Introduction to Research
Prof. Prathap Haridoss
Prof. V. Anantha Subramanian
Department of Metallurgical & Materials Engineering
Department of Ocean Engineering
Indian Institute of Technology, Madras

Lecture – 40
Research in Ocean Engineering

Prof. Prathap Haridoss: Hello, we are very happy to have with us Prof. Anantha Subramaniam. He is the head of Department of Ocean Engineering here at IIT, Madras. He has extensive experience in this field; he has been in this area for over 35 years now. So, lot of industry collaborations, lot of projects, lot of research projects which maybe you know extensions of concepts that we are dealt with through industry collaborations, lots of extensive you know visits and collaborations with international universities and so on. He has very rich experience in research, in dealing with students and dealing with working with industries; you know shaping students' lives as they go about through their you know Masters Degrees, PhD Degrees and so on. So, it is pleasure and privilege that he is able to join us today. His own areas of research are Computer Aided Design and Application of CFD to floating structures including ships and other floating bodies. So, it is a pleasure to have you with us sir.

Prof. V. Anantha Subramanian: Thank you.

Prof. Prathap Haridoss: So, I just wanted to start with this idea that you know in almost any field of engineering there are certain areas that have been what we would consider as traditional areas of research, which have been around for a long time. Of course, even in these areas there are you know newer concepts that people look at, but there are some areas that we would call as traditional areas of research. So, in ocean engineering what would constitute such areas?

Prof. V. Anantha Subramanian: To start with I should say that Ocean Engineering is not a basic discipline by itself. Is an area that has emerged as a discipline, consequent to the oil crisis in the 70's. Otherwise, ocean engineering would cover the major sub set of ships, naval architecture in all its variance. So, offshore structures where then designed to be operated in the challenging environments of the oceans and then of course, there were support results and then of course, ships cannot just go and operate in the deep sea they have to come to the

harbour. So, a whole lot of disciplines have been encompassed in what we now called Ocean Engineering.

So, there is the traditional design and analysis of ships and structures, their interaction with the waves, their propulsion systems, their navigation systems, the manoeuvring, the sea keeping. Now, from there the offshore structures which are huge manmade structures, but not necessarily powered by an engine. They will have their own complexities of being floating bodies or complain bodies or adhered to the ocean bed or articulated in some form. Then you have the coastal structures, ports, harbours, coastal break waters so all these have now come under the Umbrella of Ocean Engineering. And of course, I will be missing out because our department as now forayed into what we called Petroleum Engineering. Although strictly you can deal in petroleum engineering from ocean engineering, but that is what ocean engineering is?

Coming to the traditional areas of research, we can take up the challenges of all associated ship hydro dynamic problems in designing ships, in understanding the structures of ships, in the way the wind and waves interact with the ship and therefore, give rise to stresses, give rise to comfort or discomfort in terms of large motions, the dynamic effects that occur. So, these are the traditional areas of research, where you use modern tools such as of course, finite element analysis, computational fluid dynamics and these help you to therefore, understand better and understand more precisely problems which were thought to be not solvable a few decades ago. So, these are the traditional areas of research.

Now, when you come to the offshore structures, etcetera, there are long terms problems such as fatigue, the failure of certain kinds of joints and the challenges of handling these in the hostile environment in the oceans. So, you inevitably come to interdisciplinary areas, even in this already multidisciplinary area of ocean engineering that would be in terms of control systems etcetera. So these are the new areas of research where it is neither controlled systems experts, such as from let say the basic field of electrical engineering nor is it the naval architect, they have to work together and they have to understand these.

So, these are the new areas of research. Like this we could extent to the area of petroleum engineering because the challenges of exploring below the ocean bed for oil and having to monitor the process of drilling these involve lot of new challenging areas. Again the quest for energy from the oceans, we have the new areas, how to tap energy from the waves? So, we

have a whole lot of devices, some of them have been demonstrated to be technically feasible although still not commercially viable. So, we have structures called ocean oscillating water column, backward bent ducted boil, hydro turbines wherever there is current available, ocean thermal energy conversion. So, all these have given raise to new areas of research.

Prof. Prathap Haridoss: Okay so, lot of traditional areas and several significant new areas that. Of course, I think may be more so then any other discipline I think KLE in ocean engineering there is direct link with you know applications that are visible to the general public.

Prof. V. Anantha Subramanian: Very much.

Prof. Prathap Haridoss: In this context of course, when we talk of research we tend to talk of you know the relaters, the cutting edge and something that may be has a tendency for us to be associated with an academic setting. So, in this context, what aspects of research that go on in ocean engineering or of may be more immediate interest to the industry.

Prof. V. Anantha Subramanian: Yeah, that's an interesting question because traditionally industry looks forward to fast, robust tested solutions rather than deep involved research, which demands handling of it by vertical experts. And, this is something it has been catered to the industry, that we traditionally had the problem of analysis and design because again if I take the example of a ship, is a largest man made mobile object. The challenges of making this structures safe and sea worthy means you have to analyse it, you see today what we have trusted tools like finite element methods, for the structural analysis computational fluid dynamics for analysing the forces that are coming out of it and trying to address the problem of safety and comfort also. Because, you have a lot of dynamic effects occurring such as what we called shipping green water reducing the possibility of water coming on both the deck or trying to minimize the motions.

So, these are solutions which the industry looks forward to, I could add let us say for the example; Indian navy too. That we do offer solutions in these areas by analysing and experimenting with the kind of floating body that they have in their hands, to that extent the department of ocean engineering is well endorsed with the very rare combination of facilities which cannot be thought of under the university umbrella. So, to name them we have the towing tank, we have wave basin, we have the flumes, we have the best of instrumentation, automation that we are able to form, give solutions to the industry by giving them immediate

answers to specific problems. But, long term research continues because as I said earlier, the industry cannot wait for expert solution that requires lot of expertise in handling.

Again, from the industry problems where we get live data and with regard to the ships or with regard to the whatever the floating structure. We take it up further by way of analysis and here comes the interface of academic research, industrial consulting and providing solutions. That is where we have an interesting combination that we are able to use these sources that we get from the industry and try to match it to international levels of understanding, not just offering the solutions sometimes it is understanding the physics of the problem. It may not be that we really form a solution but, we even sometimes know that is certain approach cannot be had and I would say that all these help in contributing towards a research that the department undertakes.

Prof. Prathap Haridoss: Okay great, when I look at ocean engineering and say compare it with the other disciplines that are around including say mechanical engineering, chemical engineering, lot of other disciplines. One of the things I think where the ocean engineering department stands out or stands apart, is the fact that may be there are not enough you know undergraduate programs around in the country or may be even internationally which are focused on in this area. So, by the same token so when MS and PhD students come into your department, may be they are not, I have been I am curious to know to what degree you feel they are adequately prepared for handling what research is in specifically in your field? And if so, I mean or in that context, are there specific difficulties that they face as they come in, challenges that they face and if so, how do you go about addressing?

Prof. V. Anantha Subramanian: Yeah, I think you have pointed out a relevant issue there, because as I have said ocean engineering is not a basic discipline by itself and candidates that we get for our Masters and PhD programs are drawn from many disciplines. Typically, mechanical engineering, civil engineering, some from naval architecture, many from aerospace and of course, because we have the Petroleum Engineering there are some candidates coming from science backgrounds, oceanographic backgrounds, geophysics and so on.

But, let me dwell on the main part of ocean engineering. There is a learning curve that these students have to understand, what the department is about? What are the main courses? We do have a challenge because with a relatively small number of faculty being able to satisfy

the requirements that these students need to go through, we do find that unless they have gone in a little in depth into some of the fundamental aspects such as, hydrodynamic structures and of course, whatever else they want to take it, take up in their research areas. There is a little bit of I would say a limitation that they could do better, if they were geared for that. I must also say that unfortunately research is being made a rat race that there is a tendency to go for numbers, maybe it is the numbers of degrees produced, maybe it is the numbers of visible outputs produced, and that in my personal opinion is counterproductive. If we could address that problem and allow people to learn and experiment and then go about I would say the quality of research would go many notches above.

Prof. Prathap Haridoss: In fact, is in that context I was curious since you have had you know so much experience working with industry and research institutions, internationally as well as in India and so on. In your view, in fact, as exactly as you pointed out you know there are certain matrix that people use and sometimes those are even misused. In your view, what is a good way to look at progress in research from a student prospective or as I know as you interact with the student? How would you feel, when do you feel you know the student is actually making progress in a general sense with respect to research?

Prof. V. Anantha Subramanian: I think the first step would be that the student should not be straight jacketed that from day one the problem is presented and he is asked to work on that. He have to allow the time for a little bit of learning, I know that student will work or for that matter anybody will work only under pressure. So, the pressure has to be applied on them, but this pressure of looking for numbers, if we could take it out, would help them to settle down. The system expects the numbers therefore, they are busy preparing numbers.

So, I think we should be delink this to some extent, without reducing the pressure on them, which means that in first semester when they typically are busy with their courses, the mandatory courses to be taken, we should allow them to interact with other peer group meaning other researchers. Learn the basic tools because I personally believed that the research, whether it is a MS or PhD level is reaching the peak of the pyramid. So, there is a base irrespective of what you are doing, students have to be mandatorily exposed to that and have to get the confidence of that and finally, learn to stand on their feet. If this model could be added, I do not think this is idealistic I have been trying to apply this to my own group and I would say in our humility that we have been successful, maybe the time does'nt meet the stiff deadlines we don't get a PhD in 3 years or something like that. But, I feel this is a much

more hold some way of approaching research and more important is students who come through such a process are easily absorbed in jobs.

Prof. Prathap Haridoss: Ok.

Prof. V. Anantha Subramanian: It is a very satisfying end result of all the work.

Prof. Prathap Haridoss: In fact, in this process by which this student settle and then grows in the research area, in the research setting I think there is a lot of importance to the extent to which the students interact with their peer other students who are present and also with the faculty that they work with, their guide and so on. Maybe a bit of mundane question, but in your view you know what do you see as you know how often students should be meeting their guides? Because, it is very different from a course based kind of learning, there is a lot of I mean influence and importance to this interaction that makes a difference in how they grow. So, what do you think are you know good frequencies with which people should be meeting the guides and how they should be going about it?

Prof. V. Anantha Subramanian: Yeah, that's again a very interesting question because whenever I have addressed the students in their research methodology course, I have tried to put this question as a starter for the course, how many times do you think you should meet the guide? So, I get lots formula on that and of course, many students obediently feel they should meet their guides regularly. I am against that, I would say there would be contact with the guide yes, and the real smart student is one who will get the queue through many casual meeting and also with the meetings of other students.

So, in an ideal sense if you want put a number may be once a week is fine, but more important is the student is able to stand on his feet, put in his efforts because I have always seen that there are so many students who you may be seen around but they come back with results, that is a very important thing. And, they do not get the sense straight, it is not that easy problem, but they have learned to reach out to different sources, put their effort, done their design, done their fabrication, even gone to the market and got the things fabricated it.

Again, I would say maybe I am just putting it in my experience. That I have a group of about 30-40 and we have everybody for everything. So, whether it is a software and induction of the new comers into the learning process for different softwares or whether it is the fabrication or whether it is experimentation. So, I see a harmonious group therefore, I would

say that building a group is very important to help succeed in research and learning from each other rather than, just from the guide. So, I don't think that it is important to meet the guide on a very frequent basis, if they have to meet, most welcome. I do not think that, that is a formula to success.

Prof. Prathap Haridoss: Great, I think that is a very valuable insight into you know what should be going on and at least how the student should approach it in their mindset. So, you were speaking about you know the successful students who complete all their activities here successful and so on. Now, when we look at MS and PhD research type of students, there is always this feeling, in not just in ocean engineering across all disciplines that when you an MS or a PhD you are an expert in an sort of narrow area. As supposed to journalist, who would what now, which is what we would associate with the bachelors degree. Now, of course, being an expert is a good thing but, at the same time that probably narrows down, the kinds of positions that they can get into the jobs that they are getting and so on. So, in your experience, what sort of positions do MS and PhD students completing degrees in ocean engineering, what sort of positions do they go to or they get?

Prof. V. Anantha Subramanian: Yeah, I do believe that acquiring a higher degree in the environment of IIT does not mean achieving proficiency in a particular vertical area alone that is important. But, more important is the problem solving capability, the ability to look at something if they are independently and in depth, the ability to get a team together and work. To me these are the strengths, which give them the job opportunities. Again, I would say I have been very lucky that all my scholars at the time of finishing have been already placed in a job. Of course there are disadvantages, that the student has no time to prepare the visible research outputs, this is the only hassle. Otherwise, I would say that they have been by and large place and I would say that the reason for that is because they have brought these consults, because you do not know where which particular opening you are going to get.

So, essentially you have to take your research here as a learning experience, the ability to solve problems and with this they are able to adapt. Typically, my students have been going to the design organizations, maybe shipyards, may be offshore industry, they have been able join the computational fluid dynamics application software development companies, such as CD-adapco and so many others Eaton and so on. They are there in many industries where, they get compartmentalized and are looking at part of a CFDs solution there, either formulating or developers or testing etcetera. But, by and large I would say whatever they

have done let's say, level confidence which they exclude and that seems to help to meet. That is a very important thing because if you are lucky you manage to work in the same vertical area that you choose for a PhD. But, most of the times you have to be open enough because maybe some other day you will come back to the area or maybe destiny will take you to some other area. So, I think we all have to take it easy, enjoy the research, do what you are doing, don't lose sight of realities, be able to project that you are versatile. For me this is most important.

Prof. Prathap Haridoss: Great. Okay I think maybe you already sort of addressed, what I wanted to ask you next, but in any case I just wanted to know, are there any specific words of advice that you have for students who are aspiring to join an MS and PhD program in ocean engineering?

Prof. V. Anantha Subramanian: Yeah, students who are aspiring to join MS and PhD, first they have to feel convinced that they are not venturing into some unknown area they have to feel comfortable. I do feel that the branch is so broad based and so multidisciplinary and interdisciplinary, the adaptability with which they can go and work in so many wild areas of specialties, that is one thing. The second thing is people need to learn to share and exchange knowledge, it would be very wrong to think that you are working in a narrow area, you would rather individually or you rather work in small groups or even as individual because to me these are much more important in achieving success in a future carrier. The other thing is don't forget to be happy because if you are not happy whatever you do, you cannot get the best of things. Again, I say this from experience because, if a student or a teacher or whoever is not going to enjoy what he does or she does every day, there is no motive because finally, that is a life philosophy that the objective is to be happy everyday and follow that.

Prof. Prathap Haridoss: Okay Great. Very nice words to conclude this discussion with I think. So, it talks about both professional growth and personal growth.

Prof. V. Anantha Subramanian: Both are connected.

Prof. Prathap Haridoss: Great. Thank you Prof. Anantha Subramanian for joining us, it is a pleasure to have you.

Prof. V. Anantha Subramanian: It is my good fortune that you wanted me to say a few things. This will benefit researchers, new students who want to look into IIT and take make the best out of their carrier.

Prof. Prathap Haridoss: Thank you. Thank you so much.