



Multidisciplinary Research

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Multidisciplinary

mul-ti-dis-ci-pli-nar-y (mŭl'tē-dīs'ə-plə-nĕr'ē, -tī-)

adj.

Of, relating to, or making use of several disciplines at once: a *multidisciplinary approach to teaching*.

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Multi- Inter- and Trans- disciplinary

- ★ Multi and interdisciplinary research are often used interchangeably, but originally they referred to different approaches.
 - When experts from different fields work together on a common subject within the boundaries of their own discipline, they are said to adopt a multidisciplinary approach.
 - However, if they stick to these boundaries they may reach a point where the project cannot progress any further. They will then have to bring themselves to the fringes of their own fields to form new concepts and ideas--and create a whole new, interdisciplinary field.
 - A transdisciplinary team is “an interdisciplinary team whose members have developed sufficient trust and mutual confidence to transcend disciplinary boundaries and adopt a more holistic approach”.
- ★ As a first step we will look at multidisciplinary research and its benefits in health research.



Multidisciplinary Approach

- The multi-disciplinary approach to problem solving is strongly advocated by a wide group of experts:
 - "the traditional chemistry/physics/biology departmentalised university infrastructures - which are now clearly out-of-date and a serious hindrance to progress - must be replaced by new ones which actively foster the synergy inherent in multidisciplinary."
 - Nobel laureate and President of the Royal Society of Chemistry, Professor Sir Harry Kroto
 - A US Report, "Bio2010: Transforming Undergraduate Education for Future Research Biologists" that was requested by the NIH and the Howard Hughes Medical Institute strongly recommended that undergraduate biology education should incorporate mathematics, physics, chemistry, computer science, and engineering until "interdisciplinary thinking and work become second nature."
- There would appear to be a need for all of us to re-skill ourselves to be able to work effectively in multidisciplinary teams.



Multidisciplinary Research

- ✦ The multidisciplinary approach to research is one of the new hot topics in medical research, where the use of multidisciplinary research teams has become ubiquitous, particularly in the USA....
- ✦ A search through Google for “Multidisciplinary Research in Medicine” yielded 4,370,000 hits !
- ✦ Some examples:
 - ...At the State University of New York (SUNY) - the University multidisciplinary research cooperative is a collaborative group of pharmacists, internists, and clinical scientists who complement each other in qualitative and quantitative endeavours and whose goal is to initiate and perform collaborative research in General Internal Medicine and Clinical Pharmacology employing diverse quantitative and qualitative methods.



Multidisciplinary Research

- ...Stanford School of Medicine have a special support programme for supporting multidisciplinary research (MDR) with particular reference to translational research
- ...At Cornell the research and educational programs of the Division of General Internal Medicine draw upon the talents of a unique multidisciplinary research team, comprised of faculty experts in health services research, clinical epidemiology, health education, psychosocial science, biostatistics, data analysis and computer programming, measurement theory, sampling and program evaluation, including cost-benefit and cost-effectiveness analysis, medical informatics, decision analysis, survey research, operations research and health economics.
- ...At Keele University in the UK in 2004 the Faculty of Health launched three multidisciplinary Research Institutes: Science and Technology in Medicine, Primary Care and Health Sciences, and Ageing.



Multidisciplinary Research

- ...In the USA, the National Institutes of Health (NIH) has awarded scientists from Emory University and the Georgia Institute of Technology two new collaborative research grants, totalling nearly \$10 million, to establish a **multidisciplinary** research program in cancer nanotechnology
- ...At Imperial College, London, the Tissue Engineering and Regenerative Medicine Centre has been established as a **multidisciplinary** team of specialists subjects important in tissue engineering, such as: cell biology, transplant biology, gene expression, gene therapy, immunology, sensors, imaging, bioactive materials, orthopaedics, cardiovascular surgery, and minimally invasive surgery.
- ...At the Mayo Clinic in Minnesota USA, the Clinical Research Scholars Program combines course work and a mentored research experience to produce leaders of **multidisciplinary** research teams that will advance the biological and technological discoveries into the best practices of disease prevention, diagnosis and treatment in the 21st century.



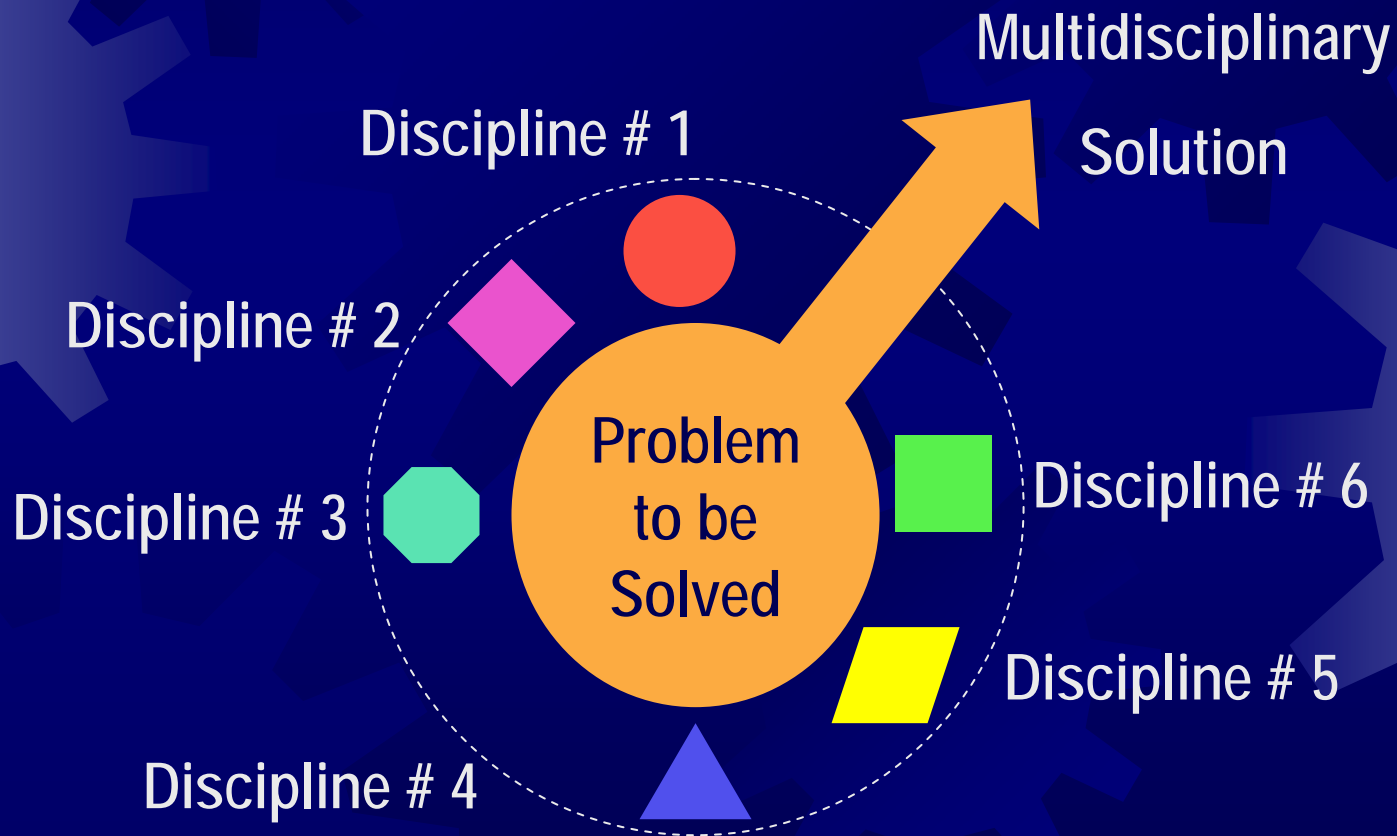
Why Multidisciplinary ?

- ✦ By bringing a team of people of varied expertise together to “solve a problem” quite often a more efficient solution is achieved or a solution is obtained when one may not be possible without the multidisciplinary approach.
- ✦ An individual or an individual specialism can quite often develop “tunnel vision” when examining a problem where it is difficult to look beyond the “usual way of doing things”
- ✦ By forming a multidisciplinary team or by working with other disciplines it becomes possible to think outside the box.
- ✦ This ability to think outside the box may be essential to solving the problem in question.
- ✦ The problem may also be so complex that its solution requires expertise across a range of disciplines.



Multidisciplinary Research

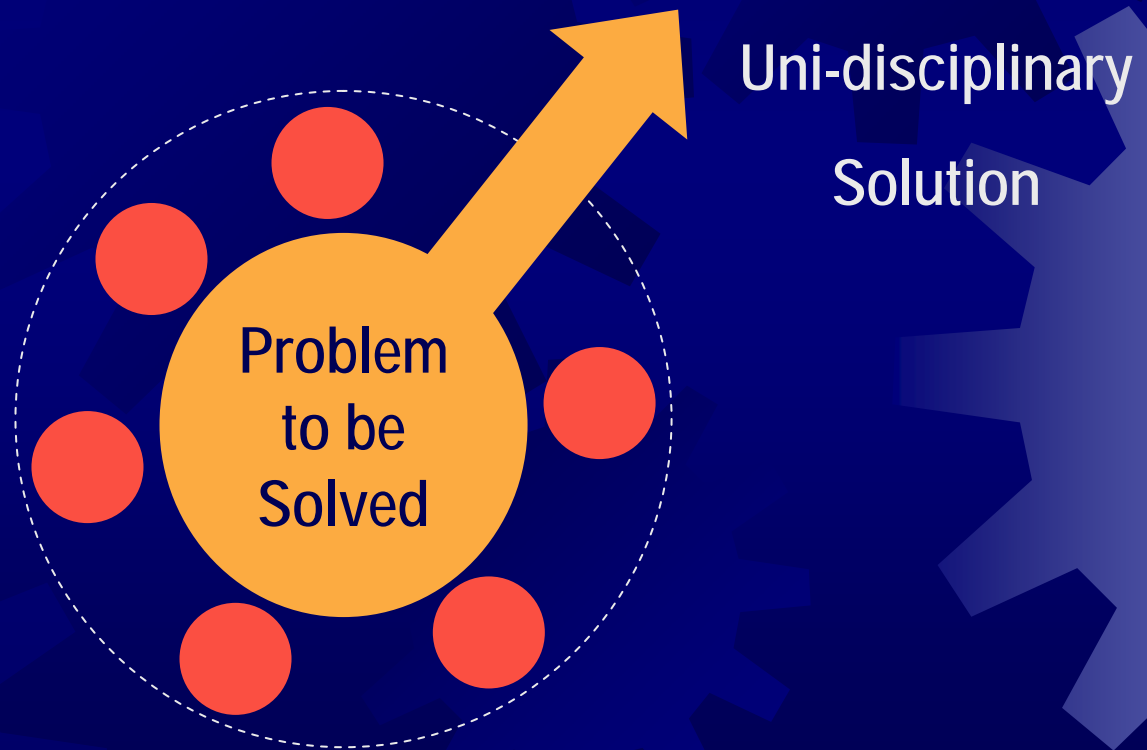
- So multidisciplinary research harnesses the expertise of a group of people from different specialisms to investigate a particular problem.





Multidisciplinary Research

- ✦ The alternative is a unidisciplinary solution where the expertise of a group of people all from the same specialism attempts to solve a particular problem.





Why Multidisciplinary Research ?

- The evidence is that multidisciplinary research in medicine works – particularly as most medical problems are multi-faceted thus requiring a range of expertise to properly investigate and potentially solve these problems.
- For instance the Human Genome Project, one of whose aims was to identify all the approximately 20,000-25,000 genes in human DNA would not have been successful without the use of a multidisciplinary team of scientists and engineers. Bioinformatics, in particular, played a key role in the project.



Multidisciplinary Research – A Case Study

- To further develop our understanding of the multidisciplinary model of research we will use a case study approach.
- The case is a multidisciplinary research programme being carried in co-operation between UL and the MWRH on the development of new techniques for the assessment, management and treatment of vascular disease with particular reference to venous leg ulcers.



Multidisciplinary Research – A Case Study

- ★ One alternative to the multidisciplinary approach to this programme of research might involve vascular surgeons and nurses developing management and treatment systems in isolation.
- ★ Another alternative would involve scientists and engineers working in isolation from surgeons and nurses to develop techniques for the assessment, management and treatment of vascular disease.
- ★ However both of these approaches are problematic as the development of technological interventions in medicine usually requires medical science and engineering expertise.



Multidisciplinary Research – A Case Study

Venous Leg Ulcers – Research Questions

- ✦ A significant problem in vascular disease is the management and treatment of venous leg ulcers
- ✦ Typical treatment for venous leg ulcers is compression bandaging - however after 12 weeks of bandaging only 60% of ulcers are healed
- ✦ Research Questions being considered are:
 - Can this healing rate be improved?
 - Can an new technological intervention be proposed?
 - Can a better understanding of the reasons for leg ulcer formation be obtained?





Multidisciplinary Research – A Case Study

Venous Leg Ulcers - Required Disciplines

- ☀ To answer these questions the following expertise may be required:
 - Vascular Anatomy – to understand the structure of the vasculature of the lower leg and its function in blood flow return
 - Vascular Physiology – to understand the physiological mechanisms in blood flow return
 - Wound Care expertise
 - Biomechanics - to know the extent of calf muscle pump action we need to know how much active plantarflexion action the patients elicits on a daily basis – how active/inactive is the patient
 - Radiology/Imaging – we may need to get images of the calf muscle of the patient to determine if the muscle shape is abnormal
 - Engineering – to develop a device we need engineering expertise
 - Biochemistry – we may need to do a biochemical analysis to understand the mechanism of venous leg ulcer formation
- ☀ So clearly the problem being addressed is multidisciplinary by nature.



Multidisciplinary Research – A Case Study

Venous Leg Ulcers – Research Team

- ☀ Currently a multi-disciplinary team has been formed to address these research questions:
 - Prof. Pierce Grace – Consultant Vascular Surgeon
 - Mr. Paul Burke – Consultant Vascular Surgeon
 - Mary Clarke-Moloney – Vascular Research Nurse/Postgraduate
 - Dr. Fintan Wallis – Consultant Radiologist
 - Dr. Gerard Lyons – Biomedical Engineer (Electronics)
 - Dr. Derek O’Keeffe – Biomedical Engineer (Electronics)
 - Dr. Richard Conway – Computer Engineer
 - Karol O’Donovan – PhD researcher
 - Alan Godfrey – MEng researcher
 - Paul Breen – PhD researcher



Multidisciplinary Research – A Case Study

Venous Leg Ulcers – Research Team Expertise

- Prof. Pierce Grace – Extensive knowledge of the problem and experience in it's current treatment, Vascular Anatomy, Vascular Physiology, Assessment of Vascular Disease
- Mr. Paul Burke – Extensive knowledge of the problem and experience in it's current treatment, Vascular Anatomy, Vascular Physiology, Assessment of Vascular Disease
- Mary Clarke-Moloney – Extensive knowledge of the problem and experience in it's current treatment
- Dr. Fintan Wallis – Radiology
- Dr. Gerard Lyons – NMES, instrumentation, accelerometry, measurement of human movement, biomechanics
- Dr. Derek O'Keeffe – Accelerometry, Design of embedded systems, Application of NMES
- Dr. Richard Conway – Design of embedded systems
- Karol O'Donovan – Design of sensor based systems
- Alan Godfrey – Mobility monitoring
- Paul Breen – Design of embedded NMES systems



Multidisciplinary Research – A Case Study

Venous Leg Ulcers – Evolution of the Team

- In 2000 Pierce Grace and Ger Lyons agreed to collaborate on a MSc project investigating the effect of NMES on popliteal blood flow in healthy subjects. This was the primary topic of Gemma Leane's research masters being carried out in the Biomedical Electronics Laboratory (BEL).
- The BEL provided NMES expertise and equipment and the test rig. Subjects were recruited amongst the UL post-grad community.
- The MWRH provided access to the Doppler Ultrasound equipment of the Vascular Imaging Laboratory and to a trained equipment operator.
- The study produced very interesting results and was published in the *European Journal of Vascular and Endovascular Surgery*
- Lyons, G.M., G.E. Leane, P.A. Grace. 2002. "The Effect of Neuromuscular Electrical Stimulation (NMES) of the Calf Muscle on Venous Velocity in the Lower Leg of Healthy subjects". *European Journal of Vascular and Endovascular Surgery*. 23(6), pp. 564-566.
- This first experience of collaboration was very positive and in 2003 Mary Clarke-Moloney registered for a MSc at UL under the joint supervision of Pierce Grace and Ger Lyons to continue the work of Gemma Leane, but now focussing specifically on patients with venous leg ulcers and also investigating the effect of mobility on leg ulcer formation



Multidisciplinary Research – A Case Study

Venous Leg Ulcers – Evolution of the Team

- As comfort was considered an important issue in the application of NMES, Mary Clarke-Moloney then wrote a paper on the relationship between comfort and electrode size and location during electrical stimulation of the gastrocnemius muscle which was accepted for publication in *Medical Engineering & Physics*
Lyons, G.M., G. E. Leane, M. Clarke-Moloney, J. V. O'Brien and P. A. Grace. 2004. "An investigation of the effect of electrode size and electrode location on comfort during stimulation of the gastrocnemius muscle" *Medical Engineering & Physics* 26(10) pp. 873-878
- At this time the team were successful in securing funding of ~ €150,000 from Enterprise Ireland as part of their commercialisation fund.
- These funds enabled the recruitment of Paul Breen as a postgraduate researcher and thus Paul was available to work with Mary on the NMES-elicited haemodynamic response testing in patients with venous leg ulcers and thus engineering expertise was available when required.
- A paper has been submitted to the *European Journal of Vascular and Endovascular Surgery* based on this work and it is expected that it will be published following minor revisions.
- Two other papers are in preparation from this study

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Multidisciplinary Research – A Case Study

Venous Leg Ulcers – Evolution of the Team

- As part of her M.Sc. Thesis preparation, Mary then wrote a detailed literature on Venous Leg ulcers and their Treatment and this work has been submitted to *Critical Reviews in Biomedical Engineering* and feedback has been very positive – it is expected that this paper will be accepted for publication following minor revisions.
- Around the same time another Ph.D. student at the BEL, Karen Culhane investigated the use of accelerometers to measure mobility in elderly patients – one of the impetus for this work was encouragement from Pierce Grace that this work could have wide-ranging potential. Two papers were published from this work, one in *Clinical Rehabilitation* and another in *Medical Engineering & Physics*:

Culhane, K.M., G.M. Lyons, D. Hilton, P.A. Grace, D. Lyons. 2004. “Long-term mobility monitoring of the elderly using accelerometers in a clinical environment” *Clinical Rehabilitation*. 18(3) pp. 335-343.

G.M. Lyons, K.M. Culhane, D. Hilton, P.A. Grace and D. Lyons. 2005. “A description of an accelerometer-based mobility monitoring technique” *Medical Engineering & Physics* Available online 19 January 2005



Multidisciplinary Research – A Case Study

Venous Leg Ulcers – Evolution of the Team

- Another Faculty member at the BEL, Dr. Derek O’Keeffe secured funding from IRCSET for a postgraduate researcher Karol O’Donovan and these two researchers have merged into the Vascular Science/Engineering research activity.
- The first task undertaken by Karol O’Donovan was to detect calf muscle pump activity without EMG, but instead by using an array of accelerometer sensors – this work has been published as a technical note in *Medical Engineering & Physics*

O’Donovan, K.J., D.T. O’Keeffe, P.A. Grace and G.M. Lyons. 2005. “Accelerometer based calf muscle pump activity monitoring” *Medical Engineering & Physics* Available online 17 March 2005

- A follow-up study evaluating the effectiveness of airline recommended exercises in eliciting calf muscle pump activity has been completed in collaboration with the University of Ljubljana in Slovenia and a paper is in preparation for submission to the *British Medical Journal*.



Case Study in MDR

- So in approximately six years a Vascular Science/Engineering activity has evolved from no activity to an active group of post-graduate researchers with close to 9 papers either published or being close to published in international peer-reviewed journals.
- A key reason for the success of this collaboration is that the research programme is multidisciplinary where the team are carrying out work at the boundaries of our respective disciplines
- Our experience is that there are huge opportunities to make significant contribution to the science and engineering by operating at the boundaries as we bring a unique skill set to the problems of vascular disease.
- Another advantage of this research is that it is translational in other words knowledge obtained from basic research is expected to be translated into diagnostic or therapeutic interventions as the research involves both clinicians and medical device specialists.



Case Study in MDR

- ✱ A multidisciplinary team is an evolving entity:
- ✱ One of the features of the multidisciplinary approach is that the multidisciplinary team meet on a regular basis to discuss problems associated with the research programme and to monitor progress
- ✱ The fact that the team meet and discuss the work programme together means that the different disciplines start to understand better the capabilities and limitations of the other disciplines and all members of the team begin to develop a clearer understanding of the problem being addressed.
- ✱ This increased level of understanding can trigger a realisation of potentially new research opportunities.



Suggestions on the Development of MDR

- ★ One suggestion is that the team start with a medium to small project that has a reasonably good chance of success and perhaps initially use a small team so that the team develops confidence that they can work together on multidisciplinary research and that a successful outcome can be achieved.
- ★ Before starting the work programme, it may not be a bad idea for to team to write up a memorandum of understanding which might contain the following:
 - A rationale for the work programme to be undertaken
 - A summary of the work programme
 - The members of the team and their expected contribution
 - An approximate timescale for the work
 - How the outcome of the work will be disseminated
 - An agreement on the publication of the work
 - An agreement on any possible commercialisation of the work



Suggestions on the Development of MDR

- One model for MDR that may work locally is to involve a UL researcher in the team – an academic can leverage manpower such as final year project students, ERASMUS students and postgraduate students that might be crucial to the successful execution of the project – this can be particularly important as HAS staff are doing research on a “part-time” basis and having a person available to spend large amounts of time on the project can make a big difference.
- HSA staff are important collaborators for UL staff as they provide an entree into health research which is growing in importance – so there should a strong level of interest from the UL side.



Suggestions on the Development of MDR

- If possible a researcher could register for a postgraduate research degree at UL – this could help the professional development of the person – and the postgraduate could be jointly supervised by a UL academic and a HAS staff member - this activity can strengthen the MDR team.
- UL would be very supportive of HAS staff signing up for postgraduate research degrees
- Signing up for a postgraduate degree gives the project a 2-3 year commitment and can help to push the project over an initially shaky start.
- The project selected is important - all sides of the multidisciplinary team must be a benefit from doing the work – so the project needs to be multidisciplinary and require a fairly balanced contribution from the different partners



Suggestions on the Development of MDR

- ✿ An important feature of the MDR team is that each member brings important skills and expertise to the table that facilitate the problem solving exercise.
- ✿ Each team member must be valued for their contribution
- ✿ There must be mutual respect by members of the team for each other
- ✿ There must be a willingness by the team members to attempt to understand “where the other team members are coming from”
- ✿ Each member of the team must feel that they benefit from participating in the team’s research programme – mutual benefit.
- ✿ Each member of the team should actively contribute to the research programme while the contribution of different members of the team may vary depending on the phase of the project.

The background features a dark blue field filled with various shades of blue gears of different sizes and orientations. On the left side, there is a vertical strip containing a collage of colorful gears in shades of orange, yellow, and brown, with a textured, almost metallic appearance.

Thanks for your Attention



Suggestions on the Development of MDR

- ★ A little bit of patience and persistence would not go amiss – success may take a little longer than initially anticipated – you are now working to the timetable of others – but it is worth persisting.
- ★ Start as soon as possible a programme of writing up the outcomes of the research – both conference papers and journal articles – this exercise can strengthen the cohesiveness of the team and provide encouragement to continue.
- ★ Writing papers as a team, where team members are required to put their ideas down on paper can stimulate new ideas for research.
- ★ Sometimes preliminary or even a medium-term investigation can establish that a research idea has no future – this is the nature of research – you just do not want too many of these experiences or the MDR programme can come to an abrupt end