2015

Interviewed by Professor Angela Duxbury, Editor in Chief of the Journal of Radiotherapy in Practice

This is the second in a series of JRP interviews with individuals who have and are recognised for an expert knowledge in their subject area in radiotherapy and oncology.

INTRODUCTION

AD: Good morning Andy, thank you for agreeing to be interviewed today to talk about your contribution to the world of radiation physics, your career and your views on current and future practice. I know you have contributed significantly to the education and training in the field for a number of years, I look forward to exploring these contributions with you today.

Qu. What first inspired your passion for radiation physics and the desire to make an impact on the education of others in the field?

AB: I would love to say that there was a grand plan but there wasn't! I came to radiotherapy physics from a Solid State Physics research position at the University of Newcastle Upon Tyne in July 1992. As is typical for a post-doctoral research associate I was employed on a fixed term contract and, although I had recently been offered a contract for a further 5 years, my daughter's birth in 1991 left me wanting permanency and I was potentially interested in something different. I came across radiotherapy physics almost by accident. A friend of mine was being treated with radiotherapy and I gave him a lift to the Department in Newcastle where I saw a sign for radiotherapy physics or medical physics, I thought it looked interesting and investigated further. I wasn't aware that there were big groups of Physicists working in hospitals and actually thought that medical physics was a subject contrived for A level exams! I was interested and applied for a couple of jobs; I didn't get them and then applied for one here in Hull. My wife's family was from Hull, so I guess Hull was one of the soft targets for us in a way. I applied for a job in the Medical Physics computing group but it turned out to be a job in database computing instead of scientific computing or computer modelling which was essentially what I did at that time. I didn't get this job either, but whilst being told this in a telephone call, one of the guys who had interviewed me told me he was interested in my application and I was invited to an 'second interview' at his house in the evening. A week later he called me and he offered me a job. I had absolutely no idea of the details of the job and I didn't know any of the background, other than it was radiation and atomic physics that I had studied in my degree. However, I was really interested given the way he had 'sold it to me'

and I thought I would give it a go for a couple of years to see how it worked out, if it didn't work out I would look for something else, and now the rest is history ….I suppose you could say that fate and a gamble (mainly on my boss' part) took its course.

When I started working in the field, I immediately saw lots of opportunities to really change and develop things in practice. It was 1992, a time when in every department the treatments were mostly 2D and planned using plain films. We had one CT scan slot a week for prostate treatments and we had to select a patient and send them to Radiology at another site. From this scan we got one slice through the isocentre and brought it back on an 8 inch floppy disc from the other hospital to our department at Princess Royal Hospital, to load this data into the treatment planning system. I thought there has to be a got to be a better way to doing this so we developed faster and more robust ways to get the data, resulting in more patients having CT scans for planning purposes and introduced 3D planning. By 1996 we had integrated the use of MRI into our brain planning and by 2000 we had acquired our own CT scanner.

I remember two key conferences that made me realise how exciting the opportunities in radiotherapy physics were. One was an IPEM meeting in York in 1993, a physics meeting, where I started learning about other interesting things going on in the UK departments. The second was a meeting in 1994, in Manchester, the International Conference on the use of Computers in Radiotherapy (ICCR)-this was this was an international meeting that contained lots of talks about interesting and novel computer applications and really pushed the boundaries of their use in Radiotherapy. This meeting was where I first heard the phrase intensity modulated radiotherapy (IMRT) and learnt about how conformal therapy was becoming the standard treatment of choice in the United States. I remember thinking 'that's it, this is how radiotherapy has got to be delivered' so went back to work and started the implementation of 3D conformal therapy in the Department in Hull.

AD: At that time, was Hull one of the first Centres on the UK to implement IMRT?

AB: Yes, we went clinical with IMRT Jan 2002 and were one of the first Centres in the country; we had been working on this for a while before many others switched on to it. It was because I always had a lot of support from my boss (Mr Viv Whitton); for example, in my appraisal in 1995, I said to him that I needed to learn more about IMRT. Having established that there wasn't anywhere in the UK with the same experience building in the USA we decided that I probably needed to go abroad, so he helped me, by giving me the permission (as they say in managerial language, these days) to think about going abroad for weeks at a time to learn about IMRT. I also had a lot of help from Varian (through Arthur Kay and Michael Sandhu), they had seen a paper I had written on Enhanced Dynamic Wedges and invited me to present it to some key departments in America. So over a few years I made connections with the Mallinkrodt Institute in St Louis, Stanford University near San Francisco and Wisconsin University in Madison amongst others. The people I visited then all remain close friends now; Dan Low, in St Louis (now at UCLA), Art Boyer at Stanford (now retired), Rock Mackie who is well known for the development of Tomotherapy whilst at the University of Wisconsin, along with many many others who I met through them such as Jim Dempsey – inventor of the Viewray machine and Sasa Mutic.

Art Boyer was a very well known Medical Physicist who was in charge at Stanford at the time, he was extremely supportive (even inviting me to stay at his house for two weeks) and I brought back some of their ideas and techniques to the Department in Hull. Dan Low was very instrumental in my developing an attitude that these 'new techniques' were just as valid in our clinic as the large American ones and he and I continue to work closely. Rock Mackie is a wonderful innovator and was my inspiration when I started to consider creating a business out of VERT.

I made connections with CMS who were a St Louis based company who produced one of the early IMRT planning systems and worked with their research group to develop inverse planning and leaf sequencing algorithms which

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could be applied in their treatment planning system. In those 'early days' we were one of their development partners, so we got a head start on implementing advanced techniques in the UK. To me this was the way to do it.

AD: I have known you for some considerable time and know that, as an individual, you never see any barriers to what is possible in practice-you see challenges not problems, but also you work collaboratively and bring others around you along the journey. You also truly believe in the importance of the education and involvement of others and their development.

AB: Yes, it's one of the things that I have always enjoyed about working in Radiotherapy, is the multidisciplinary aspects of our work. When I started learning about radiotherapy I realised quite quickly that this was an interesting mix of atomic physics, biology and other sciences, and that working with other groups of professionals, like radiographers, oncologists and radiologists was something that I really valued and enjoyed. It still feels this way now, I really enjoy coming to work and always look out for 'what can I learn from other people today' and am always looking for ideas that can be picked up and put into practice. Something I have always taught my trainees and my research students is that don't ever think you know all the answers, because you don't, but to listen to others around you and let your mind expand and explore what they are telling you.

I have always enjoyed teaching since teaching undergrads and mentoring MSc and PhD students when I was a post-doc at Newcastle University. When I first came to Hull I was asked to teach at Hull University on a physics course including medical physics. This was good because a lot of it was new to me and I believe you don't truly understand a topic until you have to teach it to other people! I have always liked the idea of being able to make things accessible to people so they can learn effectively. A few years later, I was invited by you to teach at Sheffield Hallam University, this was a fantastic experience and I always enjoyed it. It made me realise that many students found the physics difficult and mystifying and therefore 'closed their minds to it'. I worked hard to make this information accessible and learned that there was no point in standing in front of a class of radiographers, who had given up their weekend to study a post graduate course and putting them to sleep with equations and slides full of text, I developed my teaching with presentations containing very visual information, for example, using cartoons and simple examples. This is where the concept of VERT (Virtual Environment for Radiotherapy Training) started to be born. I thought there has to be a better way to teach physics principles, especially the new and complex concepts that were currently in development, for example, intensity modulated radiotherapy (IMRT) and image guided radiotherapy (IGRT). I discussed it with a friend of mine (Roger Phillips) who was a Professor of Research in Computer Science, who asked me if animated graphics might help. Having worked alongside the military in the past, I knew about flight simulators, tank simulators and helicopter simulators, NASA simulators, and this set my mind racing! That's more or less when the idea of VERT developed.

AD: I guess VERT also developed from your fascination with computer graphics and games, I guess?

AB: Yes! VERT was something that dropped out of our educational research and scientific research I was doing with some colleagues. Primarily I have always really enjoyed teaching and looked for different ways to facilitate it and allow continual learning. For example, one of the things I have enjoyed and felt a great achievement was teaching IMRT in the Balkans following an original invitation from the IAEA. We brought several hospitals up to speed on conformal therapy and IMRT in places like Bosnia, Serbia and Croatia, in places that have suffered terrible wars and conflict in the recent past. One of the challenges there was the amount of equipment available for hands-on training. Another reflection gained whilst teaching at Sheffield-Hallam was that if students didn't get it after a couple of explanations then something different was needed.

I always used to like using visual aids in my teaching and found it an enjoyable way to learn. One of the people that I have inspired by and

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learned a lot from who has influenced my teaching and presentation style, is Mark Kessler from the University at Michigan, who is a very good friend of mine. His lectures are always fantastic, so I have tried to adopted some of his techniques and use illustrations and interesting pictures, people learn more when they are having fun-it's a fact! There is a phrase now called 'gamification', you hear it a lot in Computer Science circles, it refers to the use of computer games to teach and to assist learning. Before I had heard it or it was coined (!), it had occurred to me that my young son, who was about 8 or 9 at the time, could probably list all the weapons used by the American military, due to the fact he loved playing computer games that involved destroying zombies. The ease of gaining knowledge through enjoyment wasn't lost on me!

AD: You have alluded to VERT being an important development in your career. I know that you have achieved a wide variety of developments, so can you outline what you consider to be your three biggest achievements to date?

AB: I would put these under the headings of academic, clinical and business if you like. I think academically it's being to be able to integrate or work with people from different backgrounds: multidisciplinary working. For example, the partners in my business are computer scientists. It was working with computer scientists and realising how they could help me and how I could help them, basically how we could work together and achieve much more than trying individually. This has always being the case and I can give examples with my work in MRI, CT, radiation physics and now our pre-clinical research group. I have always enjoyed setting up seminars for people to get together to share information and ideas on what we were working on or interested in and inviting people who I thought could contribute, individuals from engineering, physics or mathematics or computing, biology, chemistry, radiography etc. I am proud of the way we have achieved things through multidisciplinary working and making it happen, this has been enjoyable.

Clinically, the thing that really does give me a buzz is fact that in Hull, we were an early adopter of IMRT and then more recently I was asked by Mike Richards and Tim Copper to lead on the roll-out of IMRT training across the England. I took a pragmatic approach to helping people to identify their 'blockers' to implementation and then provided training for Departments. We have helped departments throughout the UK and also supported international radiotherapy providers. Our Department in Hull was identified as a Department that could train departments to bring others up to speed. This is something that I am proud to have been involved in. I have always been striven and proactive in ensuing that other people in the Hull Department get involved, so others have had the opportunity to get involved and benefit from the experience.

Business wise, obviously I have to mention VERT as an important aspect of this. Business wise we are in a position now where we have more than 100 systems around the world in 20 different countries and continue to grow. It's not the fact that it is a successful business that gives me enjoyment; it's the fact that we have achieved something that had been adopted by the international community and has become so successful. It still gives me the biggest buzz –the hairs stand up on the back of my neck, when I visit a customer site and sit in front of a VERT installation wherever it is, for example, in Hong Kong, Japan, Australia or America or South Africa. I think yeah we achieved this and 'it's pretty cool'.

Coming back to the question -what gives me the most pleasure and what do I consider to be my greatest achievement? I think it is fact that we have changed the way that therapy radiographers are trained in England and that we are making a progressive change to the way training is provided across the world. Many centres in England use VERT and all the higher education institutions (HEI's) have been using VERT since 2008, now it is being used to help bring radiotherapy care into the 21st century in places like Africa, Russia, Asia and South America.

AD: The VERT is not only impacting on radiotherapy training, some HEI's are using this immersive environment in paramedic training, physiotherapy, nurse training, for example, so it is having a much wider impact in education.

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AB: Yes, that's what I am most proud of, it's that we have achieved something that is so practical, and in some sense we just connected all the dots together. On the other hand we really promoted it. When we started the project, I am sure the majority of people thought we were crazy and no one would be interested in it. One of my close friends introduced my presentation at a major international conference by saying that – but quickly followed up with 'but, boy, was I wrong'. Nevertheless, some people understood what we were developing, the senior staff at Sheffield-Hallam amongst them! Basically, you don't learn to fly a Boeing 747 with 300 plus passengers in the back without having gone through simulation training first, so why should you learn high end radiotherapy and be able to operate a high tech linear accelerator with a patient on the couch? The same approach to providing a safe environment for learning is just as true in other disciplines, but mainly I think they all grasp the fact that if trainees are enjoying using these tools then that alone has a positive impact of their learning.

AD: One other important impact VERT has had to therapy radiography training is on the improvement of recruitment and retention of student radiographers. It is an important tool in recruitment days, whereby prospective students can gain an important insight into what the role and radiotherapy is all about; to better inform their career choice.

AB: I think VERT can really inform and challenge people's perspective of what radiotherapy is all about. I have heard people say that they hadn't appreciated that there was so much patient contact and frankly, it's better to filter out people who think it is a purely technical job at an early stage. I consider these applications are yet another success for the application of the technology; as inventors we didn't really anticipate such a use, but the users quickly decided the benefits and it is used at careers fayres and during interviews and selection of new staff.

AD: The VERT has now got a worldwide reputation and you have talked about where the idea for VERT came from, can you talk us through the details of the journey and give us a flavour of some of the barriers that you needed to overcome to get where you are today?

AB: The journey really started during the time when I was teaching on Sheffield Hallam University courses: during the week for pre-registration students and on Saturday mornings for post graduate students. The venue was several miles away from the clinics and of course, the clinics were very busy. The challenge then was how I could make the teaching interesting, more relevant to what they needed to know and to assist them in applying the concepts to practice. For example, the concept of the isocentre is both simple but very complex. From experience, not everyone in the class would understand the concept easily, so I needed a more interesting and graphical way to teach or demonstrate it. If you were in the clinic you would rig up a front pointer on the treatment couch and a front pointer on the head of the machine and demonstrate the concept very easily. I thought how can we do this in the classroom without relying on photographs and pictures and how can we bring a linac and equipment into every classroom. As mentioned earlier, I discussed this with a friend of mine (Roger Phillips) who I had worked on other projects with in the past; we talked about how to apply better visual teaching for radiotherapy. We discussed the concept over a period of time and eventually came up with the idea of producing 3D articulated model of a linac with an ability to control the gantry rotation column and put 'patient data' on the treatment couch to show where the tumour might be. We developed a prototype, working with an MSc student in 2002 and planned to take it further with a PhD student. We then did the classic thing for a group of 'old school' academics and we submitted a paper to a conference in the following January, expecting to get all the work finished! The student working on the project had health problems and gave up her studies but we were fortunate to be able to bring another colleague (James Ward) on board who offered to finish the work. He did a fantastic job, re-coding absolutely everything in 4 weeks flat and over Christmas, so we had something that we could display at the conference. Interestingly, this work remains pretty much the backbone of VERT. We started to talk about this work at

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various conferences. Roger and James would present at the computer science conferences and I presented at radiotherapy conferences. The first time I presented on VERT was at UKRO in York, in 2003 and over the next few years we started to generate some interest. We build a prototype with software that could be projected on large scale screens at the computer science department at Hull University, using cinema grade 3D projectors; this continued to develop over time. We had also added the ability to load up treatment plans from the treatment planning system and we developed a Dicom interface so we could load plans from anywhere.

At the time, we were trying to work out how we could have a 'proof of concept' put into Sheffield Hallam University. Discussions got so far and then Charlotte Beardmore, a professional officer at the Society and College of Radiographers, became interested having seen some of the presentations that I had done. Charlotte was a member of the NRAG Workforce Working Party and indicated that they were interested in learning more about VERT. This culminated in a meeting with Sir Mike Richards, the National Cancer Czar, in October 2006. He thought it was a fantastic idea and that it should be made available to all training centres in England to solve the problems associated with the recruitment and retention and the training of enough therapy radiographers to meet service demand.[1]

We were very excited about this, we thought we would able to put a system into to SHU and one into London somewhere and this would be allow us to showcase the system to the world. What we weren't aware of, was that Mike Richards was lobbying for Department of Health (DoH) funding and in 2007, it was announced that the DoH would support the funding of innovative teaching solutions being put into to all 10 HEI's across England and all the radiotherapy centres, 5 million pounds was identified.[2] We made a bid to provide these systems and all of a sudden, the business venture was becoming a reality. We had been developing VERT in our own time, after hours, without any research funding etc., we had just done this for fun! We were aware that we couldn't deliver this business and continue to develop the product further by continuing in the same manner, so we set up a company, called VERTUAL, in Sept 2007.

We then rolled out the system to all HEIs in England by end of April 2008, it was really important to get this right for all concerned. We managed this by bringing in people who had been doing business for many, many years. We were smart enough to realise that we had created a new and interesting product by collaboration between a radiotherapy physicist and two computer scientists; we knew that we knew nothing about contract law or accountancy and finance, marketing and business development, so we brought people in to advise us on these aspects of business and that's why the company has been successful from the outset.

We started the company by doing the roll-out of VERT across England, we installed the systems into the HEI's first and then into 35 cancer centres. The key point at that time was, having realised that we had 'saturated' England already, if we wanted to make this into a continuing and successful business, we really had no choice but to into the international market immediately. That was scary and exciting at the same time!

AD: From my perspective, because English HEI's had the VERT facility, when we had visitors, they were very impressed with VERT and even envious, so the system sold itself. Even today, educators continue to find VERT invaluable and they keep on developing different ways to use it in their teaching. The applications, dimensions and possibilities are endless-I don't think that the system will ever stand still-it will continue to develop.

AB: I agree, for example, when I gave the training to the staff, following the installation of the system in Cape Town, I learned about some possibilities for VERT from one of their staff. I had just finished a training session and we sat down and we figured out how you could demonstrate some of the important concepts of plotting tank dosimetry, this stimulated further exploration by James and myself of what we will take further as a new feature. I tell people- don't think of VERT as a graphical tool that you can

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use to teach with, think about it as a linac in the classroom because it will do everything you expect a linac to do, except produce ionizing radiation! The big advantage that virtual reality brings to learning, whether it's VERT or a flight simulator used to learn to fly a 747 or a spaceship, is the fact that you can make mistakes in a safe environment without harming anyone. It's a bit like military pilots learning to successfully land a plane, and then they do it with one engine out, then with both engines out, then while being shot at whilst trying to land on an aircraft carrier. You can ratchet up the complications and problem scenarios without any real element of harm, nevertheless whilst exploring the impact of associated risk in safety.

In radiotherapy, you can look at the impact on the delivery of the radiation when treating a patient who is in the incorrect position. You can look at where the dose will be delivered and the impact on critical organs. One of VERT's features allows you to mis-position the patient and show how the proximal organs at risk are getting 'hotter' and 'hotter' as the positional error increases. This visualisation is so valuable and important in helping students to understand the requirement of accuracy. It is all well and good saying actions need to be accurate, but how can you easily gauge accuracy in a radiotherapy setting? Is it 1 mm, 2 mm, 10 mm or 15 mm, it could mean any of these. In a radiotherapy setting, 3 mm is almost an infinite size error and yet you struggle to pull your fingers apart 3mm accurately. However, VERT allows you to demonstrate the impact of a 3mm error in positioning the patient very clearly. In this visual environment, you can look at simple concepts, for example, making sure the field lights and the radiation beam are aligned through to more complex concepts like radiobiology and VMAT delivery.

AD: What are the next steps for VERT, what are you going to develop next?

AB: We are constantly developing VERT and we introduce new features every year, often these are incremental changes rather than step changes, but we are currently working on some big step changes. One of which is that we are exploring how we can support the roll-out of proton therapy, whereas it is not new there is an explosion of interest in proton therapy because the cost of producing the systems has reduced and the UK now has a national programme working to installing the equipment for proton therapy.

We are currently having discussions with proton equipment companies to scope out a VERT system which could be an enhancement on what we have done in the past, thinking in terms of control systems and how we would take the existing VERT system a step further ahead. It's something we haven't looked at before, so we working with people to understand proton dosimetry and all of the nuances that make it more complex than photon planning. Recently, I have been meeting with experts from physics and clinical backgrounds who are helping me work through what would be the most valuable concepts to demonstrate to people in the classroom about protons. Everyone knows that the best thing about protons is the Bragg Peak effect and the dose stops dead and protects the distal OARs, but we could argue the worse thing about protons is the Bragg Peak effect because the dose stops dead and there is no margin for error. We have been discussing, how we can use VERT to show treatment plan robustness and help people understand what the implication of the plans are. We hope to have something ready to support the current UK major proton installation project and I hope we can engage with the UK national project as well, we are not taking this as a given. We are working with the company that is providing the equipment into the UK and into projects in Denmark. We are also working with a Japanese company on their projects across the world.

Recently, we have had discussions as a company about something that I am personally keen to develop. I have a passion to redevelop some of the anatomy training tools that we created in the early days, but didn't ever commercialise. We know that VERT is used to teach anatomy and so we want to make some enhancements to the software to make it easier to use for this purpose and maybe make it relevant for the diagnostic radiography schools as well. We are interested to learn from people what they would find useful and consider to be want us to develop.

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AD: Do you have a VERT society across the world and how do you communicate with users across the globe?

AB: Yes, we have a VERT user group and there are VERT user meetings, these are very successful. We have just instigated a research group; working with Adele Stewart–Lord, a senior lecturer at South Bank University, Adele did all the ground work to pull people together who are interested in carrying out research work involving VERT. So we now have a research specialist interest group and this complements the user group. The user group fluctuates between meeting every year or 18 months and this last one, the fifth one, was staged in Portsmouth and was very well attended. We invite interested people along, as well as VERT users and members from international sites. We also host an American users meeting at the same time as ASTRO each year. These are all very successful productive meetings, where experiences are exchanged, new ideas get discussed and new developments are requested.

AD: Where do people find information about where and where these meetings are taking place and developments about VERT systems and products?

AB: We have a dedicated web site at www.vertual.co.uk, we try to keep information live on there all of the time. In the past, we have tried to host and facilitate a virtual web based meeting space/portal where people can share ideas. We know this could be improved, so we working with users to agree the best system to use to improve this forum; it could be hosted on our web site, a separate resource that we could sponsor, or perhaps one of the University based departments could run or host the website. This came up in the research group with a strong desire to have some open access and peer managed/ supported portal for posting articles on how VERT is being used. We are keen to support this because it would help those who are starting out in research and help 'in-experienced researchers' to write papers. It would be invaluable for those who can post their research into a supportive and safe environment and gain feedback, to develop and produce good research and Journal papers. This is something we encourage in our users, with whatever resources are available. It comes back to supporting the development of individual's research and academic skills and the roots we have in education.

It's fair to say that we now have an international community sharing their work on using VERT and this fact, gives us a bit of a buzz. We have a system over on the west side of the standard world map in both Vancouver in Canada and Seattle in the USA and one on the eastern side of the world map in Wellington, New Zealand, so as a joke I came up with the phrase that the 'Sun never sets on VERT' and this has been adopted as a marketing phrase!

AD: VERT plays to the concept that individuals learn though a range of different methods, for example, through the use of hearing, reading and the important power of seeing and visualising concepts, in order to learn.

AB: This is the reason why we went for 3D graphics in the first place. It has been a challenge for us all along because of the extra expense of the 3D equipment for the visualisation, but given you can harness its ability to give people experiences that are not available in the real world it is extremely valuable in the education setting. For example investigate the impact of patients mis-positioning or machine mis-calibration, peel away the patient's skin or view the CTs in relation to the linac isocentre or gantry position.

AD: I think that VERT is always going to be synonymous with radiotherapy training; it's now viewed as an essential component of training. You have always been recognised as someone who sees' things coming' and what the future holds, so I would like to ask you to tell us what you think the future hold in practice? What do you think is going to be the major technological advancement that is going to have a big impact on practice?

AB: This is an interesting question because someone is always going to come up with something that you didn't expect and that then changes 'the art of the possible' and you think that is just obvious – why don't we already do it

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like that! I remember the first time I saw Rock Mackie present Tomotherapy as an Ah-ha moment. I think it was 1995 and he was still in the 'garage' research phase of his work, there was no prototype as such only a bench top model that had been developed at the University of Wisconsin. We can quibble about the role of the early IMRT solutions (NOMOS) and the use of arcs in the 60 s – however in my view Helical Tomotherapy with its integrated imaging changed the way we deliver radiotherapy by rewriting the rule books. Along with some clever engineering, it was the newly available computing power that made all this achievable and the really big advancements are still going to be achieved by harnessing superfast calculations and communication technology. The latter is something we take for granted, but think about it; for those of us who are old enough, when you watched science fiction such as 'Star Trek' in the 60 s or 70 s they would flip up a screen and talk to somebody far away. In those days you would struggle to maintain a trans-Atlantic phone call, but now we all have cell phones and can be accessed more or less all over the planet. I think that communication technology will play a big, big part in the future. In the clinic we are thinking of developing adaptive techniques, so what is the ultimate end point for adaptive therapy? I think it means we would assess the patient that day by taking some imaging data and make a decision on how best to treat them, rather than trying to fit them to a 'pre-plan' as we do now. One of the other interesting developments at the moment is the cobalt-MRI device and the MRI-linacs that are being developed in different places. The reason for these developments is that you can image whist you are giving the dose and see what organs are receiving. So then, how are we going to make this work? We need the computer power to be able to process the information fast enough for the operator to make the go or no go decision. Again, we need to consider the communication technology. In a well governed department, we need to get the information transferred across the Department to ensure the decision to treat is shared by all those concerned. It's all about integrating and clearly presenting the necessary information so we can make a decision 'on Tuesday' to safely make a treatment change and then 'on Wednesday' to potentially change the treatment further. The dose you know you gave on Tuesday and Wednesday may inform how you treat the following day. It often seems that the time lag in getting decisions cause significant delays in clinical management due to the 'slow nature' of our communication in the hospital, whereas in actual fact the military have developed very sophisticated systems to allow remote diagnostic and treatment decisions for battlefield casualties – so there is something we can probably learn here!

Radiotherapy isn't going to change dramatically, there will be different types of machine in the future and technology is developing rapidly, however, the underlining philosophy behind the machines is fairly stable, so it is the expansion of imaging and the integration of systems together that will be the game changers.

Another thing that fascinates me and is subject of my research work with colleagues at the University of Hull is on the bioscience side-looking at chemical markers that indicate responsiveness to radiotherapy. When looking at genomics, we may be able to determine that 'Mrs Smith' is going to be more sensitive/responsive to radiation or be able to predict the severity of the 'acute' side effects she may experience leading to a different treatment objective for her over someone else with apparently the same disease. Perhaps we then use the imaging and computer power to monitor things more closely during treatment. Of course we are describing 'adaptive therapy' here. Everyone has an opinion on what the term adaptive therapy means, but for me the exciting opportunity is the ability to closely monitor the patient's response to radiotherapy and not only consider keeping the treatment on track with the original intent, but to consider making sure we can titrate enough dose into the tumour to a safe end point thereby giving the patient the best chance of disease control. This aspect of personalized medicine with radiotherapy fascinates me and I believe is where we need to spend more time and research monies.

AD: Looking into the future, how far away are we from when radiotherapy as a treatment becomes obsolete?

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AB: Well, that's the age old question! I remember when I started in radiotherapy in 1992; my boss said that, on his first day in 1969, he was told that radiotherapy would only be around for another 10 or 15 years. I think radiotherapy will remain as a main stay for cancer treatment and there is a stack of statistics that back that up. Over 40% of people, who have their disease controlled by treatment, receive radiotherapy. It's always going to be part of multi-modality treatment where combined treatment is advantageous; there is plenty of work going on in this area, for example looking for more drugs that sensitise the disease to the radiation. One of the research projects that I am currently involved in and supervising a student from the university, is concerned with radiotherapy induced PDT (Photo-dynamic therapy). It is possible to inject nano-particles into an organ which will then produce light when irradiated with x-rays, which in turn can be used to activate PDT drugs inside the organs either as a radiation sensitiser or as a therapeutic agent. Our project is concerned with designing these nano-particles to be both effective carriers of the PDT agent and the light source that activates them.

AD: Andy, I would like to take this opportunity to thank you very much for taking the time to share your some of your journey and thoughts and views, with the Journal's readers, I am extremely grateful to you and look forward to learning about the future developments of VERT.

Post Interview note – January 2016

All those in the Radiotherapy community that know me well will understand this (indulgent) addition. Throughout my professional career I have used a mantra that has served me well: "Born to Lose, Live to Win". To me this has always meant that having identified a problem – just get on and solve it. The phrase was coined by Ian (Lemmy) Kilmister who sadly died on December 28th 2015 only days after being diagnosed with Cancer. As many of my lectures over the last 20 years ended; I have been privileged to have been a part of the Hawkwind family and my thanks go to Lemmy whose attitude and approach to life taught me the arts of tact, subtlety and making very (very) loud noises. RIP Lem x Andy Beavis.

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