Career Options for Undergraduate Majors in Engineering Science, Physics or Chemistry

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Thayer offers a B. E. program that provides an accredited engineering degree after five years (although many students achieve it more rapidly through careful course planning). If, however, you want to stop after four years, what are your career options? The answers are essentially the same if you majored in Physics or Chemistry. How can you use your degree? What kinds of jobs are available? Or, if you decide to go on to graduate school, what should you expect?

First, let's be clear that it's no failure to stop your education after a Bachelor's degree. There are many reasons to stop – perhaps financial, perhaps personal, perhaps you'll just be tired of studying and want to get on with your life.

<u>What are the possibilities for those with A.B. degrees?</u>

Do you like laboratory work? Jobs as technicians are abundant. You would undoubtedly have to learn on the job and might have to take one or two courses giving you specific up-to-date information. But your undergraduate experience in science will provide you with the basic knowledge you need to understand your job.

Do you like working with computers? An array of jobs involving computer design and analysis are available.

Be imaginative in your search. Companies dealing with electronics, mechanics, chemicals, all use technicians. Today's high-tech health professions offer a growing number of opportunities for physical sciences majors; for example, ultrasound, X-ray or MRI imaging all use technical staff and your A. B. degree will give you an advantage over those who do not have such degrees. A solid science background will prepare you for advancement in these fields, and you might be inspired eventually to go on and get the Master's degree that would be required to move beyond the technician level.

Technician jobs are available in small companies, large companies, universities, hospitals and government laboratories. You will need to be far-ranging in your search, however, because it may take a while to find just the right job; the recruiting for these jobs is not as avid as that for those with formal engineering degrees. The same institutions described later in the section on opportunities for PhD's will have opportunities for technicians as well.

If you're willing to give up laboratory or computer work that involves you directly in the scientific work, there are many more opportunities. Technical sales, marketing and public relations are three fields where your science degree will be very useful. When ***sales*** people really understand what they're selling and how it can be useful, they are respected much more highly and are much more successful. There is always need for sales people in high tech areas.

Marketing is slightly different from sales. The role of marketing is to find out who is likely to use the products of your company, to find out what their needs are that your company might fulfill, perhaps suggesting new products or new uses for old products, and acting as liaison between the sales department and the technical people within company. Clearly, the more you understand the physical sciences behind the products of your company, the more successful you will be in marketing. Your degree will provide an excellent background. There is huge potential for advancement within high-tech businesses – these jobs can pay very well.

Public Relations involves translating the work of your company into clearly written press releases that can bring attention to the work of your company. Ideally you would both understand the technology and write well to be successful in this field.

Financial Consulting is another career path. You might wonder how you can "consult" after only an A. B. degree. Do you really know enough to give advice? Actually, you will be given a topic— a high tech company or product or commercial activity — and you will spend most of your time surfing the web, reading newspapers and magazines, and summarizing the information that you find. This information will be provided to folks higher up in your company who do the actual "consulting." You will learn a great deal of information that will be helpful to you, should you decide to join one of the companies that you've researched. Often consulting jobs require travel, to study the companies on-site.

If you write well, you might consider ***Technical Writing***. While it may perhaps not be easy to find such jobs, an understanding of science and an ability to write offers an important potential career. We need more people who can translate the work of scientists and engineers into prose the public can understand. Many large companies and government laboratories use science writers to communicate to the public. So do newspapers and magazines, of course. If you're interested in this field, you should try to get an internship that involves writing, to prove your ability.

Science and technology policy is another avenue to consider. The State Department, for example, has a number of opportunities for those who are interested – either in the foreign service or as a civil servant. In either case you'd have to take the appropriate exam and it would help if you had shown some interest as an undergraduate in policy questions, probably by taking one or two government classes. Besides the State Department, the Washington D.C. area is filled with policy "think tanks" who hire those with solid science backgrounds. Similarly, the health industry is putting increasing effort into policy issues and need employees to help them – it is amazing how relevant the physical sciences are to health. You could even think about becoming a patent examiner.

How to prepare for entry level jobs

Most applicants will have had summer internships or research experiences in science or engineering. This means they will have letters of recommendation that can attest to their abilities and interest in fulfilling responsibilities. You should make every attempt to have such experience. You don't need to have paid jobs – just the experience (although of course it's nice to be paid!). Then your job isn't really "entry level" – you've already had experience. The NSF (National Science Foundation) has an REU (Research Experiences for Undergraduates) program that makes summer opportunities available at universities throughout the country. Check with your department, or look on line, to find one that might work for you.

You'll need letters of recommendation from professors as well as research advisors. The better they know you, the more they can write. Go to their office hours and discuss your interest personally before that day, in your senior year, when you're asking for a letter. Or ask and answer questions in class, so they'll already have known you. Or go up after class and ask questions, walking with your professors back to their office. Or work for them as a grader, or teaching assistant. Ideally you'll be known by three professors in your University, or one research advisor and two professors.

You'll need a well-written resume and cover letter. You'll need an ability to carry on a job interview. Your undergraduate career office should be able to help you with these. Ask your parents and friends to practice with you until you're comfortable.

Why might you decide ending with a Bachelor's degree is the route for you?

These jobs will have less pressure than those that require advanced degrees. They'll more likely be 8-5 jobs. There will be time for other interests, whether family, sports, music, community activities, or other avocation. These jobs will have more portability. It is often difficult for two professionals within the same family to find excellent jobs at the same location. All of the jobs listed above are available in abundance in most locations. Perhaps you're ready to make money, paying off your student loans. (Remember, however, that if you **do** decide to go to graduate school, your loans can be deferred until you've completed your education, and your salary will usually be considerably higher after that.) Perhaps you've a drive to teach in middle or high school. There is a serious dearth of science teachers who've in fact been trained in the sciences. You'll be almost for sure guaranteed to find a job! Of course you'll need education courses and certification unless you teach in a private school. Teaching credentials usually take about a year, although some areas have special programs that will allow you to simultaneously teach and work toward your certification.

All the positions I've talked about are entry-level. In every case there will be lots of opportunities to move up into management, or become an entrepreneur and start your business, or eventually to go back to school – in many cases paid by your employer! The direction your career will go will depend very much on what you find your interests are. Do you want to spend your days in the laboratory or in front of a computer? Or do you like to deal with people? Or are you good at managing? You won't know the answer until you've tried your entry-level position for a few years. Then you'll want to look for opportunities for advancement, which can sometimes come from surprising places.

Combining an undergraduate degree with other professional degree

A solid undergraduate education in engineering or science can be an excellent basis for an MD degree, or a law degree. So much of medicine today involves high-tech equipment and processes, that an understanding of the underlying science is tremendously helpful. Of course you need the biology and courses required for getting into medical school, but after that, the admissions officers look at a diversity of majors, and look particularly favorably on undergraduate science majors.

Combining a law degree with an undergraduate science degree leads naturally into patent law, an important and interesting field. It takes both scientific knowledge and legalese to write patents, which can be filed for either objects or processes. Also, many lawyers that work in or for high tech startups have science backgrounds. The same is true for large firms in the high-tech industry that need legal advice on a wide range of issues.

Suppose you get a Master's degree

This could be right away, or after you've worked in one of the jobs I've already talked about. A Master's degree will give you employability in higher level jobs than a Bachelor's degree. In fact, most really productive engineering jobs require a Master's degree, because there is so much information to learn before you can be fully up to speed. In fact, even in engineering a bachelor's degree doesn't usually qualify you for any higher jobs than a bachelor's degree in physical sciences. Most engineering students go on to the Master's degree – either immediately or eventually.

If you have an A.B. in the sciences, you might consider a M.S. in Engineering, which is often considered by employers more desirable than a M.S. in Physical Sciences. Most engineering programs will take graduate students without undergraduate engineering degrees; undergraduate degrees in Physical Sciences will suffice.

There are two kinds of Master's degrees: one year of all courses or two years with a thesis. Not all schools offer the all-courses option. This approach gives you a deep immersion in a specific field and lets you build up a working knowledge-base. But you don't usually carry out research. If financial aid is available at all for this option, it is usually quite limited. Often students in this program are working in industry and their companies are paying their tuition and providing them salary. They may be enrolled in the all-courses option while working full time, taking one course at a time over a number of years.

The other Master's degree requires a thesis, a path that usually takes two years to complete. However, the second year is worth it, because it gives you a definite advantage in getting a job – you've already proven you can carry out an independent project. The other advantage of the thesis-option is that complete financial aid is usually available. The University will give you tuition remission and provide a salary, usually paid for by a research grant of the professor you work for, but sometimes by a teaching assistantship. When you leave school you'll only have the debt from your undergraduate education to pay off.

Jobs available for those with Master's degrees in Engineering or Science

Jobs are available in large companies, small start-ups, government laboratories, university laboratories and hospitals, among others. You will do many of the same things that you might do with a bachelor's degree, except at a higher level. You'll come in with more pay and because of your experience you'll find it easier to get your first job. You'll be given more independence and expected to be more productive. You might be given one or more technicians to oversee. I have the following analysis of what technical jobs are like:

High school degree:	your work is checked hourly
Two-year college degree:	your work is checked daily
Undergraduate degree:	your work is checked weekly
Master's degree:	your work is checked monthly
PhD degree:	your work is checked yearly

Between the times that you have to check in, you're given a great deal of flexibility in how you get your work done – as long as you get it done. This independence is the real advantage of a Master's degree, and even more so of a PhD.

These jobs can be primarily laboratory-based, or computer-based, or a bit of both, depending on the particular technical job that you take. You may find yourself moving into management, worrying about budgets, helping find funding, ordering equipment, overseeing, manufacture, analyzing failures, etc. The possibilities are endless and career growth will come from seizing opportunities as they are presented and proving your ability to solve problems.

The Masters degree can be combined with other professional degrees even more effectively than the Bachelor's degree. You are well qualified to teach high school, go into patent or high-tech law, move into the health professions, go into financial consulting, or combine your MS with a business degree.

<u>Should I go for a PhD?</u>

I believe that you should not go for a PhD unless you have a burning desire. It is not easy to carry out a research project all the way to completion (let alone the coursework!), and you'll need determination to hang in there. It will take somewhere between three and nine years. Only the most experienced and lucky make it in three years. Only the most marginal (either academically or financially) take nine years. The average is 5-6 years. I can see only three reasons to get a PhD:

1. You are fascinated with your scientific subject and you want to follow it wherever it goes.
2. You are fascinated by the idea of a career in research, and you'll learn how to do it, no matter how long it takes.
3. You love the lifestyle of a graduate student, and you're willing to string your professor along while you do what you want (these are often the 9-year students!).

<u>How do I choose a graduate program?</u>

You should begin by asking yourself a few questions:

- **Do you like experiments, computer modeling, or theory?**

These are the three modes of doing science. ***Experiments*** means getting your "hands dirty," actually working with physical things in a laboratory. Of course, some of this may be working with relatively automated equipment, and your hands won't actually get dirty! If you like doing experiments, you should look for research programs that will enable you to learn these skills. ***Computer modeling*** and/or simulation means spending your days in front of a computer. Many of today's research problems lie almost entirely in this domain. If experiments in the laboratory do not excite you, then you should look for programs that emphasize simulation and numerical modeling. ***Theory*** means that you will spend a lot of time at your desk, with your head in your hands, thinking. Even so, there will still be a lot of interacting with others and mutual thinking, because this is the way that fundamental ideas are moved forward. The challenge of theoretical research is to come up with simple concepts to explain our complex world. Theorists need to interact closely with each other, as well as with both experimentalists and computer modelers, since physical experiments and/or simulation are necessary to validate the theories.

If you choose your research program carefully, you might be able to combine both experiments and modeling. In fact, in some cases you might be able to combine all three modes of doing science.

- **Do you like "small science," "big science," or group research?**

  Small science means individual, small-scale, laboratory work that can be carried out alone, or perhaps with one or two others. Some examples are lasers, soft materials, solid state, bio-physics. Individual research enables considerable flexibility in approach. You might have an idea one day and carry it out the next.

  Big science means large communal projects working at large facilities. Some examples are high energy or particle physics, space science. This may require traveling to a facility to carry out research. It usually requires long lead times in planning and carrying out the experiments before results come in, and then considerable data analysis.

  Group research is intermediate between the two. Experiments are sufficiently complicated that they require teams of researchers. Semiconductor device fabrication could be an example. One person designs the chip, another fabricates it, and the third tests it.

- **What are your long-term options in the field?**

  Will jobs be available in the future? Is it a growing field? Is it fascinating enough to keep your interest? Will it continue to be funded by research agencies? Will there be jobs in this field wherever you want to live? Will expertise in this field be portable to other areas of the country (or world)? You may need this if your partner also has a high-powered job and you run into the "two-body problem."

  You might consider research at the boundaries between two fields, such as physics and engineering, physics and biology, etc. However, most faculty members suggest that if you do cross-disciplinary research, it will be easier to a faculty position if your PhD comes from a traditional department, and not a cross-disciplinary one. This advice does ***not*** hold if you want to go into industry. In that case it won't matter – just what your research is.

  Fields that support our national needs can be expected to grow for the foreseeable future and will provide excellent opportunities for employment. Some examples are energy, health, and complex systems.

- **Is it a quality research program in a respected school?**

  Does the school and your prospective advisor have a solid and high quality publication record? Will high quality students be your peers? Are the research programs well-funded?

- **Does this branch of science turn you on?**

  You will be committing yourself to working intimately in this field for the next 5-7 years. You'd better be fascinated by it, or you'll rapidly get to where you hate it, or are at least bored with it!

<u>General advice</u>

- Don't be afraid of failure. If you haven't any failures, then you haven't tried hard enough! Failures should be learning experiences.
- Get active in organizations, both to learn how to work with others and to get yourself known. In school these will be student professional organizations. You can then transition into volunteering in these organizations as a professional. The network of friends will be invaluable, particularly in finding new jobs and sharing scientific knowledge.
- Leave time for social life. You don't want to burn out!
- Learn to complete projects, papers, etc. even if there is no deadline. It takes courage to decide when a project is completed enough to publish! For researchers, published papers are the "coin of the realm." You need to be comfortable with writing them. It will also help your PhD thesis if you write it up each section as you complete that part of the work. Delaying all the writing to the end is deadly!
- Be flexible, open to change. If your project doesn't work, find another. If you and your advisor don't get along, find another.
- Seek others with similar background to compare experiences. Find out that you're not alone in your reactions to the challenges you face.
- Travel, give talks at conferences, introduce yourself to people, don't be shy. You will start building the professional network that will last you all your life.

<u>Do you want to become a Professor?</u>

A typical academic track is as follows:

- Post-doc (1 to 3 years)
- Assistant Professor (7 years)
- Associate Professor – usually with tenure (7 years)
- Full Professor (until you retire)

If you are very successful, you might be given a "chair" or a named professorship. For example, I am the Sydney E. Junkins Professor at Thayer School. This is considered a promotion and usually means an extra increase in salary.

You might want to go into Academic Management. If you are successful, a typical track for tenured faculty is to become Department Chair, then Dean, then Provost, then President.

<u>What does it take to obtain Tenure?</u>

The criteria for tenure vary so much that it is impossible to generalize. However, you will need to be author of a suitable list of publications in well-respected and refereed journals; you should have given some talks at conferences. You should have obtained some level of research support. You should have directed some students in research. In a

PhD granting institution you should have guided some PhD students. You should have done the appropriate amount of teaching and advising undergraduates. In some schools this will not count for much, while in others it could be even more important than your research record. You will need to talk with your institution to find out what their criteria are. Finally, you will probably have been asked to do some service to your University. This doesn't usually count for much, so be careful not to get sucked in to doing too much.

The other major criterion for tenure is the letters that will be obtained from professionals in your field. This is why it is so important to network – people need to know you. These letters should say that your work is well-respected and that you are one of the leaders in your sub-specialty. The letter-writers will have learned about you by hearing your talks and reading your papers. Your visibility increases dramatically when you volunteer to work on professional society committees.

If you want to achieve tenure in a major research university, you will need single-minded dedication to top-ranking research, as demonstrated by your publication record. You will need to prioritize your time. You will need to be selfish in controlling your time so that you can get the important things done. In my opinion, the order of importance for your activities should be:

- Research grants
- Refereed Publications
- Graduate students guided
- Conference presentations
- Service to Technical Community
- University classes taught
- Undergraduates advised
- Service to the Department and the University

Why did I list research grants first, even before publications? Because once you have them, you can hire PhD students, which should dramatically increase your productivity. On the other hand, you rarely get funding without first demonstrating some success, so refereed publications are also crucial. Hopefully you will have done this during your PhD research.

<u>Holding a Long-term Research-Track Position</u>

Some people decide not to enter immediately into the tenure-track rat-race, but after a post-doc accept a position as "Research Scientist," or "Research Fellow." After promotion they would be called "Senior Research Scientist," "Senior Research Fellow," or "Research Assistant Professor." Later promotions may be to "Research Associate Professor" and "Research Full Professor".

These positions are not usually tenure-track. They are called "Soft Money" positions, because they are funded by research grants and the position is available only as long as the research grants keep coming in. Very often a scientist will transition from an ordinary post-doc position of one of these, as soon as they begin to bring in their own research grants. Some schools encourage these researchers to teach occasionally as well. These positions may be attractive to those who want to work part time, particularly to raise children. By focusing only on research, these positions enable scientists to focus on publishing.

I stayed in a soft money position for a long time, working part time to spend more time with my two children. I was able to concentrate on research and not dilute my time with teaching and university service. As a result, after 14 years of soft money positions, I was promoted to full professor with tenure at the University of Southern California. My record at the end of that time, prior to tenure, included 39 papers in reviewed journals, 11 published conference proceedings, 3 book chapters. I had organized two conferences and edited their proceedings. I had served terms of Associate Editor of a refereed journal, and on 8 different committees for my professional society. I had received 5 patents and consulted for 7 firms. I had guided two PhD students directly, another 5 indirectly, and 5 post-docs. And I had brought in $1.382 M in research funding. The point of this recitation of facts is to show how important it is to be productive if one wants to convert a soft money position into a tenure-track position. Soft-money positions may be a very effective way to tenure if the need for productivity is kept constantly in mind.

The biggest down-side of a soft money position is that there is no financial security. It was this lack that drove me to seek a tenured position. However, if one is part of a two-career family, this may not be a driving issue, and the flexibility of these positions makes them very attractive.

Opportunities for PhD's in Government Laboratories

The U. S. Government has a surprising number of opportunities for PhD's in Engineering, Physics and Chemistry in their laboratories. Some of these laboratories are within the government system and employ civil servants. Others are run by Universities of other institutions on contract to the U. S. Government. Their scientists both carry out original research and often also oversee contracts to outside vendors for extramural research. Most of these organizations bring in fresh PhD's as post-docs that can often be converted to permanent positions. Some of the laboratories require U. S. citizenship and secret clearances, while others don't. Many offer summer internships. Their websites all provide extensive information.

The National Institute of Science and Technology (NIST) Laboratories, located in both Gaithersburg, Md., and Boulder, Colo., conduct research in a wide variety of physical and engineering sciences. Their recent research in laser cooling has recently won the Nobel Prize.

The Department of Energy (DOE) has laboratories of particular interest to physicists:

Ames Laboratory (energy generation and storage)
Argonne National Laboratory
Brookhaven National Laboratory
Fermi National Accelerator Laboratory
Idaho National Laboratory
Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
National Energy Technology Laboratory (Fossil Energy)
National Renewable Energy Laboratory
New Brunswick Laboratory (Nuclear Materials)

Oak Ridge National Laboratory (Nuclear Technology)
Pacific Northwest National Laboratory
Princeton Plasma Physics Laboratory
Radiological and Environmental Sciences Laboratory
Sandia National Laboratories
Savannah River National Laboratory
Stanford Linear Accelerator Center
Thomas Jefferson National Accelerator Facility

The NASA facilities of greatest interest to researchers in the Physical Sciences are:
Ames Research Center
Glenn Research Center
Goddard Space Flight Center
Jet Propulsion Laboratory
Langley Research Center
Marshall Space Flight Center

The Navy has the prestigious Naval Research Laboratory, in Md. The Army has a similar Army Research Laboratory. The Air Force has research laboratories at several of their Air Force Bases: Wright-Patterson, Hanscom, Kirtland, Eglin, etc. The intelligence community also has research laboratories, both classified laboratories and the Applied Physics Laboratory in association with Johns Hopkins University.

A number of government agencies have varying degrees of research opportunities, agencies such as Environmental Protection Agency, NOAA (National Oceanic and Atmospheric Administration), Nuclear Regulatory Commission, USGS (United States Geological Survey).

There are also Federally Contracted Research Centers, of which the most notable are Aerospace Corporation, Lincoln Laboratory and MITRE Corporation. Research organizations include the non-profit Battelle Memorial Institute, SRI International and Sarnoff Laboratories, as well as the profit-making company SAIC.

By now, you see that there are a large number of research laboratories with ties to the U. S. Government. This should encourage you to consider this avenue for future careers. Compared to the other options, these laboratories probably provide the most family-friendly environment and job security. While some dedicated researchers may voluntarily put in overtime hours, this is usually not expected and most workers can expect reasonable working hours, often with flextime. Many of these facilities provide on-site day care.

Openings in these laboratories come and go, depending on their budgets and needs. Personal relationships are especially helpful in locating jobs here; summer internships and post-doc positions are usually a good way to build such relationships.

Jobs in Industry

Generally there are two kinds of industrial jobs that offer research opportunities. Some large companies still have research laboratories, although they have shrunk considerably in recent times. Examples are General Electric, Hewlett-Packard

Laboratories, Motorola, Intel, IBM, Dupont, United Technologies Research Center, AT&T, etc., as well as many software companies.

At the other extreme are high-tech start-ups, new businesses where venture capitalists provide funding. In between are small high-tech firms funded by the government through SBIR (Small Business Innovative Research) contracts.

The cultures of these two extremes are very different. In some ways working in a large company is similar to working in a government laboratory. They usually have excellent personnel departments that work within structured institutional policies; vacation time and working hours are well-defined and in many institutions are family-friendly. They will have standard policies for purchasing equipment and materials, for travel, etc. Your project will be well defined, often a year or more in advance. The institution sets the research agenda, and your success depends on how well you meet the needs of the program. You will report to a boss. In many cases you'll be encouraged to write papers and give talks at conferences. You'll often have to write proposals for your future research that will need to be funded, either from within the institution or with an extramural government grant. The salaries in business are generally larger than in government, but there is often less job security.

By contrast, in startups everyone chips in to do what has to be done. Startups can be very exciting, but are usually very time-consuming. The tasks can change from week to week as the needs change. The pay may be low, but you will be offered stock in the company, which may grow to considerable amounts if the company is successful. There's no job security, but opportunity for a "killing" if the company is successful. And if it doesn't work out, there are many opportunities to move to another small company, where your experience will count for a great deal. It is a very exciting way to live. As you can imagine, however, it is not especially family-friendly. Indeed, you can expect to be asked illegal questions during job interviews, such as if you are married, or expect to have children. These start-ups don't have time or energy to have personnel policies. They are motivated only by success.

By contrast to industry, academia is do-it-yourself. You must decide what you work on. You must do the hiring and firing. You must fight for space to carry out your experiments. You are your own boss. This means that your time is your own, but you must learn to structure it well. You will run your own research group like a small business. You must fight for money, students, space, but you will have the assurance of a guaranteed salary. You pay for this security by devoting time to teaching.

In a small business you do all the above, but no teaching, with no assurance of salary; you don't have to teach, but can expect large financial dividends if you succeed.

Successful academics become the world's expert in a narrow field. This is how they get tenure. In industry you are successful if you give your allegiance to the company and do whatever they need. You might come up with a new idea that can be developed into a product or process. Or you may become the company's expert in a given field. Or you might be asked to solve a range of interdisciplinary, across-the-board problems.

In academia there is always more than you can do – teaching alone could swamp you. You must learn to ration your time, or you will become overloaded! On the other hand, you work at your own pace and set your own hours. There is always summer vacation.

The decision as to whether to go into academia, government, large company or small start-up should depend on whether you think you're self-motivated in coming up with and carrying out ideas, or you'd like some input from above.

Industry pays better, but academia offers more job security (assuming that you get tenure!). On the other hand, academics can increase their salary by consulting, and can also start their own companies. But experience working in a start-up would teach you the secrets of starting your own company. The decision of which kind of job to take is up to you.

Remember, of course, that one track does not preclude moving to another. Academics leave to start companies. Successful industrial researchers move to Academia, etc. The important thing is to carry out research defined as successful by your institution and document your success, preferably with publications.

Non-Research Options for PhD's in Physical Sciences and Engineering

If you like to teach, you might consider a future teaching in a college rather than a research university. Today many colleges expect you to do some level of research, using undergraduate assistants. It can be lots of fun. It does NOT mean that you've failed if you don't get a faculty position at a major university! Many people try a research university and decide that the high pressure of these jobs is not for them. They trade the rat-race of finding research funding for teaching more classes.

Community colleges offer opportunities for PhD's as well as Masters graduates. They have large teaching loads, as many as 20 student contact hours, but they can be a very inspirational place to work because you have the opportunity to help disadvantaged students. Often theoreticians are able to continue their research while teaching in community colleges. Opportunities often exist to collaborate with researchers in nearby universities, particularly during summers.

And remember that world-class high school physics teachers often have PhD's. Certainly our high school science classes need knowledgeable teachers!

If you like to interact with people, consider academic administration, not on the tenure track, but in an administrative position that can use your science background. An example is positions created to improve the teaching of science, or help the school obtain research contracts, or in public relations, or administering a research unit. Many people find it exciting to remain around the university and partake of all that it offers.

Management is another option for PhD's who don't want to continue in research. The commercial sector has lots of opportunities in management within high tech companies. You will begin in project management and perhaps work your way up to managing large groups of people, and eventually a company. A PhD really helps you on the fast-track to important positions. Sometimes PhD's go back to school and get an MBA after a few years of business experience.

Policy is an important avenue for PhD's who want to leave the research track. The skills that you learn in carrying out a PhD help immensely in sifting through issues to help formulate policy. Opportunities in policy-making are particularly strong in government, and are also available in companies that serve the government (in Washington these companies are called "think tanks"). You will read the research of others and synthesize it into reports that will inform decision-making. For example, today's emphasis on the need for new sources of energy to replace fossil fuels has raised a number of policy issues. Can nuclear power be safe? What about nuclear waste? Can carbon sequestration be successful in enabling coal-fired power plants without increasing greenhouse gases? In a policy position you will read research papers on these subjects and formulate your recommendations, based on the facts as you understand them. This can be a very powerful way to use your PhD.

The American Association for the Advancement of Science (AAAS) has a fellowship program that inserts newly minted PhD's into science and technology policy-making positions in Washington. You will be placed in an agency within the Executive Branch or with a Congressional Committee or Congressperson. Many Fellows go to the State Department. It is an opportunity to try out a totally different use for your PhD. The positions are one year, renewable for a second, and many of the AAAS Fellows decide to remain in Washington, either working within the government, or with one of the many nearby institutions that work on science and technology policy. Others decide after this break to go back onto the research track, in academia, government or industry. Information about this program is available on the Web.

I've given you a lot to think about. I hope that it is helpful. Be sure to make use of the Career Center at your school. They, or your school's Alumni Office, may have contacts that can get you in the door of the place that you'd like to work.

And good luck on your decision-making process!