Vice Chancellor Professor Maria Hinfelaar introduction:

Welcome everybody, to the first of our series of public lectures here at the university this year, and for the first public lecture we are very proud of the first public lecture to be delivered by Professor Caroline Gray who is the site director at our Optic facility, the fabulous Optic facility over at St. Asaph, which has absolutely fantastic facilities which is working really closely with the Optics and photonics industry; we're going to hear about that in the talk. So the theme is about how SMEs and academia can work more effectively together and I think what we are doing ,what Caroline and her team are doing at the Optic facility at St. Asaph is a really good example of what can be achieved. We're right in the middle of the delivery of some very exciting programs which Caroline is going to share with us here this evening, so I'm going to hand over to Caroline now, so Caroline is going to talk us through the theme of optics and photonics and working with the SME sector in our region and beyond and that also includes international work what the team is engaged with. And we're going to allow some time for questions at the end so we'll see how we go, and then there is time for some more networking and more drinks if people are thirsty, so over to Caroline.

Professor Caroline Gray:

Thanks everybody for coming, and it's nice to see, I wasn't sure if I was going to get an empty room or a full room so I was half right, ok. I just want to talk a little of me, because you know, people don't know me, who am I? Where did I come from? Well cute kid at the bottom became me so why have I put that on there because, my journey is quite unconventional in the academic frame so to give a little bit of background as for the work history and my journey, gives you some indication of why I can talk on this subject because of the experience that I have had of working within SMEs and large companies, along the way as a consultant myself, as a technical consultant, and then finally my position here at the university within the Optic Centre. I think I've learnt a tremendous amount about how valuable the academic sphere is to industrial partners coming from an industrial background and coming into academia later. So, that has given me the vision of how we can work to build the bridge between the two; so, why do people need to innovate and why do businesses need to innovate and you know, why should we all work together to progress and help businesses, where their technology needs are; how do we bridge that gap? You know, businesses are busy you know and what happens is sometimes you get in and you know you're too busy to look at the technology around you, so how do we support people to do that. So some of the reasons why businesses need to innovate and need to change would be changing business environment, covid-19 was a massive change, for businesses you know, we immediately had to change to digital platforms, the networking stopped and travel ceased, so staff changes, disruptive technology, if you've got a single technology business and other technology comes around and disrupts that, there’s a real business need to change. So technology advances improving processes with the development of different technologies and things that are available, changing customer needs, customers get more demanding as technology and things become available, their expectation rises about what they should have and then of course there's competition. So those are the reasons why businesses need to innovate.

Types of innovation and the impact, innovation can be in very different ways, it can be incremental through process engineering, process development, gradual and continuous improvements which have that sort of low impact, but keeping you ahead of the technology if you've got a regular... Sustaining that gives you a much higher impact within the market and then disruptive technology changes, electric cars, you know, hydrogen fuel cells, those types of technology that are occurring. Hyperspectral imaging we're working on now for communications and imaging, those are the disruptive technologies of tomorrow and they will eventually become the accepted technology. I always use the laser as a good example of that, got locked away in American Laboratories trying to produce a massive laser and getting photons to lase within a chamber and everything else. Now you can have them to play with your cat you know, and the technology is there.

So things change, and what's the process and where’s the challenge? The challenge I feel, and what I’ve seen is the fuzzy front end of that where you've got an idea, a challenge, how do you funnel that, and research you've got the blue sky and you've got those innovative steps and the technology levels or however you want to divide them up; what that means is that means nothing without it making that journey into adding to the economy and adding to companies, so how do we make that? So here's the academic interface and you've got all of these funnelling research, and developing that process, and that’s where the university can sit right between the companies, the company can develop it; the deployment and the impacts on the economy and on the scientific community as well, because the recognition you get from the launch of that technology.

So common challenges that the SMEs and companies may face – why can’t they interface with companies easily, the time available, urgency of need versus reaction time of an academic institution. Historically that's been my issue, as an MD of a company of a manufacturing company, trying to engage with universities, it was too slow, my problem was six months old by the time I got round to doing anything, so finances, always comes back to money, the amount of paperwork that's generated with grants etc. Concerns of IP, companies are very protective of their IP, and universities are historically, Glyndŵr is very refreshing in its approach, but historically, the IP has had to be grabbed by the university and controlled by the university. So allowing companies to keep their own IP and develop it in a partnership so that can be shared and just finding out who can help ad you know, that's hard. Who do you go to in university, if we phone the university now and go I've got a problem and I really need a solution to this to this issue, how effective are we at getting that person to the right place? Are we set up for that, it's a good question.

This is one I like, because it tells you the cultural differences between the two, so the focus of your R&D and your innovation in academia is driven by the Curiosity and the exploration and that's the orientation of it and that's the driver. In industry, it's about developing a product or a process and focused, so these are the same outcome but a different cultural approach. Core rationale, I won’t go through them all but there are some quite interesting ones, develop and grow the knowledge base, academic institute, that is our aim, want to create skills for tomorrow and also develop the technology of tomorrow within a company. They want to increase their efficiency, increase their market share, increase their bottom lines. The same rationale, same objectives to explore and prove new ideas, but at different cultural approach to that so we need to close that cultural gap, and talking to people through the CPE program I’m working on, it’s the language we use and things like that will help to close the gap. Judgement, performance, evaluation you know in academia we’re judged by our peers, we’re peer reviewed on publications that's what we do. In industry you’re accountable to the boss or board, yes we are in academia accountable to the board but not at an operational level that's carried through. So quite different outcomes and cultural focuses and interpretations for the same issues.

What's the difference financially? This was a wake-up moment for me when I started working within the university, and what I found is the biggest difference and why is there this valley, and I think it's financially driven, which is my theory, so from an academic research project it is massively simplified the journey. Ok, so you get a grant to do your research and you work through that grant your capital purchases at the beginning you get your equipment. If you start-up company and you’re starting with an idea, you're starting from here and you're trying to get to that point, you're trying to grow your financial position, you're trying to get your investors, you're trying to do that so, that creates a valley. And you know hearing in common language the ‘Valley of Death’ or is it an opportunity gap, and that's my view so to me, that's my theory of why we see this and how the valley is created and I do believe it's financial. The way the financial model sits for innovation and for development.

Operational challenges, releasing capacity within a company, that's a big deal. They employ people to do a job and make things, you know and so to develop R&D facilities and capabilities - it's a big commitment for a company; contractual obligations, they've got deadlines we've got deadlines to deliver our projects and financial models; the skills development within companies, and also the test facilities and equipment. And that's why universities can really help companies because we have fantastic facilities at the Optic centre as Maria has said, and we have a huge amount of capability within Glyndŵr University, within the composite centre on the materials, and all of our research base and those facilities and equipment can be very useful to our industrial partners and certainly some of the newer investments in optics through the CPE program are proving that service that the university can offer to larger companies, who have similar equipment, but that equipment is dedicated to their service or their products so they can't break into that cycle. So having that remote R&D facility where they can come and develop their process and it's on the same scale as their manufacturing process then they can transfer that directly into their business and they have that capacity and they continue the manufacturing; they don't have to the break into it so that's proving to be very much the case with what we're doing.

And obviously financial constraints is one that drives us all, not just businesses so we could create an awful lot if we weren't financially constrained. Breaking down the barriers and building the bridge; recently I've had the pleasure, honour to head up a project we developed called the Centre for Photonics Expertise, I’m going to call it CPE because it's a bit of a mouthful, that's the only acronym I'm going to use. Because that was a vision I had probably 5 years ago now, 6 years ago; the project’s been running for almost 4 years, it took almost 2 years to get it over the line. It's been hugely successful and the real focus of that project was to try and build boundaries and build our industrial partner relations and build those bridges as we say. So it's a working example, quick summary at the bottom there, we've done in those 4 years over 80 collaborative R&D projects working with 60 (I had the figures because we've got the exec meeting tomorrow) 60 Welsh businesses supported and we've got over 70 new and improved products or processes. Now those are all industrial partners where those projects have increased their turnover or increase their efficiency or they've managed to save jobs because they've managed to lower their production costs, so it has a very valuable part to play and it's also generated other things like other grant applications, KESS studentships and PhD opportunities across the four partner universities. It has also united four Welsh universities in its operation and that is a huge achievement and also we have a common documentation a common agreement and that relationship is absolutely solid, every academic partner has delivered fantastic results which will go through a few of those afterwards.

So, Centre for Photonics Expertise - what is photonics? I may be preaching to the converted I know I am to a few of you cause you're my colleagues, but, it’s the science of light really, the engineering of light and it touches everything that we do. So the UK photonics output is around 13.5b a year , it’s huge, where is it, photonics technology it’s a support technology it's an enabling technology that's why it's so big. Everybody has a smartphone that's photonics, you know everybody has cars. Photonics is employed with thermal imaging, lasers as I say, some of the techy stuff but everyday items as well and your light bulbs and things. A little bit of background on the photonics industry, borrowed, we are members of the photonics leadership group so we are entitled to use their numbers; the market scale of the photonics industry, it is huge worldwide 730 billion dollars. There's a bit of disparity between these numbers as they are taken from two sources and the reason being is that photonics is quite hard to judge because it goes from components right the way through to systems, so your chip manufacture is a photonics device so as are all of the electrical components and many of them. So that shows, in the UK 15.6b Euros so actually it does count that's you know, we can do with a piece of that couldn't we?

And that's what it's made up of, components, imaging chips, subassemblies that go into a small unit that goes into a bigger unit photonics device; imaging systems, displays, telescopes, everything is a photonic device and online services, and that's where the big money comes from because you've got your fibre optic communications, your satellite systems, everything else, it all adds up to that value which is why it's such a huge number.

What's happening in Wales? We're actually quite big players in Wales, photonics employs 4392 people in Wales, that's a lot of people really for a small country in one discipline. And we're growing within the UK, photonics industry is growing, you’ve got the semiconductor facilities in South Wales a huge investment by the Welsh government; you've got the developments we’re doing at Optic, you've got companies right on the Optic doorstep who are doing amazing work within imaging systems, military systems. So huge amount of activity centred around St. Asaph and there's a number of companies around Wrexham as well so our small part of Wales is actually quite a large part of the Welsh contribution.

So where does photonics sit in the turnover and employment sector? It's pretty high actually, you know it's higher than the steel industry, higher than electronic components, it's on a par with the chemicals and pharmaceuticals industries, so it holds its own. And the manufacturing, which is a real economy driver, I’m a big driver in believing that manufacturing is key to wealth within the country and we should be developing manufacturing and supporting manufacturing. So output 23%, car manufacturing is photonics based and 50% of air and spacecraft manufacturing is photonics based so huge output.

So making it work; it is your everyday technology, from the candle to the LED light bulb, fibre optics communications, laptops, medical imaging, more recently UV sterilisation of hospitals. We were involved in developing a system that sterilised ambulances so they could be used during covid particular; security, Christmas trees, Galileo - it's quite old you know, the telescope; the E-ELT which is being built in Chile, the team at Optic have had a huge input into the development of the processors for initially for the primary mirror, but those skills that were developed, we’re now working on a system for the pre focus system for the E-ELT, so that work is carried through, so that's a 1.6 million-pound project for us. So it’s to manufacture the mirrors and the support systems for those mirrors. Fantastic opportunity. Gwyliwr we named it, which is ‘watcher’ I think in Welsh, that's an ultra-lightweight telescope. We answered a call as a university for the development of a lightweight system to go on a haps platform, which is an unmanned flight platform surveillance, it had to weigh under 2 kg and it’s a DERA, defence funded project. We were successful in getting the first round, we were the only ones in the first round that produced a model and a prototype, and we were successful in the second round and we developed the system further. We’re now working with QinetiQ on the fourth round of that program and we're developing a lidar system a LIDAR version of that system. What does it do? Well a LIDAR will give us much more definition but the one we initially developed was a visible system a telescope system, it weighed 1.6kg, it’s very light, and you know it's something we should be proud of we own the licence on that, so that's an example of going from a grant funded project through to a marketable product.

Our partners with CPE are Aberystwyth University, University of South Wales, and Bangor University. We operated in only in the west Wales and Valleys region because that's where the funding was - all of these projects we've undertaken were in the development areas of Wales and not in the high level industrial areas, ironically, we couldn't do any projects in Wrexham, but we could carry them through to the west Wales and Valleys region where the support is needed and the development of businesses is absolutely key for the Welsh Government Innovation strategies.

It's 4 years as I said, it’s £7.3m total project, that includes the match funding from the companies as I say with the four partners it was company focused development, so what we wanted to do was have a quick turnaround address some of these concerns when we did our initial market survey. It takes too long, too much paperwork, so how could we overcome that? The CPE model. By uniting the four universities, getting common agreements, getting common NDA set and in place, and we have the business development function going in and talking to companies and asking them what was the itch you can't scratch in your manufacturing, you know, what is your issue? Is there anything we can do? We didn’t talk to them about photonics, this was the key for engagement, we talked to them about their needs and what they needed; it was only then when we took away the potential challenges that we had and we reviewed that as a technical team away from that partner and then we would potentially offer a solution. So the business development function was about clear engagement on the company's level on the individual's level and that really was a game changer for opening doors. Had some very good business development people who did a good job as well, so we've identified significant capital investment already, made into each of the academic partner, we’ve had £1.5m worth of Optic including the only production scale vacuum coating R&D facility in the UK. That's quite significant for us as a university, at the end of the project we will be able to move out of that boundary constraint and I'm pretty sure there will be much wider demand because we had enquiries outside of region previously so, very valuable resource for Welsh companies. So as I said, we placed the developed expertise of each partner institute and that meant that once we’d reviewed it online (all our meetings were online before covid so it was quite easy to transfer over, so luckily we were already on that platform) we would review it as a team of experts across the photonics disciplines Four universities have four very different strengths within the photonics sector and the brainstorm the solution and the best the strongest solution and the best solution for the company was the academic institute that picked up that project. We have two projects in the optic Centre that are run by USW because they were more familiar with the technology and gave the company a better solution, so putting the right people in the right place very quickly and very effectively. And we created that academic capacity. The project employed 9 full-time researchers to support businesses over 4 years; that’s where most of the money went apart from buying expensive pieces of equipment; the real investment for that was in the people, creating the research base, creating that capacity that could work directly with companies straight away, without having to go for funding, separate funding, the resource was already there. And that's the key to success with engagement with companies: having the resources available, having the resources and the right equipment available to support what they need. The feedback we had, we had two surveys running recently, I’ve seen preliminary report from 1 and the final report from the other and they all say the same thing: it's the speed and the reaction and the level of support that they've had during the projects that really makes it a project that they would re- engage with. Over 85% of the companies that have engaged with us wanted to do another project with academic institutes so excellent fallout.

There we go, so as I said it's low risk, you can try something out at low risk; the company's contribution was in kind so they had to match their efforts, it's truly collaborative, where we can only claim if the company puts in 50% of the activity and so they were fully involved and fully engaged with the program all the way through. They could get to explore their ideas in a low risk environment without disrupting manufacturing or production so ideal really for people to work through those ideas, and we had some ideas that really did come to excellent fruition.

So that summarises all of the activity there up to the end of Q 15. And so 50% longer term collaborative partnerships due to CPE, so that's where the projects have gone beyond CPE and they’ve got additional funding or the company has invested and that's grown from there. Five KESS studentships you know, that's quite significant as well, net jobs created, in a time of recession and high inflation to create 3 new technology jobs is good, it's a good you know it’s a good result. The number of projects that we have undertaken is quite significant.

Ok so what have we been doing, what are the projects involved, so I’ve included a few case studies briefly, a bit wordy but I'll talk you through them, The problem here was Welsh slate in Blaenau Ffestiniog, they make, the majority of what they do is roofing slate, they pack them into boxes that look like that and they’re all slates, and they had a guy sat there counting them, every one of them in the box, and they said there’s got to be a better way to do cause he keeps getting it wrong, they talk to him and then he had to start again and it's all very inefficient. So we came up with an idea where we could do like a machine vision off-the-shelf solution, we mocked up a prototype and took it to Welsh slate, it went brr brr brr and it counted the number of slates within about 10 minutes, less than that probably, five minutes by the time we’d set it up and everything else. And it was accurate it was repeatable, it meant that guy could go off and pack my boxes and increase the throughput. A very simple you could buy it off the shelf solution but we knew you could buy it off the shelf, we knew where you could get it and we knew how to put it together and that's the difference they didn't have that technology or expertise within their company and they didn't know it existed. So at that level, that's where we were.

Next one, was a little bit more sciencey if you like. Robertson Geo, they have a borehole camera which was going out of focus because of the massive temperature range it goes through; we did a remodel on the system and identified the thermal focus degradation, and this is a Glyndwr Project and the optical performance testing to improve, make a prototype to improve that performance across that huge temperature range. Successful outcome, we’ve redesigned it, they’ve purchased a replacement lens and I think we're in the final test, Neil’s here, he will know, we’re in the final test period where they're going to drop it down. But we designed the thermal balance of the optical design to improve that, that will perform between the + 20 and the -125 degrees, that's down a big hole so they can look all the way down without losing focus.

From boreholes to animal faeces and parasites, so this is a project for agricultural projects and that was to help with the resolution of the microscope that they were using to look at treating parasites in animals. They wanted to review the reduction, basically they are looking animal faeces but we redesigned the lens for them and recommended a different system so that they improve the resolution so that they could start to pick up, I think it was, yeah, the resolution went from 5 NM down to 1.5 NM, massive improvement in the resolution of that so that they could witness what they were seeing and now they can see, they could identify the parasites. Huge breakthrough for them because you know they’re developing treatments for parasites in animals and they can identify and improve the performance of their items.

So again, Allied Aerosystems, they are company that we were trying to get UKAS approval for a test instrument, so I won't go into any details on it, so basically they had to characterise the performance of the system and they didn't really know how to do it, how to characterise it, so we did the testing for them and the calibration exercise for them. The idea was to obtain UKAS accreditation so that they could become a testing lab for other users so again, all over the place from animal faeces to slates to very interesting projects.

This one is probably my actually because it's diamonds, everybody likes diamonds don't they; we didn't get any free samples unfortunately, but that would have been nice. Diamond Centre Wales working with the laser group at Bangor and some of the imaging stuff that we have, and so they are registered diamond merchants and security of diamonds and provenance of diamonds is quite an issue actually, and traceability, so what they've done is developed a technique using very high powered laser but very ultra-fine resolution with what they call a super lens, which is focusing the beam down very small. It's to produce like a QR code that's on the diamond, it doesn't change the look of the diamond at all, you can't see it, it's way beyond the resolution of the human eye. The whole thing is about 300 microns which is about human hair width is a good scale for that I think. And the idea now is to take that further, they're going to work with diamond Centre Wales, Diamond Centre Wales is going to set up pods around the world, their mission is huge growth because they are going to set up facilities around the world to identify and mark diamonds so they are traceable and can be registered and licenced and, huge amount of work coming out of that for Diamond Centre Wales who are a very good advocate of the program as well, they've spoken on sessions that we’ve had, they’ve spoken about their work with us. Next stage for that would be to use a laser to put the code inside the diamond with the laser and part of the capital investment is a Femtometer laser I think they said it was, so it can decrease the spot size and also focus inside the diamond so it can't be ground off. Because obviously at the moment it can be, so proof of concept and new to the firm products, process, and huge growth.

Ok so Qioptiq, they are large manufacturing company down the road in St. Asaph, huge employer locally, you know world-renowned optical system manufacturer right on the doorstep, probably one of the main reasons that and Pilkington Glass, why the Optic Centre is where it is and how it came to fruition right at the beginning as part of the Technium Network. This is the development of the vacuum coating facility which I mentioned earlier, that's what it looks like doesn't look like a million pounds worth does it really, but it is. The project aims there were to provide two things really, the development, space ,and capacity for companies to develop their next generation of projects and also for us to develop capability in producing advanced coatings, and to marry that with our extensive metrology capability and to develop that future project for the university to develop the high power laser optics facility and testing. So it all ties in together with a future vision for the centre and for the research activity and it does provide capacity and that for R&D. If you create capacity you create development and success; capacity and opportunity are the key drivers for that.

Tata Steel, huge industry, and they had an issue with a film on the glass and they wanted to, they had an inline measurement system that was losing focus because of the film that stops the metal sticking together so we supported them together with USW, we feedback. In fact this project is nominated for one of the technology Awards tomorrow night in Cardiff, so the Wales technology awards; this project is one of those that has reached that level, so fantastic opportunity working with a huge company and a very successful outcome.

Space Republic, basically they wanted, it's about cleaning and UV sterilisation using UV light to sterilise work spaces. Hot desking is a big thing; we've got pods all over where we were having a reception; the idea was to develop a system that was in there that was UV light when the person left you shut the door, the UV light would sterilise the environment very quickly and then that environment is sterilised for the next person going in. So quite successful, and just prototyping analysis, just designing potential links so, it just gives you a flavour of the type of applications and the level at which you can work with not a huge amount of resource but you can make a huge impact by creating opportunity and capacity for people to work with.

That's the network of, you can see, the activity is clustered around Aberystwyth, Bangor you know, so the reach to the companies that we've worked with is bound to that West Wales and Valleys region, so we would hope to be able to push in to Cardiff, Newport, Swansea, Wrexham, and across the border into the northwest, Liverpool, Manchester, so huge opportunity there and potential for collaborative work. Even supported our own company, well Bangor did, under a project which was good so big spread of different companies.

Some industrial partner feedback, this is taken from the WaveHill report that I mentioned before, the team’s said the university was very good very understanding all saying the right thing and we didn't pay them very much, but yeah it's good to have that positive feedback. For us they’ve invested in the right type of equipment that suits exactly our location a stone’s throw from the factory so it makes for a good relationship, creating opportunity and capacity.

So other strengths universities offer, local industry focused skills training we can offer, and that's an important part of the university function is to develop skills. High value equipment resources, workforce of tomorrow that's what we're providing, market leading technology and thinking vision and a new perspective, we’re a modern university and we need to work, we work in a modern way with companies.

Other Glyndŵr technical activity, Glyndŵr Innovations is the university’s own spin-out company that delivers optical systems and optical components; it’s the only one in the UK that can provide components for telescope mirrors up to two meters in size so it's a large aperture capability with extensive complex optic tech systems. So really breaking the boundaries of tolerance and performance at same time working as an SME on that platform. Walking the walk as we say, not just talking the talk.

Couple of examples, the LIDAR telescope system for the haps platform, haps platform is there, you can see that, it’s a Zephyr platform. We have worked with them to develop the optical system and later on the LIDAR system which is where we are now. My colleague has been buried in the lab all day because we're getting a visit from them early next week, so exciting project for us because we've taken that from concept right the way through to product, so we gone through the whole journey and we have a significant partner in QinetiQ to deliver that, so it's a three-way partnership between BAE Systems, QinetiQ and Glyndwr because of the programme.

Again the IDOM E-ELT pre-focal optics system, so that’s the optical test for one mirror, it’s the thing hanging from the top, some of my colleagues here this evening saw it this afternoon being tested so it does exist, we can replace that with the photograph now. So what we have to do is test the mirrors, the support system has to be replicated because the tolerances are so tight, the gravitational effect alone of how you hold the mirror will just push it out of tolerance by a significant amount so, it has to be very much, you can work on the bench and then you put it on a telescope it's not going to work so, there's a significant amount of design. We have the capability and we've developed the capability of designing opto-mechanical systems, optical design, optical fabrication, optical systems development and assembly so the full package to support our business as well as the collaborative businesses we have.

Hyperspectral imaging program, that’s again I've mentioned that just to give you an idea of what that is, that's part of the Endeavour programme; Endeavour was a partnership between Welsh Government and Airbus, and Airbus put 50% in Welsh Government put 50% in and the outcome of that is we are providing costings for hyperspectral imaging system which is a huge project for Airbus and we are developing our own system. Very excited about the results of that if anybody wants to know what it is, catch me when I've got a glass of wine in my hand.

So what's next? Talk to us really, that's all you have to do, just talk to us, ay way you know you feel that we can support. Currently aiming to obtain additional funding and the network remain strong and the joint collaborative partners, our main aim really is to continue to be the trailblazer project between industry and academia and I think Glyndwr can lead the way. We have a model that works, it's proven, proven over 80 + programs so we want to carry on doing that.

That's it, thank you.

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