ON PH.D. IN ELECTRONICS AND ELECTRICAL ENGINEERING: A PERSPECTIVES

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ABSTRACT
In recent years, there has been a growing interests and increasing attention for researchers and students who embarks and pursue the PhD degree in particular to electronics and electrical engineering. There have been several scattered information that provides literature reviews in the area. However, up to this date, it appears that there is a lacking of a single useful paper that may provide useful information and advices in specific for PhD students under in the electronics or electrical engineering discipline. The focus of this paper is to give comprehensive insights, useful advices, background knowledge, and valuable source of information for students entering a PhD in electronics or electrical engineering program. An attempt is made to address this issue by combining the proponent experiences, several available articles, and reading materials, presenting therefore this paper as a useful guide and a reference compilation. It is envisage that this paper may provide potential benefits for students who undertakes PhD in electronics or electrical engineering, and may have a future career direction through research.

KEYWORDS: *Education, Electronics Engineering, Electrical Engineering, Ph.D., Research*

I. PH.D. IN ENGINEERING

The author considers an important experience and task to write something about this topic because in recent years, there has been an increasing number of students who wish to pursue a doctorate degree in engineering, and yet most students do not know what they have entered; thus, ending up miserably and have not finished. While obtaining a PhD in engineering is an individual triumph. The calculated risk and cost is too high to take. As the saying goes, *many are called but few are chosen*. A clear goal and vision is a must for every students before entering in this new path. It is important to consider that staying actively in a technical career and research engagement should be your prime goal and motivation. Taking a doctorate degree in engineering is a mental, financial, physical, spiritual, and emotional struggle where you need to face doubts and fears. Being brave, and utmost determination is required, which is expected for the potential students.

Entering a PhD program is a serious business. Most students are not sure what they are apt to. Hence, they could not get out of it. They applied, enrolled, take courses, but never had a clear goal and vision with what they are going to do. A vision to publish papers and do researches. Never have a clear vision on how they could get out of the program in a shortest possible period of time.

The excitement of PhD normally starts in the beginning. Motivation is very high at the start of the first semester class but in the middle years and in the long run, motivation keeps on decreasing. Gradually, as years passes by, you will lose interest in continuing and what stays is the commitment.

PhD is a very long term investment; students are investing themselves to be a good researcher. It is depth and not broad. A deep understanding on a certain and chosen topic. Hence, a potential student entering the program are expected to be dedicated, motivated, committed, and notorious hard workers. A high technical knowledge is a requirement before entering the program. Often, the best candidates have a working experience in a research and development (often known as R&D) environment, have

several conference papers and journal publications, somehow with teaching experience, mentored thesis of graduate and undergraduate students, among others. While most of the universities do only accepts PhD students who have MS degrees, there are some universities accepting students in a PhD program with BS degrees.

Under normal circumstances, there are two main goals in obtaining a PhD. One is to become a scientist in a research institution while the other is to become a professor in a university. Most of the cases, the latter applies. On the other hand, if the objective is to become a president in a business company, profiteering, obtaining promotion, or just to prove that you are the smartest of all, then embarking a PhD degree in engineering is just a pure waste. Although, there are some few exceptions but it is not further recommended embarking yourself in a PhD career. Otherwise, you will find yourself in a difficult situation in the long run. If you are working full time, try consider taking a long term leave at work before entering in the PhD program. Management and research are entirely opposite and different. It would be difficult while in a management position because the job consumes your time and you need to work for deadlines. Personally, I never saw a person who is a leading research scientist and a president of a company at the same time.

Examine your environment firstly before taking a PhD. It is also important to assess your status, family, job, hobbies, finances, etc. because this may affect during your journey towards PhD. There are some instances where some of this fades and get compromise. If you can manage these things and other important aspects in your life, then you can focus and you are on your way to succeed.

A very good environment invites a good research. In my experience, there are times that I need to go to a coffee shop because the environment in our home is hot, most especially during the summer season. However, noises are everywhere in a coffee shop; thus, making my creativity and productivity to stifle. Hence, it is hard to think of good ideas and write a paper even your enthusiasm is at peak.

Obtaining a higher salary should not be the prime instinct. It should not be the primal drive or you may end up wasting your time. These are not advisable for students who wish to enter a doctorate degree in engineering because in the long run, it will not help, you will not be able to finish, and may end up being miserable. In such occasions, taking up a doctorate degree in engineering is just another a pure waste. The motivation should be of research because the student is expected to perform a lot of experiments, which is normally a learning by doing scheme, read a lot of papers and write articles in his field of interest even after graduation. Reading, writing, and experiments will be your new career life. Doing research should be the best motivation for any students entering the program. If this is lost, then everything is lost. Never ever undertake a PhD in engineering if you do not feel doing research and writing papers at all. Most often, prolific scholars are the best candidates. There is no other way to motivate yourself in doing PhD than research and writing. If you love doing research, writing articles, reading and reviewing papers, then you have done a good job of entering the PhD program.

Motivation should have to do something with passion and ambition. G. H. Hardy [31] once said that *noblest passion is leaving behind something of permanent value, and ambition is the driving force behind the best works in the world*. While teaching can give motivations, there are some professors who are not inspired to take research but are wonderful lecturers and are legendary in terms of teaching. Also, there are some who are good in research but are bad in teaching, while some others are good in teaching but are poor in research. However, situations can vary sometimes but you have to remember that PhD is all about research, experiments, and writing. Hence, never consider yourself taking a PhD if you do not have the passion and aptitude to do these things. Otherwise, you have to abandon hope of graduating. Self motivation and the determination are the most important character that any researcher should and must have because without it, everything would be a waste.

There would be a time where you are all alone doing in your research and you may know how terrible that feeling is. This is true most especially in the difficult times. You may think sometime in the long run that deciding to take a PhD was a wrong decision. Commitment plays an important role in times like this. I do rarely see a PhD student who gradually graduated on time, there may be perhaps some exceptions, especially if the science citation indexed (SCI) journal publications are not a requirement, but this is very rare case. Normally, it takes an average of three to four years to finish the degree. But in reality, it runs six, seven, eight, nine, and up to forever years to finish because of the dissertation and publication requirements. On the other hand, some students have not yet even proposed a dissertation topic within the first four to five years. Procrastination is one of the greatest enemy in doing PhD. Creative brains are valuable and they should not be wasted because there are many new problems

arises in the field, waiting out there to be solve. Although, there are some students who are good and active in doing researches. I seldom find students who publish prolifically. This may also apply to some degree holders, where some are actively publishing papers, while others do not. Further readings is suggested by the author on [1] - [30].

The remainder of this paper is organized as follows. Section II presents some advices for the course works, and also in the examinations. Section III describes the usefulness of literature review and oral presentations for the PhD students. In section IV, the author introduces in detail about the motivations in the stage of PhD dissertation. Sections V, VI and VII provides an advice to the advisee, and the role importance of an advisor, and the reviewer, respectively during the duration of the study. Sections VIII and IX discusses the sandwich program support for the dissertation, and the contributing role of the management for the PhD students. Finally, this paper is summarized with a brief conclusion.

II. COURSE WORKS AND EXAMINATIONS

Normally, the comprehensive exams are of two parts: written and oral. My advice is to compile your lecture notes, power point presentations, and examinations from all course works. It would be better if you still have all of them during your BS and MS studies. Most likely, the examinations play within these circles. You should know the basics by heart, but do not limit the basics from ohms law to amperes law and/or wave equation. Learn to derive equations and know how to use them in real world engineering applications most especially in your field. Advance your knowledge by reading journal articles. Learn the new definitions, terms, algorithms, mathematical equations, among others. Learning these things will help you in examinations and dissertation as well.

Remember that you will be bombarded with a lot of technical questions by the committee where some are invited outside of the institution, and you are expected to be competent by answering them properly on each and every questions being raised. Your answer sometimes lead into another question, while other questions are surprising and unexpected. One may possibly ask to write down and explain the equations that governs the firefly or with the wolf search algorithm. Thus, you have to prepare yourself on things like this. Remember that you are in a PhD level student and are currently being examined. In times like this, you are not in the right position to argue with the panel committee. Most likely, the panel committee in the examinations will also be the same committee in your dissertation. Hence, be professional, matured, and objective at all times.

In some universities, a two term course is required for PhD students who took Master of Engineering (MEng) instead of the Master of Science (MS) degree. While, industry based practicum and thesis have differences, there are several studies done by the MEng students that can parallel or compete with the thesis of MS students. The process for directed research is rigorous where you need to propose and succeed in the final oral defense. Also, you need to submit your study and be accepted in a conference or in a journal. It takes a year or two to complete this whole process before proceeding into the dissertation stage. Unless the student is fully prepared, this is a very difficult situation for MEng students.

III. LITERATURE AND PRESENTATIONS

The computer internet and the other research organizations database offers tremendous articles in almost any fields of expertise and it is growing every year. It is imperative to read and cite the articles which are highly relevant or close to the specifics of your research study. While, there are professors who observes the importance of literature review, some panel committee may skip the importance of literature review. This is prevalent sometimes. Almost in a shortest period of time, new techniques are proposed, and new development arises, making therefore the literature to grow and also to progress tremendously. These are all evident on the number of papers published in conferences, proceedings, and journals. It is not advisable to limit the literature that are carried out from the last five years to decades ago. It is the duty of a PhD student to keep abreast with the latest literatures in his field of expertise; hence, develop a concrete, comprehensive, and up to date summary of various methods that are available in the literature.

It is good to spend several weeks or even some few months on your power point presentation. Think and rethink about what you are putting on the presentation for your dissertation because sometimes

panel members does not have much time to read your documents because of a very busy schedule and therefore formulating their question based upon your power point presentation. In presenting your research, discuss things which are material and relevant. Avoid doing gestures that can intimidate the listeners. Turn off any mobile gadgets. Dress neatly and properly. Two to three days before the actual date of the oral examination, remind again the panel member committee about the time and schedule of your oral defense. There are some instances where a panel member is late because he was not reminded about the schedule of the oral examinations. This may worry the student and he may possibly lost his flow on the idea of his presentation where he must be meditating with, before the start of the oral examination.

Upon my perspectives, it is a must for researchers to attend a conference. Well, one of the reasons why is to say, or to remind that he is not alone doing research and there are others too who are experiencing the same journey and who are riding on the same boat. Another is to learn, to update, and network from other PhD students and researchers.

IV. DISSERTATION

Abraham Pais [32], a world renowned physics professor from Rockefeller University once said, *I spent every night until four in the morning on my dissertation, until I came to the point when I could not write another word, not even the next letter. I went to bed, eight o'clock in the next morning, I was up writing again.* Before starting a research, it is a good idea to keep in mind the fundamental question: What are the outstanding problems in my field that is ground for a PhD dissertation? Should you wish that your dissertation work be of significant and may gather a high impact value, then you have to work on important problems on your fields. Select which problems are the most important, and work for it. Otherwise, if you are not working in an important field, then your research would be of less value. Most likely, you will not get recognition and your work may not be cited by other researchers. When doing a research, keep in mind that citations should be also one of your objectives. Hence, the first thing that you must do is to identify what are the important problems in your field and propose a new angle of solution for it. It must be a novel approach.

On choosing a topic, it is recommended firstly to explore the expertise and research publications of the faculty members in the department. Never undertake a dissertation proposal on your own that no one of the faculty members is active into. If the faculty members are not active in research, most likely you would be limited in choosing an advisor and a topic that the faculty member is able to guide you on. Once you choose a topic, you have to do a research on what has been done in any aspect of your proposed research through the searching of the library archives, in the conferences, proceedings, journal database, etc. It is a good practice to discuss with your advisor and keep your advisor updated with all of your works. While most of MS thesis provides an improvement or some modifications of the previous methods or solutions proposed in the literature. The PhD student should keep in mind that, the novelty, innovations, and significant contributions are the primary highlights of the dissertation. Another question to ponder is, how would you know that your proposal, once it is presented to your advisor, it offers no horrific rejection, and can be accepted as a PhD dissertation. Most likely, you may end up revising your work after consultation. The worst case is being rejected. Though the concept of novelty varies from reviewers, advisors, and students.

Nowadays, it seems plausible to ponder that integrating the computational or the artificial intelligence algorithms and microchip development are used for a dissertation proposal. Most of the MS thesis or even the practicum based projects of the MEng students nowadays do incorporates the computational intelligence as part of the project solution. The applications of ASIC, computational intelligence in the different fields of electronics and electrical engineering is relatively inevitable. Algorithm development and software programming plays a very important role in the dissertation. FPGA and DSP chips are important hardware modules to test your proposed idea. It is good to have a solid background in C, VHDL, ASM, etc. If the PhD student have some years of experience in a research and development environment (embedded systems, hardware and software integration, etc.) then this would not be a problem. Firmware programming and hardware design, development and debugging is a very difficult job, most especially if you are dealing with computational intelligence. Starting from scratch scenario may take most of your development time, it may possibly take months, or worst, even up to years.

It is a very good advice to start your dissertation research and writing as early as you can. Preferred date is during your course work days or even start right away when you get accepted in the program. Many students had fallen or had lagged behind because the dissertation topic was explored after they had done or finished the academic course and comprehensive examinations. Write every day, make a diary and notes about your experiences and difficulties during or on the way of your paper writing. It is impossible to create a dissertation proposal for weeks, or even for the first several months. A good dissertation proposal requires years or so, of constant research. This makes the student be stressful during on his way to research because his motivation may go down. It is very important for the student to keep his motivation up. While most of the students follows the classic routine (i.e., develop the title first, followed by introduction, methodology, etc.) only to find out in the end that the title differs a lot with the research and it does not fit with the study. It is a good practice that the whole body of the research proposal must be done first before proceeding with the working title.

Dissertation requires the student to be a full time so he could spend quality time in writing. If a student had a full time job, most especially being in a managerial position, then it would be difficult to invite creativity and develop a high quality research. In this case, you must understand your purpose, situation, and priorities. These are the important times that you should work effectively. Sometimes in my experience during writing, or when solving a problem, ideas are running out. When I am not effective during writing or I cannot think of a good solution to ponder with, I used to walk or jog trying to divert my thoughts to alternative areas, until a good idea and solution may outburst, or comes out in my mind. This technique sometimes do works but the most important thing is to mingle the idea (problem and solutions) in your mind, if all idea runs out, then the dissertation could be disastrous. You will feel pressure and think that you cannot be able to finish PhD anymore.

The student should keep a record of progress. He must look unto himself if he is progressing or not in a daily, in a weekly, and in a monthly basis. As much as possible, it is not recommended to join in any other projects outside the interests of the PhD dissertation. Some students join a lot of projects and do multitasking jobs. In cases like this, it is important to remember always your purpose. You took the program because you wanted to obtain the degree, and not to profit on projects, which is not part or even a goal in obtaining PhD. If a group of students joins in a project outside their dissertation, they have high hopes and spirits in the start. However, in the middle and in the long run of the project, there comes at a time that some of the group members quits. There was also a bright student who proposed an abstract mathematical theory, although it seems to be convincing and good enough to accept as dissertation proposal; however, one of the committee seems to refuse and asks to develop instead of a hardware prototype utilizing the theory. It was shocking. I tend to ask myself, how it be possibly to develop an uncanny hardware prototype using an abstract mathematical theory.

Be careful and be sure not to lose all of your soft copy files, It is necessary to backup your files. Losing all your hard work files would be the worst day of your life. All your hard work data is gone and it is awful. Do have an external hard drive, or do use cloud storage, and from there you can save your work. Otherwise, you may end up finding a computer service for data recovery and pay the expensive price. More information can be found on references [43 - 45], [48] - [60].

V. ADVISOR

It is advisable for the professors who handle thesis courses of the undergraduates to put into practice the good research principles. Make them understand proper research practices. If these things are not done during their undergraduate years, and they took sooner the MS or PhD, most of the times, these students could not be able to succeed.

It is the duty of the student to read several important papers of the professor and observe if your research area can do match with his area of specializations. Study how their published papers are constructed. Most likely, this will also give you an idea on how he will probably advise you on your research study, and how you may be able to construct your future research paper with him.

It is good to choose an advisor that has recent publications in a good and reputable journals, editors and reviewers in some respected journals, currently active in research, has a sole authored papers, authored a book, have some experience in the industry, and as much as possible, he have a research laboratory. It is very important that an advisor must actively publishing papers in his area of specialization. It would be good that an advisor is a well known in the field, and stay on current with their specializations.

However, there are some cases where an advisor spends little time keeping current because of their extracurricular work and teaching duty.

Consistent advising is good because it is from there, where we can see and measure the progress of the student. A weekly progress report should be mandated for the PhD student, and this is highly effective if the advisor had a research laboratory. In this way, the advisor can always visit the laboratory and may ask the student about their respective progress. You must take note all of his recommendations and there must be a real advancement in your work from weekly to monthly basis. It is not a good practice to the advisee to just merely asking numerous questions without showing real progress in his work even at the proposal stage. Sometimes, in such cases, the adviser may be dismayed to the advisee, and perhaps may not be interested in advising with the PhD student anymore.

An advisor who has variable ideas can be frustrating and stressful sometimes to the advisee. They often have a fruitful ideas but does not estimate the feasibility. When an advisor is proposing on things that cannot be possibly achieved, or kept proposing on things which is trivial, then the students progress cannot possibly be made. An idea that is varying from time to time can never make any real progress, you will find yourself doing an endless revisions. The motivation and determination of the student may slow down and the desire to continue is no more the same, when he first enter the program (i.e., during the first year). Starting to propose with high dreams and hopes but ends up miserably.

The advisor is your main parent during the days, months, and years of doing research. The advisor has the capacity to build or destroy research spirit and confidence. The advisor holds the key to motivate or destroy the students willingness. Hence, selecting an advisor is a highly crucial and important task for the PhD student. The best advisors are accomplished writers. They are hard workers even at their busiest schedule, they continue to work with their respective researches, and do review their advisees papers. It is important to understand that a proposal should be of deep and quality, and it cannot be expected to an advisor with variable research interest. Only a specialist in the area can guide you unto it.

As stated, motivation is a key to succeed. Hence, advisors should kept on motivating their advisees to push through with their researches. Encourage students to publish papers, even simulation programs may help. This will boost their productivity and will help them realize if they are really fit themselves in the program. Try to review the publications of your advisor. In most general terms, you will be limited within the research interest and specializations of your advisor. It would be difficult if your research interest does not match with any of the specialized professors in the department. Your research could not be able to guide accordingly. It would be a good practice if the advisor may ask his advisee to present his research once in a week, and give a mock final presentation where all of the possible questions may induced before proceeding to the oral defense. Advisors should necessarily do their job as advisors. A good advisor ask the advisee to produce reputable results or data based upon testing, present in the power point every detailed results and draft the preliminary paper if the method and results are accepted. The basic duty of an advisor is able to correct and rectify everything before submitting the paper in a good journal for publication. Research progress does not accept excuses but only results. An ideal advisor is updated on what is recent in the field nowadays. What is recent in the publications, what are the latest techniques, tools, methods, hottest problems, etc. He is knowledgeable technically and could answer his advisees query when a problem encounters. A good advisor is open and replying to all means of communications, and can be contacted beyond his consultation hours even during the semestral break, where you can discuss with him the progress of your work whether through the formal or informal settings. There are some instances where the research direction of advisor does not match with the taste of the advisee, and some of the times the advisee does not agree with the recommendations of the advisor. Having an argument with the advisor is not a good idea. Though, changing an advisor is possible, but most of the time the advisee do not do it, fearing for the future consequences. The worst thing that may possibly happen is to transfer into another school, or do quit graduate school.

Although there are some exemptions, if an advisor is burden with administrative task, his focus may divide, and may result to be dormant in terms of high quality research publications. In general, research and administration is inversely related. Some advisors cannot able to advise their students properly because of their workload in teaching, and progress depends only on their students. This is the sad reality sometimes and; thus, the quality of research is sacrificed. The mantra *leave it all alone to the*

advisee seems to be one of the most scariest thing that you could hear. In cases and times like these, if you do not have the tenacity and willingness, you may easily give up and abandon hope.

While an advisor is supposed to act as an advisor, after helping the advisee in the research during consultations, and gave a signal for the final oral defense. There are some instances where during the presentation, the advisor together with the panel committee, acts as a referee, and ask a lot of questions during the oral defense. This situation is shocking sometimes to the advisee. Be wary and prepared on some unexpected scenarios.

There are some students who presented a beautiful crafted PhD dissertation proposals in the field of medical imaging, communications, power electronics, controls, etc. Yet, when these proposals were presented to their respective advisors. A horrifying rejection has been made, and one of the reasons were depth and novelty. Deep and novelty dissertation topics can only be done by an advisor who is well known in the field and is publishing high quality research in his area of expertise. An advisor who has little into no publications is considered to be dangerous. The advisee should not expect deep and novelty dissertation if an advisor has diversified and scattered research interests in almost all areas.

Initially, there are several things that can happen to the student: the right advisor but with a wrong topic, the wrong advisor but with a good topic, the wrong advisor and a wrong topic, and the right topic and a right advisor. As much as possible, the advisee should not to be encourage to create a research topic on his own. It is the basic duty of an advisor to choose a topic for his advisee to work with. In this way, he could be able to advise the PhD research properly. Creating a research topic where no professor in the department is actively doing a research with it, is a total disaster and; thus, all efforts may put into vain. Several supplementary materials can be obtained from [61 - 64], [71].

VI. ADVISEE

There are times when you are working in a research laboratory, motivation may go down and you may sometimes experience depression most especially when you cannot solve the problem. One solution may lead into another problem. This is the true nature of research where most of the time it is difficult to succeed the problem. Being deep and utmost understanding of the problem is required. On the personality side, these things may keep you low, humble, and not to abandoned hope. Advisors are demanding good results. Hence, you need to effectively manage your research success and failure results. The advisor will normally says it is done if the research is published. If you are a scholar, then you have to use your scholarship effectively and that you must be divorced from work or professional career related. Use your time effectively in doing researches since you are paid by the government or private agency to do this job. The most important motivation in obtaining a scholarship is to divorce itself from the professional cares, and have a full time in study, or in the research.

Sometimes, there is a specific question in your mind that even your advisor could not answer. So, it is your task to do it alone by yourself. This is prevalent mostly during the dissertation stage or in a research course where you cannot be able to solve the given problem. Do not be shy to email the authors of the paper, some are replying and are willing to help you on your problem. Although, some answers may not provide specifics, it may give you a hint, or a clue on how you can solve your own problem. When you could not solve the problem, most of the time, it take hours to days to solve for it, sometimes it takes weeks up to even months. This is normal. Therefore, it is advisable to keep the idea linger in your mind. In my experience, sometimes, the solution comes out during walking in the park, eating in a fast food or restaurant, doing some morning or evening exercise, jogging, and although it is awkward, sometimes in a daydream.

When your brain is at peak mode, you must use it to do productive work. Good research practices is all about focus and being productive. A productive student uses his quality time to study. If you are tired or stress, take a long sleep, do some exercise, gym workout, jogging, etc. This may help your body and brain to regain energy, attention, and focus again at work. When doing research, maturity and being independent is needed. Abigail Van Buren [33] said that *maturity is the ability to stick to a job until it is finished and the ability to perform a job without being supervised*. Under normal circumstances, there is no one to advise you when to do your research, no one will teach you how to do research, and no one will motivate you in doing research. The movement of research does all depends on you. Hence, you need to always push your research spirit, will and determination.

Although it is not a necessary in some cases, having some years of experience in a research and development job (e.g., embedded systems, software programmer, circuit designer, etc.) may give you an insight on what may PhD be look like, and it helps you on your research journey. If you are loyal or committed on a project during your R&D days, where most of the times you work long hours, and go home late at night to solve the problem, then most likely you may be a successful PhD student. Real engineers works hard and stay committed to their job. Commitment means for better and for worst you accept no excuses but only the results of your work. Scott Adams, the author of the famous Dilbert Comics once said [34] *Engineers like to solve problems. If there are no problems handily available, they will create their own problems*. Keep your spirit willing because the flesh is too weak when it comes to research. There are lot of distractions around and you cannot focus, but if your spirit is willing, you can do accomplish better. Sleep tight, do rest, and eat well, attend church gatherings, do physical exercise, go out with family, be a loner sometimes, discuss with advisor, meet friends, visit places, play a music, etc. In short, life should be balance. These are normally the ingredients of doing the research. As much as possible, be positive and keep all negative emotions out, so that you may be able to focus properly on your research work. Again, be positive.

In some cases, there are PhD graduates, which are burned out on years of working with their dissertation. Hence, they never did any research anymore nor published a paper after graduation. They even work outside of their research field or specializations. This is prevalent most especially if life is not balanced. Be wary that there are some PhD students and research scientists who commits suicide [35]-[36] and one of the cause for it was depression. In the article [36], it states that being a scientist commits the highest suicidal rate. When you think that you are in depress mode, you must take a break from research. I suggest not to watch any movies since you are already exhausted in front of the computer. When you are depressed and burn out, it is impossible to be productive at work. Hence, you cannot finished the job properly. This is difficult indeed most especially for the students with no research experience. If these things may happen, I suggest to have a one day to one week break from research, take a tour yourself from things in the outside world. I do suggest not to touch research during these days but contemplate or meditate what you have done for the past weeks or past months of doing research. Too much doing research work do wearies the body. The mantra *all work no play* seems to be inevitable but there would really come a time where you are stymied writing with your research as if nothing is happening with what you are doing. It is advisable to have a social life, read self help articles, do browse some biographical sketch of some scientist and mathematicians, eat outside, talk to people outside of your research such as your old friends, etc. Also, it is a good habit that you and your fellow researchers in the laboratory may have some bonding like eating out lunch together, mountain climbing, swimming, going out to visit historical places, do attend a concert, etc. While being independent and sometimes being an introvert may help you in doing research, it is however still not recommended to isolate yourself from others and life in the outside world. Talk to other people outside research, Talk to your long time friends, colleagues, etc. In this way, your will and motivations may rise up again.

While publication sometimes could not guarantee that you can pass the final oral dissertation defense. Likewise, there are some students who have failed in the final dissertation stage even though they had publications in the science citation indexed journals. I could have imagined the emotions during those times, it must have been very difficult. In other cases, there are also some cases where the student is already more than seven years in the program and yet he is still working on the comprehensive examinations.

Before embarking a PhD, it is a recommended to keep a diary until you get finished. Start collecting journal articles and conference papers in your research field of interest. Do not only collect but read avidly and do learn from it. Try to do simulation work if necessary. The PhD student should always be aware on what is currently happening in his field of expertise. Hence, he should be constantly reading articles because new methods and techniques do appears almost every quarter. Develop a self progress report. This may help you monitor on what you are doing in order to achieve your target goal, which is years from now. At the very start of the PhD program, it is suggested that you should start writing dissertation proposal. In paper writing, commitment plays an important role. My suggestion is you have to write your dissertation for at least two to three hours per day. If you are too busy, try your best to write at least one hour per day. The famed author S. King [37] is said to be writing at least ten pages per day and he writes even in the holidays. You have to make sure that what you are writing can be acceptable as a dissertation proposal but do not just do classical research. You have to make your

dissertation citable. You have to make sure of the impact of your research to the readers and other researchers, so they can learn from it and may possibly apply on their respective researches. In this way, your work may get cited. You have to be very careful and plan ahead when you are about to start to write for this will take much of your time, devote sleepless nights, and may give impact on your future research work.

The downfall of some dissertation projects was starting to develop a system, hardware schematics, programming, etc. without realizing if the project may get approval or not. Be productive, work with some open problems in mathematics and simulation research with advisor. It is recommended that you have to do these things so that you are ready when you enrolled the dissertation course. In this way, you can possibly finish on what you have started. Make sure that you have available resources, external support, funding, and article literatures online, among others. Constant communication with your advisor is important. If you do these things, then your dissertation proposal may almost get approval. But you have to make sure that none of the students are doing the same proposal as yours. Take a survey firstly on the previous dissertation, or you may ask your advisor if there are topics already that was disapproved by the panel committee. Ask what was happened. In this way, you may avoid future mistakes.

Although, this may give an additional load, I suggest that aside from doing the research topic with respect to the dissertation, you should also produce a paper on your own research interest and publish your own findings on it. Writing a book is also a good idea but it is not advisable. The notion of doing these things is to keep you always motivated in doing research. Take charge of your research, take charge of your career, you are the only one who really knows what to do, and what you should do. Sometimes, it is good to rely with your instincts and intuition because most of them are correct. In this way, you can be able to finish on what you have started. While teaching can help you motivate doing researches, in the end, it is not what PhD research is all about. Research is different from teaching. A good recommendation is do thesis supervision to the MS or BS students. It will help you also think of a better way of solving research problems.

There are several types of PhD students: those who are concerned with their grades in coursework, those who look ahead how to finish by starting to work with the dissertation ahead, those who published a lot of researches, those who do networks and make friends, those who enroll but has no plans to finish he just want to have several units making his career looks like impressive, those who just want to pass in a coursework and halt in the dissertation stage, those who are curious and uncertain, those who heavily rely with what the advisor says, following without a clear message how it may end through, those who proposed a unrealistic dissertation, those who proposed an MS thesis type of the dissertation, those who proposed dissertation with uncertain support or without prior knowledge how it may get supported, those who do not know how to start writing a proposal, those who are proud and arrogant in the beginning but became low and humble person in the middle years, those who are then not motivated anymore, abandoned hope, and decided to get marry, those who read a lot of articles and are great story tellers but never started any useful work, those who are still uncertain on their life, those who wanted to boost their career and end up miserably, and more others that were not mentioned.

PhD students are sometimes secretive and sensitive when it comes to their dissertation topics most especially, if they are not yet proposed to the panel committee, fearing that their idea may get copied by their classmates. While some are quite boastful asking a lot of questions and tending to convey the impression that their paper had been accepted in a conference. I remember one student on his first year in PhD, who ambitiously wants to graduate with the highest honors. He is a bright student, and excelled in almost all academic courses. His treatment of PhD do follows his undergraduate years. Five years had passed, and still, he have not proposed anything for his dissertation. He was not motivated when it comes to research. He did not understand that taking PhD is all about research and contribution for the advancement of science and engineering.

While the noble intention of social media and internet is thru connectivity and most of all—*information search*. If misused and uncontrolled, it will destroy your day and research productivity, and you cannot get accomplishment, or any work done at the end of the day. It is better if you turn off the internet, or work offline during the working hours. Experience shows that writing a dissertation while online with internet kills productivity. In references [38] - [40], the authors do emphasize that if you have been distracted more than three to five times then you will not be able to produce outstanding work during the day and it keeps doing so day by day; thus, you have to manage yourself if you want to finish your

job. Keep your brain busy in doing research. Part also of being a successful PhD student is managing productivity. Productivity is the most important character for any student who are serious in their research studies. Real engineers are productive and serious at their research. An organized PhD student is good in self management, you have to know your priorities, if it is to finish your research, or doing other non important things.

Doing PhD while working at the same time is stressful most especially if you are in a managerial level. Management is inversely proportional to the research, you normally find yourself attending endless meetings, lot of paper works and preparations, etc. Hence, you may find a small time to work with your dissertation. Having a day job in a typical eight hours per day, raising a family, and do working on a dissertation is a difficult task for the student, most especially if the financial status is in trouble. You cannot be able to give a full time focus on your studies. These are the times where the student may often lead to worries and depression. Further readings is provided on [65] - [93].

VII. REVIEWER

In this section, the author is suggesting references [84], [101] up to [105] for further peruse. Do make some intelligent guess about the research character of each the panel committee members, try to do some research about their publications and their respective dissertations. Read their papers and take note of their writing style. I recommend to attend on every actual dissertation oral defense and observe how they raise a question. From there you can get a good idea on how they could possibly ask you a question in your own dissertation oral defense. This will give you a feeling about their character in the actual oral defense where most likely it will be applied to you. You can observe a good panel member by the manner he design a question. Simple but substantial and high impact question. He had read your documents fully and understands your research presentation. Mostly if the invited panel members is not within the context of your research area, then one must expect a general, and a broad question. It is advisable in this case that you need to prepare your presentation to discuss a general overview and why do you need to conduct a research for it. Educate them and show that you are correct. On the other hand, if the invited panel members are specialist in your area then expect a philosophically particular or deep questions. Theoretically, the panel committee were formed and are invited to guide the direction of your research. However, nowadays, they are there to kill you in the question and answer portion. Expect the worst. Sometimes, best and great ideas are violently opposed and most of the times are rejected. One example was the *set theory* expounded by G. Cantor between 1874 to 1884 [41] was opposed by several giants during his time like L. Kronecker, H. Poincare, among others. Intellectual pride makes a person sometimes stubborn, and do not accept alternative ideas from others. Since panel committee members are PhD holders and are actively doing researches in their field of expertise, you must be prepared under all circumstances to answer both on the general and particular questions. Show and prove that you are correct whether on theoretical or experimental type. Your answer must followed and jive with evidences. There are several instances where during the oral defense, some committee panel members does not agree with what the student is presenting and; thus, this may turn into debates and arguments. As a rule, you are not almost in the right position to argue with the panel committee, one can only somewhat negotiate with what the panel committee wants in your research.

Prepare your camera ready dissertation and give it to the panel members two weeks or more before the actual oral examination. This may give them time to review and scrutinize the paper. Do not give your paper for them to scrutinize for a one week, since they are very busy with their own respective jobs. Sometimes, only few panel members have the time to read your submitted documents and do rely most of the time with what you are discussing, and on what was written on the power point presentation. They based their question sometimes on what you present. Therefore, you have to be wary with what you say and with what you put on your the power point presentation. This will all return to you during the question and answer portion. It is a good practice for the panel members to spend time to sit down and think what is happening with the paper itself. If the panel members would not do it and just spending some time reading the paper during the oral defense, then most perhaps you will not be able to address a good research question.

VIII. SANDWICH

One of the things that a PhD student must do firstly is to look for a professor counterpart abroad with the same and aligned research interests. Try searching for a professor who is actively doing research and published papers in a several prestigious journals. Prepare as early as you can. Everyone is asking about dissertation sandwich abroad. To experience high quality and world class research should be the ambitions of each of the PhD students. Let the students be given an opportunity to work their thesis abroad. In this way, they can experience both world class training from world renowned mentors and hands on with world class facilities. If you do your dissertation abroad most likely, you will be able to publish your results in a high quality journals. Since you are living in the other country, the beauty of being in the sandwich program was solitary, focus, and less distraction. It is conducive for a research study. This may called the *silent or quiet years*. Under normal circumstances, English is the medium of communications, if you are a foreigner invited to perform a particular research in the laboratory. Hence, you have to effectively communicate in speaking and writing via English language means.
When you are discussing with your advisor, it is expected that you are competent and knowledgeable because advisors do not like asking never ending questions when you yourself is not exerting an effort to work with it. You must show to him that you are working hard and committed. Produce good theoretical and experimental results. Normally, the sandwich program is funded for one year by the government or private institutions. A healthy research laboratory do have people trust with each other, they help each other, they work with each other, they have their own respective researches, they work independently, and they discuss the progress of their work with their advisor. Since working in the research laboratory is pressured and time is limited, give all your best, because this is the first and might be the last time that you will stay as a visiting researcher. You may find yourself busy working on research project, and not much have time reading papers, or do other things. Hence, it is advisable that before you can come to perform research in the laboratory, it is commendable that you must have already an initial project development and gathered some results. While working on the project, it is also good to start writing a research paper at the same time.

IX. MANAGEMENT

The management should also do care the needs of the PhD students. The lack of support from the management can be frustrating. As much as possible, there must be some sort of a meeting for all PhD students to discuss several issues aside from doing research. While not all students can finish PhD, the most awful thing is the blame assigning. Is it the sole responsibility of the advisee because he could not sustain his productivity level for producing research output, or is it because of the advisor, or research organizational structure, or the research systems of the department or the university. This often leads to crisis. Management should invest also research laboratory where students can perform researches, hire professors that has a professional research expertise, or are well renowned in the field, have significant contributions and publications. Tie up with local and international universities, government and private industries for research collaboration. Do provide access to close and open research journal databases, conduct symposium, colloquium, and/or conferences, do invest on the research laboratory equipments, promote research in every departments, or in the college, etc. The management should be open through all means of communications. References [106 - 110] discusses more on this area.

X. CONCLUSION

Tremendous research papers in the electrical and electronics engineering with various methods are available in the literature nowadays. Proceedings, journals, conferences, and the like, shows that these papers are products of human ingenuity in solving research problems. These researches were done majority by PhD holders, and students who are working towards their doctorate degree. Furthermore, numerous research and incrementing complex problems are also made available in the industry and research academia for PhD in electronics and electrical engineering students.
In this paper, the author provides a comprehensive perspectives in doing PhD in electronics and electrical engineering. It all starts with the presentation about the motivations in studying for a PhD. Then, the author provides a detailed review and presentation on each of the section provided in this

paper. The determination and also the strong will of the advisee is stressed out by the author for a successful PhD study. Staying motivated in doing technical researches and writing, plays an important role. The discussion about the important roles of the advisor, reviewer, sandwich program, and the management is further highlighted and presented. The author gives an additional references for further perusal on each of the sections provided in this article. Earning a doctorate degree in electronics, or in electrical engineering paves the way for numerous opportunities in the academia, organizations, and industry.

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