



**Mechanical &
Aerospace Engineering**

Nicholas Zabaras, Professor

Materials Process Design & Control
Laboratory

Cornell University
101 Frank H. T. Rhodes Hall
Ithaca, NY 14853-3801

Telephone: 607 255-9104

Fax: 607 255-1222

E-mail: zabaras@cornell.edu

URL: <http://mpdc.mae.cornell.edu/>

Guidelines for those interested to apply for admission to the Cornell PhD program and work in the MPDC laboratory in the MAE department

Last updated September 1, 2009

To reduce the effort needed to respond to the same questions from PhD applicants multiple times every year, we list below the general requirements for someone interested to apply to our program. We hope all these answer typical questions that PhD applicants may have. This document will be updated as different but important questions arise from each of you in the days ahead!

- 1. You need to be self-motivated, dedicated and intelligent student**
- 2. Good grades in your undergraduate courses**
- 3. Good recommendation letters**
- 4. Good scores in TOEFL and GRE**
- 5. A mature statement of purpose and a CV**
- 6. Your interests and background need to be relevant to those of the MPDC laboratory**
- 7. You need to be from a university with a good reputation**

In more detail:

- 1)** I am sure you heard before that `not everyone is qualified for a Ph.D'. Being a good student in your undergraduate studies does not automatically imply that you are a good candidate to the PhD program.

We are looking for **students who are competent** (students who can speak and think on their own - as simple as this task may

sound!), **intelligent** (students who have no difficulty learning fast and applying new complex concepts to their work), **self-motivated** (you need to have intellectual reasons for doing PhD), students who realistically **can critique their own performance and ability to become successful researchers**, and finally students who can **appreciate, encourage, welcome and act on tough questions, challenges and critique of their work** provided by others (e.g. their academic advisor). A successful researcher needs to be able to often take and learn from tough but respectful criticism of their work – the academic environment is intellectually demanding and often very competitive and we all want to learn and be motivated from each other. If you look for a gentle environment where no-one ever critically questions your work and accomplishments, for sure you are looking for a place where academic growth, learning and scientific accomplishments cannot take place.

Pursuing a PhD with us as a way of getting a highly paid job, an MBA or a visa to the USA (yes, we had students like that), five years paid vacation in a nice environment (yes, Ithaca is a very nice place to live and work!), etc. are not reasons to waste your and our time (and money).

Research is not like working in well defined (homework like) problems where you go from A to Z in a clearly given path. PhD research requires new skills that some even with extreme training simply cannot acquire. You should not see the PhD as a time commitment in which after 4-5 years you obtain a degree regardless what you have accomplished in your designated research area. If you find that within a year in the PhD program you still cannot reason on scientific terms and you need written notes to guide you on what you say, that will be a good time for a career change. Successful graduate students are judged not from the time they spent working (e.g. taking classes, reading books, etc.) but from their tangible research accomplishments. The PhD program is all about learning fast the fundamentals and applying them to challenging problems that generate new knowledge or

technology. Without research output, your accomplishments are insignificant regardless of the time that you spent in your work.

Here is what we look for successful PhD candidates to our program:

- ✓ Self motivation, dedication, excitement and love for discovering and learning new things.
- ✓ To 'know yourself' as the most powerful way to improve your education, academic growth and life.
- ✓ Ability to understand the work of others and being able to discuss its positive/negative aspects and future potential.
- ✓ Be a fast learner!
- ✓ Ability to communicate in scientific terms (and in clear oral and written English) your work to others (including your advisor!).
- ✓ Passion for the areas of computational sciences and materials. If you don't like computers or mathematics or physics, do not apply to our program!
- ✓ We expect students willing to become leaders in their projects and capable of generating and implementing new ideas in their research area.
- ✓ Our laboratory provides a multidisciplinary environment in which students can work and learn from others, adapt without duplication the work of others to their problems, and teach others effectively and intelligently about their research topics.
- ✓ Every professor will love to know how to make every student capable of thinking – unfortunately we don't have the recipe for that. If you cannot think on your own and have an intelligent and engaging conversation with others, you may want to think of other career options.
- ✓ If you are natural in learning and exploring new things, the PhD program is for you. You will enjoy every moment (even hard work) and you will develop and learn the skills for a successful future career based on what you know rather than what degree you hold!

Many of the essential items above are almost impossible to judge on an application form or even in a short discussion with candidates to our program. We think it is important that each of us thinks carefully of our career choices and decide what is best and most appropriate for ourselves. Discussing all these with your academic advisor and mentor(s) is strongly advisable.

2) You need to have good grades for your application to be competitive. For example, for students from the USA a GPA > 3.8/4, for students from Greece (e.g. ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ) you need a grade ~8/10, for students from Tsinghua a GPA>85/100, etc. The actual minimum GPA needed of course depends on the reputation of your school, your field of study, and other factors. With that said, if there are other positive things in your application (e.g. publications, prior research experience or a Masters degree with a high GPA in your major, etc.), then there is generally a flexibility regarding your undergraduate grades.

It helps in your application to mention your official ranking in your class if it is available. Not mentioning it often implies that your rank is low.

What courses you have taken beyond the basic ones is very important (elective courses). If your courses are of high level e.g. advanced courses in mathematics or statistics or numerical analysis, physics or materials, then that is taken as a positive element in your application. We usually pay close attention to your courses the last 2 years of your studies. Do not mention research or course experiences that you cannot document.

Since we want students with very strong mathematics background, engineering students with low grades in Engineering Mathematics are not encouraged to apply.

Your course transcripts will need to be mailed directly to Cornell (translated officially in English).

3) Recommendation letters are important. If one of the letters is negative, then your application cannot move forward. If your letters are

all superficial (e.g. I like this boy!), then they have little role to play. Letters from professors that know you through several classes and have something relevant to say about your course performance, research, etc. are very important.

You cannot expect a professor to write you a good letter unless he/she knows you from classes and your research. Being nice to your professors early on in your studies is important!

The recommendation letter is about 1 page long. In addition, the professors are asked electronically to rank you in different areas. If these rankings are low, then you will have problems (you need to at least be on the top 10% of these rankings for your application to go forward).

Finally, it helps if the professors you ask for letters are known to us for their research and ability to recognize excellent students when they see them. Also someone who studied in the USA is more qualified to comment on the ability of a student to succeed here. Letters with bla bla ... that look and sound generic don't help. Letters that compare you with other graduate students from your school now at Cornell or in other excellent USA universities are welcomed.

Since our laboratory emphasizes computational sciences with applications to materials, we look for relevant comments in these areas: comments on your analytical skills, mathematics/probability and statistics background, scientific programming ability (C++), fundamentals of materials/mechanics, physics and chemistry, etc. We don't really care if you built a bike or a paper plane as an undergraduate or if you were the captain of the soccer team! However, comments on your maturity, mental strength and ability to work productively with others in a professional and demanding manner in multiple areas are very important.

4) The requirements for TOEFL at Cornell are as follows: reading (20), writing (20), listening (15), and speaking (22). Many foreign students have difficult times to reach the speaking minimum score. If your

application is exceptional, then you can be admitted provisionally (this means you will need to take English classes in addition to your regular studies). If your speaking score is below 20, it is rather hard to be admitted even provisionally.

The requirements for GRE are not fixed. Generally, you will need an excellent score (close to ~800) on the quantitative part (basic math); verbal higher than 400-500; analytical higher than ~5. Many (especially foreign) students prepare for the GRE for months and get nearly excellent scores. This means that you need to take this exam seriously to be competitive.

You can find several books and information on the web to prepare you for the GRE. Since your score may not be good the first or second time you take any of these exams, allow for several months before your time of application to Cornell to be sure that by the time of your application you have reasonable scores. Do not wait until the last minute. Usually these exams are offered regularly every few months so plan much ahead of time.

5) In your application you need to include a statement of purpose – why do you want to do a PhD with us? What motivates you to spend days and nights studying? What does it mean to you working on a research task? Research is not the same as taking courses or doing homework and requires a mental approach and academic ability that not everyone has. After all, PhD is not for everyone, regardless of what some may think! Having a PhD provides you many degrees of freedom on what you can do professionally once you graduate and that by itself is an attractive element to many who pursue graduate studies.

While most applicants write things in their statement of purpose that make little sense (and sometimes even things that are embarrassing to read as they show lack of maturity), this is the place to show that you can write good English, that you are mature, adult and vaccinated (!), that you know the areas that you want to study and that you are ready to independently embark in a new direction in your professional life.

Mentioning life, cultural, scientific, work, travel, professional, etc. experiences that motivate you in this direction are helpful.

In your application you need to add a nice resume that emphasizes everything that is good about yourself and your education. Follow formats for nice CVs given on the web for professional applications. This is usually 1 page long unless you have publications, presentations, etc. It is common now that students who apply also have a web site where they present more details of their accomplishments – if you choose to do that, do not mix personal and professional items on the same site. Usually that's a recipe for disaster!

6) In your CV (and your application) be sure you indicate what your interests are and why they are relevant to those of our laboratory. When you apply to work at the MPDC lab, you will need to convince us that your background and interests are relevant.

If you have publications in journals or presentations in conferences, don't hesitate to email them to us in addition to the required online application package.

Please note: no one will take you to the PhD program to do specific things that you want to do. Most of the times we don't really care about what you already know or your specific research experience that you may have but what your demonstrated ability is to learn fast new things. Usually you are being admitted to work on currently funded projects. However, as you know research is working on things we don't know – in that sense you have significant flexibility to define your own direction within a given project. For sure do not write in your application that your interests are in things that are irrelevant to our current research work.

7) Your chances of being admitted to Cornell are higher if we know your undergraduate university and if other students from there successfully studied here. If your school is not known, you are possibly disadvantaged but not always. Sometime we will like to open windows of communication with new universities (and countries) and you may be

the lucky one to start this process! Students from places that we usually don't get many applicants (e.g. Europe, Australia, etc.) or female applicants or underrepresented minorities are particularly welcomed.

A few final notes:

- (a) **Regarding financial support:** Our laboratory admits students usually as graduate research assistants (GRAs). As part of this admission, with support from our sponsors, our laboratory covers your tuition cost at Cornell (currently ~\$29,500 annually), your health insurance (~\$1,598 annually), you receive an annual stipend for the academic year (9 months) of ~\$21,935 and a summer support ~8,000. Not bad for a graduate student! But nothing is for free – if you come here you will be expected to work and work hard. But work is rewarded and it will bring you closer to a PhD.
- (b) **You need to follow the guidelines for admission described at the Cornell Graduate School:** Cornell like any other university in the USA is an institution that works with policies and rules that are enforced. This means that unless you follow the application procedure described on the [Cornell Graduate School](#) web site (e.g. see the [Mech. Eng.](#) or the [Aerospace Eng.](#) web sites), you have zero chances to enter Cornell as a graduate student. So don't waste your time thinking that the admission process is our decision alone. We play the final role in the process assuming (1) you have applied electronically, (2) paid the application fee, (3) submit your TOEFL and GRE scores and (4) have three recommendation letters send to us. Only once you pass the screening and requirements of the graduate school we are allowed to look and make decisions on your application. This process looks lengthy but it is not. The system is fully automated

and allows very fast action once your material is in place. Planning early and applying early is helpful.

- (c) **Masters of Science versus PhD:** Our laboratory does not admit students for the Masters of Science degree (the same is true with most programs at Cornell). Most students go directly to the PhD program that for students in our laboratory lasts an average of 4 years (you actually get automatically in your second year a non-thesis Masters degree once you pass the so called A-exam). In your application be sure to indicate that your interests are in the PhD program. While there is also the option of MS/PhD, I would not recommend that even though many times it will make no difference. Finishing a Masters and then doing a PhD usually takes some unnecessary time for preparing the MS thesis and that can be avoided. For those interested in a Masters, should look at the Masters of Engineering program (this is a professional one year program and you will need to support yourself during these studies). Our laboratory does not in general advice MEng students.

- (d) **Applying to a different Cornell graduate field:** Cornell has a rather flexible policy where a student in one field (e.g. Applied Mathematics) can be advised by a faculty member from another department (e.g. Mechanical Engineering) who is a member of e.g. the Appl. Math field. If you want to apply to another field different from the Mech or Aerospace fields, please contact me to discuss the pros and cons of each particular field. For a good student, we will be as flexible as needed!

- (e) **Regarding the type of work we do at MPDC:** Our work on multiscale and stochastic modeling of materials over the last few years has moved to problems that require deeper mathematical and computational sophistication than a typical undergraduate

engineering student has been exposed to. Also, we are heavily involved with probability and computational statistics and at the same time our problems of interest require significant understanding of physical phenomena in multiple scales (from quantum to continuum). This is indeed a demanding domain to work on but it comes with many rewards. The types of problems that we work on are technologically relevant and up to date with the research needs of federal agencies, universities and industrial laboratories. Working on things that others care is important for employment and your future career.

- (f) **Expected type and work load for incoming students:** Depending on your background, you will have to take several graduate courses for the first 2 years of your studies (about 3 or 4 per semester). You need to see this as an opportunity rather than a penalty. Exposing yourself to other distinguished professors and other areas are important not only for your research but also your overall professional growth. At the same time while taking courses, you will also be expected to work and contribute increasingly more in research. Our laboratory expects even first year graduate students to be active research participants. This busy life style is typical in our laboratory. At the end of the day, what we value is not your grades in your courses or how many hours someone works but how much and how fast are you learning new things that impact your research objectives and deliverables. We personally prefer students that work less but are more efficient and have higher research productivity. We all know that working long hours does not always imply that you will become successful in your research!

Good students should be capable to contribute and participate in all aspects of academic life. For example, it is expected that the students should be capable and very happy to present their work

to our sponsors, in conferences and seminars. If a student does great research work that he cannot communicate to anyone (even his advisor!) will that be a very desirable situation? Also students should be happy and natural in preparing scientific papers, reports, proposals, etc. Doing a PhD does not mean that you are left alone in a basement for long time until the light hits you. We will advise you so you can gradually become more successful and interested in all aspects of our research life.

- (g) **Regarding employment after graduation:** Successful PhD students from our laboratory are highly sought for faculty positions in first class universities as well as for R&D positions in industry.
- (h) **My undergraduate degree is not in Mech or Aero Engineering. Can I still apply to the MAE fields?** Our work in MPDC is very diverse and anyone with good mathematical and computational knowledge and some background in mechanics (e.g. statics and strength of materials or fluid mechanics) will have no problem. Incoming PhD students should be capable to pass the Qualifying exam at the end of their first year of studies at Cornell. The student can select to have the exam e.g. in solid mechanics, fluid mechanics or transport phenomena. These exams cover undergraduate level material that for competent students can be acquired even within a few months for those who lack this background. Also students can take an introductory graduate course in these areas in preparation for these exams. These exams are very basic testing the competence of candidates to stand on their own feet and answer down to earth questions.

Considering the number of applications that we receive, it is true that sometimes we spent only a few minutes reviewing each application. So it is important that there is something special in your application that it is easy to get to. When you apply, try to show in your application confidence on your ability to do first class research in our group. If you

are not confident, why should we be confident for you? You need to effectively convince us that, if we don't hire you, it will be our problem not yours! If your application is not successful that in no way means that you are not a good candidate for PhD or a good addition to our lab. There are many factors that play a role in our admissions decisions and someone needs to be prepared for all outcomes.

For sure if you don't try, you will never know what life has planned for you next. At least read the poem (1911) of [Constantine P. Cavafy](#) given next for some inspiration [for your journey to Ithaca!](#)

ITHACA

As you set out for Ithaca
hope your road is a long one,
full of adventure, full of discovery.
Laistrygonians, Cyclops,
angry Poseidon - don't be afraid of them:
you'll never find things like that one on your way
as long as you keep your thoughts raised high,
as long as a rare excitement
stirs your spirit and your body.
Laistrygonians, Cyclops,
wild Poseidon - you won't encounter them
unless you bring them along inside your soul,
unless your soul sets them up in front of you.

Hope your road is a long one.
May there be many summer mornings when,
with what pleasure, what joy,
you enter harbours you're seeing for the first time;
may you stop at Phoenician trading stations
to buy fine things,
mother of pearl and coral, amber and ebony,
sensual perfumes of every kind -
as many sensual perfumes as you can;
and may you visit many Egyptian cities
to learn and go on learning from their scholars.

Keep Ithaca always in your mind.
Arriving there is what you're destined for.
But don't hurry the journey at all.
Better if it lasts for years,

so you're old by the time you reach the island,
wealthy with all you've gained on the way,
not expecting Ithaca to make you rich.

Ithaca gave you the marvellous journey.
Without her you wouldn't have set out.
She has nothing left to give you now.
And if you find her poor, Ithaca won't have fooled you.
Wise as you will have become, so full of experience,
you'll have understood by then what these Ithacas mean