# INTRODUCTION TO PROFESSIONAL PRACTICE

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## Introduction

Congratulations on passing your first step in becoming a registered professional! Many licensed professionals will tell you that passing the fundamentals exam is the most difficult part of the licensure process. So, now that the most difficult part is behind you, let's look forward to your future.

You probably think that you've done enough reading in school to last a lifetime. In fact, the reading you have done **will** last a lifetime but there is always more you need to know. This document contains *statutes* from the North Dakota Century Code and *rules* from the North Dakota Administrative Code that you will have to know in order to practice as a Professional Engineer or Professional Land Surveyor. This *Introduction to Professional Practice* you are reading now contains information that is not found in statutes or rules but will be very important to your professional career. Taking the time to read this document will answer a lot of your questions and save you time as your professional career develops.

## The Licensure Track

By taking and passing the Fundamentals examination, you have started on the licensure track. Statistically, only about 20% of college graduates continue on the licensure track to become licensed professionals. What do the other 80% do? Many graduates work in industry where licensure is often not required. Some may work for government entities that are exempt from state licensing requirements. Others continue to work in the private sector under the supervision of a licensed Professional Engineer (PE) or Professional Land Surveyor (PLS). There are also some who choose a different profession altogether. By getting on the licensure track, *and staying on it*, you will become part of the 20% who have far greater career options than those who do not become licensed.

## Benefits of Being Licensed

- I've got a good job already, why do I have to take another test?
- I'm just too busy right now; I'll take the exam in a couple of years.
- I'm not sure how being licensed will benefit me but it looks like it will be more trouble than it's worth.
- Are you kidding me? Go back to studying??

Do any of these statements sound familiar? If so, you are not alone. The thought of taking an 8-hour exam certainly seems like a lot of work, especially when you have a full-time job and have so much other stuff to do. And, of course, who wants to spend their weekends and evenings studying for a test? But rather than focusing on the extra work preparing for the the Principles and Practice exam, why not take a look at some of the benefits?

**Status:** The use of the professional title, either Professional Engineer or Professional Land Surveyor, carries a level of prestige with it. In North Dakota, the use of the title is restricted by law. Only those

individuals who have passed both the Fundamentals exam and the Principles and Practice exam and have the proper education and experience meet the requirements to use them. Signing your name and placing "P.E." or "P.L.S." behind it raises your professional credibility, and most importantly at this stage of your career, increases your employability.

**Employment Opportunity**: Companies are always looking for ways to increase their marketability to increase their bottom line. An individual who is licensed can legally take on a variety of different projects. There is no need to have a supervising professional or rely on an industrial exemption to practice. If you are licensed, you are more marketable and more profitable for a potential employer. In short, unlicensed individuals are less marketable and less profitable than licensed individuals.

**Responsible Charge:** Do you want to be the boss someday? If so, you need to be licensed. In private practice, only a licensed individual can sign and seal documents. Government agencies are taking their cue from the private sector and requiring individuals with professional licenses to progress beyond certain pay grades. If you want to design your own project and see it come to reality, you need to be licensed.

**Flexibility:** The past few years have shown that even the largest manufacturers and businesses fail. If you aren't a licensed professional, your only options are to take a job with a firm and work under someone else's supervision or find a job with a government agency that doesn't require a license. If you have a license to back yourself up, you would not only be more enticing to potential employers, but you would also be able to start your own business while you are looking for work.

**Money:** Last, but certainly not least, is higher income for licensed professionals. Average income for engineers varies depending on discipline, qualifications, experience, and location. The National Society of Professional Engineers reports that P.E.s average 20% a year more in salary compared to unlicensed engineers in comparable positions.

For land surveying, average income varies depending on qualifications, experience, and location. Registered Professional Land Surveyors average 21% a year more in salary compared to unlicensed land surveyors.

## Statutes and Rules

Since we have already mentioned *statutes* and *rules*, let's start there. Statutes are laws passed by the North Dakota Legislature and are collected into a set of books called the North Dakota Century Code (NDCC). Statutes are organized using a numbering system. When a statute is given a location in the North Dakota Century Code and assigned a number, it has been "codified." If statutes need to be changed or corrected, the only way to do it is to introduce a bill into the legislature and get it passed by your state senators and representatives and then approved by the governor. Although the process to introduce a bill isn't difficult, it isn't exactly easy either. Our legislature only meets once every 2 years so if you need a change, it's going to be a long wait. Because statutes are cumbersome and time consuming to change, they tend to be broadly worded and don't contain a lot of specific details.

*Rules* are where the details are usually located. The North Dakota Administrative Code (NDAC) is another set of laws, but these laws aren't passed by the legislature. They are created by different state agencies and regulatory boards to add details to the broadly worded statutes. The NDAC is also organized using a numbering system. These laws are referred to as administrative rules. The Board cannot create any administrative rule unless the authority to create the rule is already contained in a statute approved by the North Dakota legislature. In other words, any rule must be backed up by a statute. Unlike other rules, these rules aren't made to be broken. If they are, you could be subject to disciplinary action and your whole career could be derailed before it even gets started. Administrative rules are laws that must be followed.

## The Board of Registration

In 1943, the North Dakota Legislature decided the practice of engineering requires specialized knowledge and is so important to the health, safety, and welfare of the general public, that they passed a law that created licensing requirements for Professional Engineers. The statutes creating licensing requirements are often referred to as a Title Act. The legislature doesn't have time to review every engineering license application, so they created a regulatory board to do that work for them. In 1967, the legislature decided that the practice of land surveying was as important as engineering to the health, safety, and welfare of the general public. They added land surveying licensure to the regulatory board they had already established for engineering licensing. The board created by the 1943 title act and the amendment made in 1967 is the North Dakota State Board of Registration for Professional Engineers and Land Surveyors. That's a long name so we're going to just call them "the Board" from here on out.

What, exactly, is the Board and what do they do? As we've already said, the Board is an entity created by the legislature to regulate the practices of engineering and land surveying. The statutes that created the Board are located in North Dakota Century Code § 43-19.1. This symbol, §, is the legal notation meaning "section." Chapter 43 of the North Dakota Century Code (NDCC) deals with licensed occupations and professions. Section 19.1 is the section specifically assigned to engineering and land surveying.

The Board consists of 5 members. Four seats on the Board are for Professional Engineers and one seat is for Professional Land Surveyors. Board members are appointed by the governor of North Dakota. Unlike many other states, the candidates for appointment to the North Dakota Board are nominated by the North Dakota Society of Professional Engineers (NDSPE) for the Professional Engineer seats and the North Dakota Society of Professional Land Surveyors (NDSPLS) for the Professional Land Surveyor seat. The societies must give the governor a list of at least three qualified candidates. The governor will make the appointment to the Board from the list. Board members do not get paid for serving on the Board, but they do receive a daily payment to cover their expenses. The payment is called "per diem." Board members are appointed for 5-year terms with one term expiring each year.

The Board has a lot of authority and powers given to them in the statutes. Most of them are pretty mundane such as the authority to hold meetings, pay bills, hire staff, adopt a seal and adopt bylaws.

However, some of those powers have a lot more impact. The Board has the responsibility to enforce the laws established by the legislature. To do that, the Board has the power to hold hearings, administer oaths, take and record legal testimony, subpoena witnesses and documents, make legal findings and issue legally binding orders. When we talk about disciplinary actions later on, we'll go into how the Board uses these powers.

## Registration Requirements

One of the methods the Board uses to regulate the practices of engineering and land surveying is to license only those individuals who have met the requirements for licensure under North Dakota law. To accomplish this task, the Board uses a combination of statutes and rules. As previously mentioned, the statutes used by the Board are in NDCC § 43-19.1. The rules created by the Board to interpret the statutes are located in Title 28 of the NDAC. All of Title 28 is set aside for the practices of engineering and land surveying.

For engineering, registration in North Dakota is based on your baccalaureate degree. Different types of degrees have different experience requirements. During the licensure process, you will often hear the term "ABET." ABET stands for the Accreditation Board for Engineering and Technology. ABET is an organization that establishes standards for engineering degree programs. The standards include, among other things, specified coursework, minimum lab hours and faculty qualifications. Accreditation is given to individual programs, not to universities. For example, a university may have an accredited chemical engineering program, but the same university may have a mechanical engineering program that is not accredited. State Boards across the United States have uniformly adopted the ABET accreditation. ABET is the highest standard of education qualification. Licensure pathways exist for individuals with an engineering degree that is not accredited or if you have an engineering related degree. If you aren't certain what type of degree you have, contact the State Board office. The experience requirements for various types of engineering degrees are:

| Degree Type | Experience Required for FE | Total Experience Required for PE |
|---|---|---|
| ABET Accredited | 0 Years | 4 Years |
| Non-ABET Accredited | 4 Years | 8 Years |
| Engineering Related | 6 Years | 12 Years |

For land surveying, there is no minimum education requirement. Land surveyors need a combined total of 8 years of education and experience to become licensed. Based upon your education, if any, the experience requirements are:

| Degree Type | Experience Required for FS | Total Experience Required for PS |
|---|---|---|
| ABET Accredited BS | 0 Years | 4 Years |
| Non-ABET Accredited BS | 0 Years | 4 Years |
| Two-Year Technology | 2 Years | 6 Years |
| No Degree | 4 Years | 8 Years |

## Experience

Interns often call the Board and ask what type of experience they should be gaining to be eligible for the Principles and Practice exam. The law states that the experience must "indicate to the board that the applicant may be competent to practice engineering" or that it is "of a grade and character satisfactory to the board." What does that mean? That language is a good example of some of the broadly worded language often found in statutes. To clarify what that means, the Board created a rule in Title 28 of the NDAC. The rule defining acceptable experience is found in NDAC § 28-02.1-04-02. You should read the rule and make sure all your experience falls within one of those categories.

The Board developed an "Experience Worksheet" to assist them when they evaluate an applicant's experience. There is one for engineering and one for land surveying. Be sure to look at the experience worksheet so you will know the categories in which you need to gain experience. The Board doesn't expect you to have experience in every area, but you need well-rounded skills before the Board will approve you.

## Getting Registered

When you have completed the experience requirements listed above, you will be ready to take the Principles and Practice exam and become registered. You may be thinking that taking another exam when you are several years out of school is going to be very difficult. While licensure examinations aren't intended to be easy, they are designed to test you on how you apply the knowledge you gained either in college or while gaining experience. The Fundamentals exam focused on your mathematical

skills and your knowledge of various formulas. The Principles and Practice exam, while still mathematically based, tests your knowledge of what you actually do in your job every day. The Principles and Practice exam is more discipline specific and doesn't test as much broad-based information as the Fundamentals exam.

To take the Principles and Practice exam, you will need to apply to the Board. Applications can be found on the Board's web site at www.ndpelsboard.org. The application will ask you for your general information, the company you work for, references, and your experience. You will also need to complete the experience worksheet that breaks down your experience into various skills-based categories.

During the application process, you will need to supply additional documents to support your application. You will need 5 references. Three of those references must be individuals who are licensed in the profession in which you are seeking licensure. If you didn't take the Fundamentals exam in North Dakota, you need to request a verification of examination from the state in which you took the exam. The verification will be sent directly to the North Dakota Board. Some states charge a fee for a verification so be sure to check the fee schedule to avoid delay in your application. If applicable, you will also need to have your college transcripts sent directly to the North Dakota Board from the university.

Once you are approved by the Board, you will receive a letter telling you what to do next. The letter will direct you to the NCEES web site to register for the exam. The Board does not charge an application fee when applying for the exam, but you will have to pay for your exam and scoring when you register with NCEES. Current fees, exam dates and exam specifications can be found on the NCEES web site at www.ncees.org. While you are on the NCEES web site, be sure to check their current policies on reference material, items allowed in the examination room and what calculator you can use.

When you pass the exam, the Board will send you a letter and issue you a license number. You will receive information about continuing education requirements, renewing your license and corporate licensing requirements. The Board will award you 10 professional development hours (pdh's) for passing the Principles and Practice exam. These can be used towards your first requirement for continuing education reporting.

## NCEES

When you registered for the Fundamentals and the Principles and Practices examinations, you went to the NCEES web site. What, exactly, is NCEES? NCEES stands for the National Council of Examiners for Engineering and Surveying. NCEES was formed in 1920 by state licensing boards. Currently, all states and US territories are members of NCEES. The organization was created by licensing boards to serve licensing boards.

The main function of NCEES is to write licensing exams for engineers and land surveyors. The benefit of having NCEES write the exams is that they are accepted in all states and US territories. Some states have

additional exams that are state specific but generally, once you pass the Fundamentals and Principles and Practice exams, you shouldn't have to ever write them again.

NCEES holds a meeting annually and representatives from each member board attend. During the meeting, several key decisions are made. The content of the exams, cut-off scores, and exam pricing are voted on. The Boards also vote on changes or additions to the NCEES Model Law.

## NCEES Model Law

The Model Law is a document that contains suggested language for states to adopt into their own state laws. The language in the Model Law defines what state licensing boards consider to be the ideal circumstances under which a person may become registered. In summary, the Model Law specifies that an engineer or land surveyor hold an ABET accredited BS degree, has taken and passed the Fundamentals exam, has acquired 4 years of experience, has taken and passed the Principles and Practice exam, has no disciplinary action, and holds an NCEES record.

An NCEES record is a set of documents commonly used to support your application. Establishing a record must be initiated by you and is a fee-based service offered by NCEES. A typical record will contain your general information, licensing history, work history, reference letters, verification of your examinations, employment verification and college transcripts. If you plan to become licensed in many states, an NCEES record may be beneficial to you. One advantage to having an NCEES record is that your record is automatically compared to the Model Law to see if the circumstances under which you became registered are in compliance with the Model Law. If they are in compliance, the record will be designated as a Model Law Engineer or a Model Law Surveyor. Many states, including North Dakota, have an abbreviated application and faster processing for Model Law applicants.

## Reciprocal Licensing

Once you are licensed in a state, you may want to practice in other states as well. The process to become licensed in other states is commonly referred to as "comity," "reciprocity" or "endorsement." North Dakota statutes use the term "endorsement" so we'll use that term. Although, by strict definition, all 3 terms have different meanings, in reality they all mean the same thing. Registration by endorsement means that you make an application to another state, provide the requested documentation, meet any state specific requirements, and become licensed to practice in that state without taking the licensure exams again. All states and US territories have an endorsement agreement with North Dakota.

Multi-jurisdiction license holders are becoming more common than professionals who are licensed in only 1 or 2 states. It is likely that, during your career, you will be licensed in several states. You must clearly understand that in most states it is illegal to practice or even offer to practice without being licensed first. Nationally, practicing without being licensed is one of the most common reasons for

disciplinary action; second only to ethics violations. In addition to not being granted your license in a particular state, you can face fines of up to $10,000 depending on where you are being disciplined.

Most states have adopted some of the NCEES Model Law. However, each state also has its own unique licensing statutes. You must be in compliance with their laws in order to be granted licensure without taking additional licensing exams. Always be aware of licensing requirements in any state in which you are applying. In general, when seeking a license in another state, you should:

1. check their web site for licensing information and requirements.
2. complete their application form according to their instructions.
3. supply any supporting documentation requested, such as reference letters, verification of exams and college transcripts **or**
4. if applicable, have your NCEES record transmitted to the state board.
5. pay any fees associated with your application.
6. be prepared to take any state specific examinations or other local requirements.
7. understand their Code of Ethics and other rules governing your practice in that state.

## Disciplinary Actions

In an ideal world, you will never be the subject of a disciplinary action taken by any Board. As previously mentioned, the Board has broad powers in enforcing licensing laws. The Board can hold hearings, administer oaths, take, and record legal testimony, subpoena witnesses and documents, make legal findings and issue legally binding orders. In addition, the Board can issue reprimands, suspend licenses, refuse to renew licenses, revoke licenses, and enter into negotiated settlements.

The Board has a Legal and Investigations committee that consists of the Secretary of the Board, one additional Board member and the Executive Director. The Board's legal counsel and any investigative personnel are advisors to the committee. The committee's job is to review all complaints and direct the investigator to find answers to any questions they may have. The committee is the entity that will review a complaint and the response to the complaint to see if it has merit and make the appropriate recommendation to the Board.

The remaining three members of the Board who are not on the Legal and Investigations committee do not receive the details about any complaint that has been filed. If a complaint proceeds all the way to a disciplinary hearing, the 3 board members will serve as a hearing panel and determine if a registrant has committed a violation. Like in a civil or criminal court proceeding, a judge receiving knowledge of the facts of a case without both parties present is called "ex parte communication." Ex parte communication is not allowed by law. That's why the remaining 3 Board members who are not on the legal and Investigations committee do not receive any facts about the case. The Board may also arrange for an Administrative Law Judge to handle the procedural issues required by a hearing.

The disciplinary process is started by someone filing a complaint against a registrant. That person is referred to as the complainant. The law provides that "any person" may file a complaint. The complaint

must be sworn and notarized. Sometimes the Board receives compelling information that indicates a direct threat to public health safety and welfare but no complaint is filed. When that happens, the Executive Director may swear out the complaint. Anonymous complaints are not investigated.

When a complaint is received in the Board office, a pre-determined procedure begins. The Board has published its procedures in the form of a flow chart titled "Process of a Complaint," which is located under the Public tab at https://ndpelsboard.org/ . The complaint is filed with the Secretary of the Board as required by law. A notice of the complaint is sent to the registrant against whom the complaint was made. That person is referred to as the respondent. The respondent is asked to respond to the complaint.

Once the response is received, the Legal and Investigations committee reviews both the complaint and the response. If the committee finds that the complaint is "trivial or unfounded" they may make a recommendation to the full Board that the complaint be dismissed. If the committee believes that a violation has occurred, they will recommend that the matter proceed to a hearing. Sometimes, the committee may have questions about the circumstances surrounding the complaint. In that case, the committee may direct the investigator to interview witnesses or gather additional documents. The information is reviewed by the committee again and they will make a recommendation to the Board.

The recommendation of the Legal and Investigations committee is given to the Board at a meeting. Both the complainant and the respondent are notified that a recommendation will be made. All meetings are open to the public, but the parties are notified to make sure they know the recommendation will be presented to the Board. The Board will vote upon the recommendation of the committee. If the recommendation was to dismiss, all parties receive notification, and the case is closed. If the recommendation was to proceed to a hearing, a date for the hearing is set and all parties are notified. A secondary investigation is conducted. The registrant will prepare their defense.

Often times, a registrant will acknowledge that a violation occurred. In that instance, the Board's legal counsel may draft a stipulated agreement. If the agreement is satisfactory to the respondent and the Board, it is signed by all parties. A stipulated agreement is executed in lieu of a hearing and is binding upon the registrant. Any discipline imposed in the agreement must be carried out and all requirements of the agreement must be met before a registrant is considered in "good standing".

If you are licensed in several states and you have an adverse finding as a result of a disciplinary action, you may be disciplined in all states in which you hold a license. We spoke earlier about reciprocal licensing and how you can become registered in other states without taking the licensure examination. When you have reciprocal agreements to recognize a professional license issued by another state, reciprocal disciplinary actions are part of the agreement. If you work in several states, you can be disciplined for the same violation in several states.

This section is a brief overview of the disciplinary process and is not intended to be inclusive of every detail of the disciplinary process. At all times during the disciplinary process, a registrant is entitled to have their own attorney to render advice.

## Ethics

No discussion about professional licensing would be complete without mentioning ethics. Strong ethics are the cornerstone of professional licensing. Without a commitment to ethics, the value of a credential is diminished. Nationally, ethics violations are the #1 cause for disciplinary actions. Merriam Webster offers the following definition of Ethics:

**ETHICS**

1. the discipline dealing with what is good and bad and with moral duty and obligation
2. a set of moral principles**:** a theory or system of moral values
3. the principles of conduct governing an individual or a group <professional *ethics*>
4. a guiding philosophy
5. a consciousness of moral importance
6. a set of moral issues or aspects (as rightness)

The Board has created a Code of Ethics for Professional Engineers and Professional Land Surveyors. It is located in NDAC § 28-03.1. It is extremely important that you read and understand the Code of Ethics for any state you are working in. Violating a Code of Ethics is grounds for disciplinary action in every US jurisdiction. Each state has its own Code of Ethics, but they all have a similar premise. The premise is: having knowledge of right and wrong and, when given a choice, make the right decision.

Ethics seems so simple when it is summarized that way. In reality, some of the most difficult decisions you will ever make are ethics based. Situations will arise during the course of your career that you don't even realize require an ethical decision until after the fact. Many registrants who have been disciplined for ethical violations aren't bad people; they just didn't realize they were facing an ethical dilemma until it was all over and the wrong choice was made.

# Land Surveying Experience Descriptions

**As Built Surveys**

"As Built Surveys" are created by doing field work to locate physical improvements (buildings, earthwork, etc.) on a parcel of land. This is frequently done for projects with recent construction. The information gathered can be used in an office environment to produce a drawing showing the actual physical location of the features of the parcel.

- Unlike many land surveys, as-built surveys are utilized during the middle or at the end of a construction project. As-built surveys show improvements to the land, as they appeared in a particular point of time.
- As-built surveys may be used for commercial or residential properties. Surveys are crucial tools in the construction industry from the planning stage to the actual construction and future maintenance. A construction project begins with a site plan or plot plan, laying out the plan for the project from beginning to end. This plan incorporates any conditions already existing on a given site.
- As-built surveys may be conducted several times throughout the duration of a construction project. Their frequency and the number of surveys undertaken depend on the scope of the construction project. The purpose of an as-built survey is to verify to local and state boards that the construction work authorized has been completed according to the same specifications set during the planning stage and shown in the site plan. The as-built survey is most often used to show the building inspector that a project under construction is conforming to zoning regulations. As-built surveys may be required for nearly every type of land project, from roads and trails to utility improvements and building construction.

**Boundary Surveys**

"Boundary Surveys" are surveys made to establish or to re-establish a boundary line on the ground or to obtain data for constructing a map or plat showing a boundary line. If you are conducting a boundary survey, your work will include:

- **Client Consultation.** The first step would be initial contact with the client, where property description, location and any questions or concerns about what needs to be done will be addressed. With the amount of data readily available to surveyors on the internet a site visit is not always needed to come up with a plan of action to best achieve the client's goals. Once a plan of action has been agreed upon the next step would typically be for the surveyor to start doing research.
- **Research.** You will research records to gather all the information you will need to help with the rest of the survey process. These records may include deeds, maps, legal descriptions, easements, highway plans, benchmark information, government corners and control points.

Record keeping is a very important part of the surveying profession, without the proper knowledge going into the field the final boundary determination could vary significantly. Once the research has been completed the next step is to perform the field work.

- **Field Work.** When performing the field work, you will find all available evidence such as monuments, fences, and roadways that affect the area being surveyed. Measurements are made to create a direct relationship between all the pieces of the puzzle. Often times all structures and various other improvements on the parcel are also located including driveways, water bodies, wells or anything that looks like it may encroach onto the parcel or an adjacent parcel. Once everything in the field has been located the process of computing the boundary can begin.
- **Computations.** Boundary computations can be done in a variety of ways. A smaller more simple boundary can often be solved right in the field with the help of the surveyor's data collector and reliable field notes. More complex boundary solutions are often solved in the office on the computer using drafting software that can show the whole picture in a much clearer detail. Once the surveyor arrives at the final boundary solution the lot is ready to be monumented.
- **Monumenting.** Monumenting the parcel boundary can be accomplished in many different ways. Sometimes there will be acceptable monuments already in place that will be held as the corner of referenced to the actual corner if within tolerance. Other times no monuments exist and the surveyor will place all new monuments at all the corners of the parcel boundary. A map will be provided to the client showing all monuments set and or found and their relationship to the boundary.
- **Survey Completion. O**nce the survey has been completed a map will be provided to the client and to the appropriate recording agency with the county. This map will be a visual representation of the parcel as well as any other pertinent information that needs to be shown. The map will show the basic solution of the surveyor's computations for all land surveyors to reference in the future. All questions and concerns the landowner had prior to the survey should have been addressed by this time and the client should have peace of mind knowing exactly where their property lines are.

**Cadastral Surveys (PLSS)**

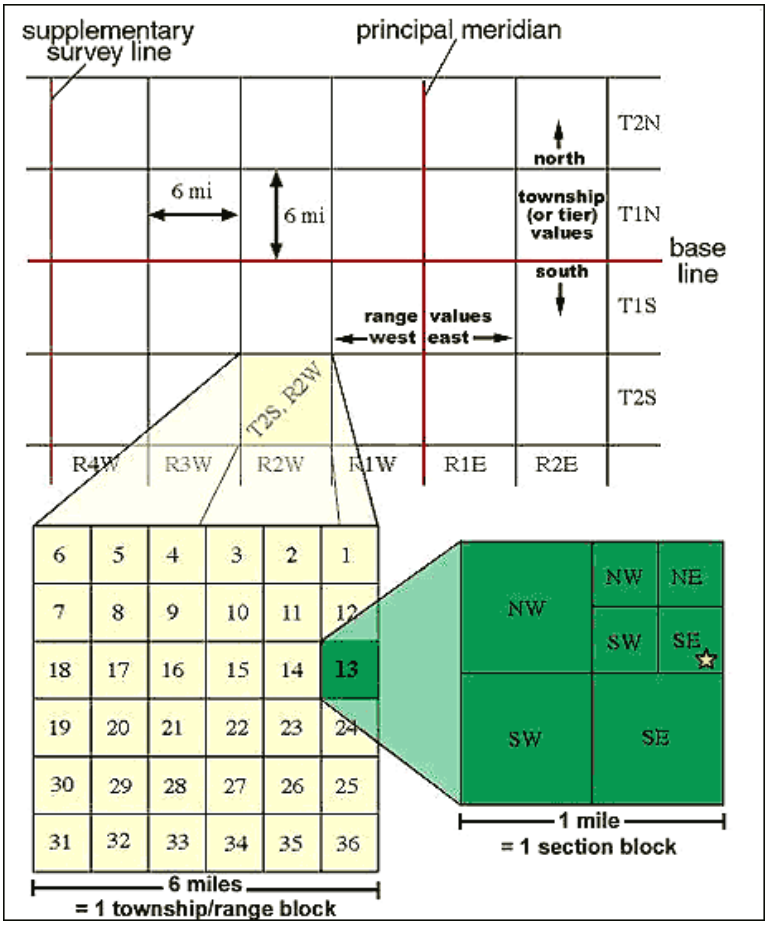
"Cadastral Surveys" relate to the laws of land ownership and the definition of property boundaries. It involves interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions, and interests in property, as well as the recording of such information for use on plans, maps, etc. It also involves the physical monumenting of property boundaries and determination of dimensions, areas and certain rights associated with properties, whether they are on land, water or defined by natural or artificial features.

"Public Land Survey System (PLSS). In order to understand cadastral surveying, you must understand the PLSS. In each state, *except for the original thirteen states and a few in the southwest that were originally surveyed based on Spanish land grant boundaries*, early surveyors established a principal

meridian running north-south, and a base line running east-west. These initial survey lines served as a basis for subsequent survey lines spaced at 24-mile intervals along the eastern, western, and southern boundaries. Further subdivision of these 'squares' led to the creation of 16 smaller squares measuring six miles on a side (see diagram). When measuring in a north-south direction, each of these squares is called a township.

When measuring in an east-west direction, each of these squares is called a range. So, a 36 square mile area located between six and twelve miles east of the principal meridian and twelve to eighteen miles north of the base line would be called township three north, range two east (written as T3N., R2E). Each township is further subdivided into 36 smaller squares covering roughly 1 square mile. These areas are called sections and are numbered within a township from the upper right to the lower right in an alternating manner (1 to 6 are numbered from right to left, 7 to 12 from left to right, etc.). These one mile squares are the smallest formal subdivisions in the PLSS system.

But to describe a location the squares are quartered, and then the quarters are quartered again, as shown. The location of the star in the figure above would be described as the southeast quarter of the southeast quarter of the northeast quarter, section thirteen, township two south, range two west. The shorthand for this is: SE1/4, SE1/4, NE1/4, sec. 13, T2S., R2W.



**Construction Staking**

"Construction staking" is the activity required to set stakes for horizontal and vertical positions on a construction site. The stakes are used to guide the contractor in the construction of a particular project. **The Board allows only 10% of time spent in construction staking to count towards your experience requirement for registration.** Construction staking may include the following:

- Surveying existing conditions of the future work site, including topography, existing buildings and infrastructure, and underground infrastructure whenever possible (for example, measuring invert elevations and diameters of sewers at manholes).
- Staking out reference points and markers that will guide the construction of new structures
- Verifying the location of structures during construction.

**H & V Control Surveys**

"H & V Control Surveys" refer to Horizontal and Vertical Control Surveys. This type of survey requires a combination of office and field work to produce a very accurate survey that establishes horizontal and vertical measurements used in survey work. Well established H & V controls are a valuable reference for future surveys in the same area. Work on this type of survey will include:

- Placing stakes and reference points.
- Documenting the location of the stakes, both horizontally and vertically.

**Legal Descriptions**

A "Legal description" is the proper combination of words, recognized by law that definitely locates property. The description may reference government surveys, coordinate systems or recorded maps. Elements of the description include land, sun, air, sky, and water.

**Preliminary Engineering Surveys**

Preliminary engineering surveys gather data for use by planners and engineers. The products resulting from engineering surveys are generally topographic maps and/or a digital terrain model (DTM). Both conventional (on the ground) and photogrammetric methods are used to gather data for engineering surveys. Engineering surveys have following types:

- **Reconnaissance Survey**
  The Survey which is done for the feasibility* and rough cost of the project is known as Reconnaissance Survey.
- **Preliminary Survey**
  The survey in which more precise information is required for the choice of best location for the project and to estimate the exact quantities and costs of project is known as Preliminary Survey.

- **Location Survey**
  The survey for setting out the work on the ground is known as location survey.

**Right-of-Way Survey**

A "Right of Way" is strip or area of land, granted by deed or easement that gives a designated use of the land to someone other than the owner. A right-of-way gives an "interest" in the land to someone else but does not necessarily grant ownership. Ownership is granted when the "interest" in the land is transferred by deed. Utility companies, such as a gas or telephone company, have an easement where their equipment is located on a parcel of land. The easement gives the company the right to enter the land to inspect or maintain their equipment.

A "Right of Way Survey" establishes the boundary of the right-of-way. A utility truck that is entering land to inspect or maintain their equipment must stay on the right-of-way. An accurate boundary for the right-of-way is essential.

In North Dakota, right-of-way surveys are regulated by the North Dakota Administrative Code. The regulations are located in NDAC §28-02.1-13 "Documents Used to Convey Real Property or Any Interest Therein". Rights-of-way are only one type of interest in land covered under this section. Easements, deeds, and any other document that gives an interest in land are included in this section. A properly executed right-of-way survey, when completed, will be retraceable, have exterior monuments set whenever there is a change in width or change in direction of the right-of-way, and will have monuments set whenever the right-of-way intersects another right-of-way or a section line.

**Subdivision Survey**

Subdivision Survey (commonly referred to as subdivision platting) is the process of splitting a tract of land into smaller parcels. This shows monumentation and survey data on a map in conformance with local subdivision ordinances. Subdivision ordinances give standards for designating residential and commercial lots, roads, rights-of-way, parkland dedication, drainage, and utility easements, and how city services will be extended to each lot. These standards are created to improve public health and safety.

Subdivisions are basically splits of property. Although they may be made for any purpose, usually they serve the purpose of selling the individual lots of land. A subdivision can be as simple as dividing a one acre lot in half or as complex as dividing 100 acres into many lots with roads and utilities.

A subdivision survey is done to delineate individual lots within the main tract. Each lot on the plat map is assigned an identifier, usually a number or letter. The plat map is then officially recorded with a government entity such as a city engineer or a registrar of deeds. This plan becomes the legal description of all the lots in the subdivision. A mere reference to the individual lot and the map's place of record is usually all that is required for a proper legal description.

Subdivision design and layout considerations must include creating good building sites, an effective street and utility layout, and assured drainage. Also, an accurate layout ensures that the improvements can be easily and correctly constructed at later stages. Generally, a subdivision project involves a survey of the exterior boundaries of the tract to be divided, followed by a topographic survey, design of the subdivision, and the layout of the interior of the tract.

**Survey Calculations and Drafting**

All of the math classes you took in Algebra, Geometry and Trigonometry are going to be vital in performing accurate surveys. Survey mathematics generally consists of applications of formulas and equations that have been adapted to work toward the specific needs of the surveyor such as:

- Units of measurement and conversions
- Check and adjustment of raw field data
- Closure and adjustment of survey figures
- Calculations for missing elements of a figure
- Working with coordinates
- Intersections of straight lines and of circles

After collecting field information, making all of the necessary calculations and checking the accuracy of your work, the information must be put into a format that everyone can understand. The usual method of doing this is to make a graphic representation, or map, of the land you surveyed. Making the maps requires drafting. The days of the drafting table, ruler and compass are long gone. Drafting is usually done on a computer with very complex software programs such as CADD.

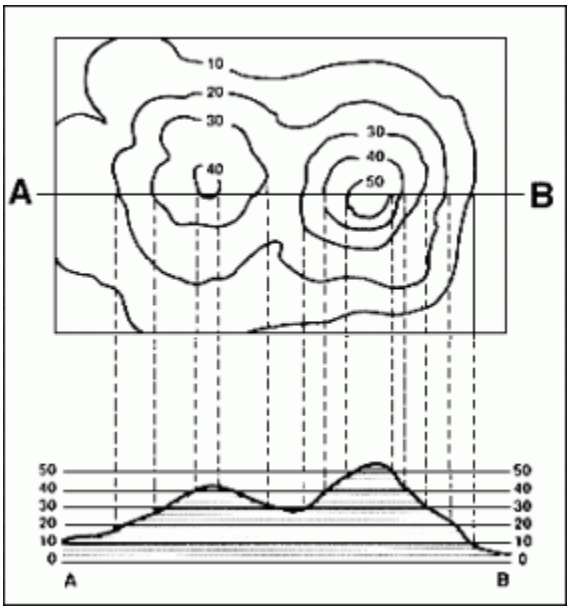
**Survey Research**

Research is a critical part of land surveying. Good research can save time and money as well as prevent redundant work and mistakes. When doing research, you will probably spend time at the city or county courthouse. Land ownership and tax records are located there. Corner recordation forms that document the location of PLSS corners are also located in the county courthouse.
Good research will include many different records. These records may include deeds, maps, legal descriptions, easements, highway plans, benchmark information, government corners and control points. In some counties, many of their records are available online. While researching, keep an eye out for any previous surveys that have been conducted in the area where you will be surveying.
Always keep an accurate record of your research. Record keeping is a very important part of the surveying profession. Without the proper knowledge going into the field the final boundary determination could vary significantly.

**Topographic Surveys**

Much like any other type of survey, a topographic survey, or topo survey for short, is done to locate natural and man-made features on a particular parcel of land. The topo survey is different in that the elevation of the surface of the land is surveyed and represented on the resulting map of the survey. The topo survey usually also includes any man-made underground features, like utility lines. The survey will also show above ground improvements like buildings, utility poles, retaining walls, etc.

The elevation or differences in elevation on the surface is usually shown as contours. A contour line is a line that connects points of equal elevation. These contours are a way to represent the relative elevations of the surface of the land.




Topographic surveys are usually carried out in order to have an accurate record of the existing conditions of a parcel of land that is about to undergo some type of construction activity.

Design Engineers use a topo survey as the beginning surface of their design and then plan what the proposed final surface will be like. Having this original surface allows the Engineer to calculate the amount of earthwork that might be needed to bring the site to the final grade. Many times, a topo survey is very helpful on a severely limited site. The site might be limited by extreme terrain (steep slopes) by existing features or adjacent structures. A precise topo survey will ensure the designed improvement will fit on the site within those limitations.

A topographic survey is done by land surveyors on the surface of the land, usually with an instrument called a total station. Some surveyors now may also use a survey grade GPS unit to do this type of work.

Either way, this is somewhat manual work. A surveyor walks the entire site taking shots (horizontal location and elevation) at a specific interval in order to meet the project accuracy requirements.
The final product from a topographic survey is a map with all of the required features shown along with the contours representing elevations. An electronic map may also be supplied to an Engineer and/or Architect for their use in further design.

**Non-Surveying Work**

Non-surveying work is any work that does not fall into one of the above categories. Work such as scheduling and supervising personnel, vehicle maintenance, organizing equipment or job planning is considered non-surveying work. Some of your daily duties may include some of these tasks but these tasks should not constitute the majority of your workday.

# Engineering Experience Descriptions

**Research**

Research is most easily defined as **"**systematic investigation to establish facts or principles or to collect information on a subject." How does that apply to engineering? In essence, research in engineering is research to improve the practice of engineering – it gives engineers better ways to do their job.

Engineering research seeks to advance the practice of engineering by means such as:

- Discovery of new materials, theoretical models and processes which can enhance the performance, quality, efficiency, cost effectiveness and life of engineering systems
- Increasing the quality of models by which predictions are made, thereby improving process understanding
- Investigating and defining the properties of new or existing materials, systems, and resources so that their use can be more appropriate and reliable to the end-user
- Developing improved design methodologies so that the resultant outcome is more efficient or reliable, or poses less risk to its end-users
- Improving control and risk management frameworks around particular families of engineering problems

Major contributors to engineering research around the world include governments, private business, and academia. The results of engineering research can emerge in journal articles, at academic conferences, and in the form of new products on the market.

Military-related research into science and technology has led to "dual-use" applications, with the adaptation of weaponry, communications and other defense systems to civilian use. For example programmable digital computers and the Internet which connects them, the GPS satellite network, fiber-optic cable, radar and lasers were originally military-related research.

**Specifications**

A specification is very detailed set of requirements that must be met by a material, product, or service. In engineering, manufacturing, and business, it is vital for suppliers, purchasers, and users of materials, products, or services to understand and agree upon all requirements. A specification is a type of a standard that is often referenced by a contract or procurement document. It provides the necessary details about the specific requirements.

A specification might include:

- Descriptive title and scope of the specification

- Date of last effective revision and revision designation
- Person, office, or agency responsible for questions on the specification, updates, and deviations.
- The significance or importance of the specification and its intended use.
- Terminology and definitions to clarify the meanings of the specification
- Test methods for measuring all specified characteristics
- Material requirements: physical, mechanical, electrical, chemical, etc. Targets and tolerances.
- Performance requirements. Targets and tolerances.
- Drawings, photographs, or technical illustrations
- Workmanship
- Certifications required.
- Safety considerations and requirements
- Environmental considerations and requirements
- Quality requirements, Sampling (statistics), inspections, acceptance criteria
- Person, office, or agency responsible for enforcement of the specification.
- Completion and delivery.
- Provisions for rejection, reinspection, rehearing, corrective measures

**Engineering Report Writing**

Language, to an engineer, is a tool as important as a calculator or sophisticated software. Engineers are writers. On the job, they prepare reports, submit proposals, create guides and manuals, and distribute information in letters and emails. Engineers may spend as much as 60% of their working hours writing.

Each document written by an engineer is produced to achieve a specific purpose. Each document is targeted to a specific audience who plays an essential role in a project in progress. Engineers who are skilled at using language as a precision tool enhance their potential for successful careers. The final report of any project is not just a formality. It is a primary product of the effort and is often the basis for the evaluation of the reporter's professional abilities. The report is also a service to those in need of the information.

Requirements for style, purpose and organization can differ greatly; the format required for one report may not be appropriate for another. They have, however, certain characteristics in common. Once submitted, it should stand on its own. It tends to be circulated, reviewed, and filed. During this process it is subject to critical analysis by a variety of readers. Report writing is one of the primary professional responsibilities of the practicing engineer.

**Engineering Calculations**

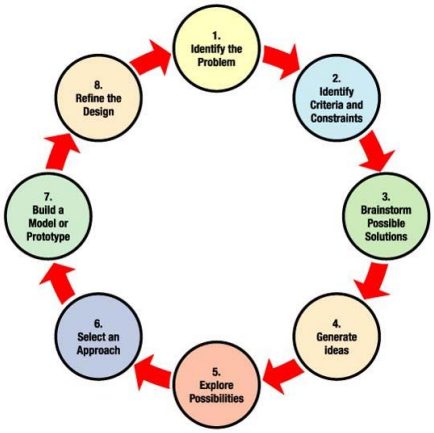
Calculating is the process of working out the answer to a mathematical problem, or a step in this process. Engineers and scientists make many calculations and estimates and base decisions on these calculated or estimated values. Often these skills are overlooked as trivial but are probably the most common source of errors even for experienced engineers. As an example, the rules determining the proper number of significant digits for a measured value are really not that difficult to follow. But if these rules are either not known or are forgotten then errors may be made. Even if these errors are small (i.e., one digit) the consequences may still be significant since most values are used for subsequent calculations. Another reason a single digit error may be important is that the one digit may mean additional costs to your company or a client.

**Engineering Design:**

Engineering Design can be defined as "The systematic and creative application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems." In basic terms, engineering design means to identify a problem or goal, come up with some ideas, and use math to make it work.

- The process to develop a design is called the "Engineering Design Process." The engineering design process is the set of steps that a designer takes to go from first, identifying a problem or need to, at the end, creating and developing a solution that solves the problem or meets the need.
- The steps of the engineering design process are to:
    - **Define the Problem**
    - **Identify Criteria and Constraints**
    - **Brainstorm Possible Solutions**
    - **Generate Ideas-**
    - **Explore Possibilities**
    - **Select an Approach**
    - **Build a Model or Prototype**
    - **Test and Redesign**

- During the engineering design process, designers frequently jump back and forth between steps. Going back to earlier steps is common. This way of working is called **iteration**, and it is likely that your process will do the same!




**Engineering Drafting:**

The process of producing engineering drawings, and the skill of producing them, is often referred to as **engineering drafting** or **drawing**. Engineering drafting is more than just the drawing of pictures. Engineering drafting communicates all needed information from the engineer who *designed* a part to the workers who will *make* it.

Engineering drafts may use technical standards that define practical symbols, perspectives, units of measurement, notation systems, visual styles, or layout conventions. These enable a drafter to communicate more concisely by using common symbols. The use of common symbols creates a visual language that helps to ensure the drawing is unambiguous and relatively easy to understand.

**Engineering Studies**

An engineering study is most commonly used to determine if a project will be successful. This type of study is called an engineering feasibility study.

An engineering feasibility study is an in-depth analysis of a potential engineering project that looks at the complete picture of the costs required to complete the project as well as the potential benefits of completion. When the engineering feasibility study indicates that the benefits are significant enough, the project moves forward to the final engineering and construction phases.

There are many components to a complete engineering and feasibility study, but generally all of them include eight essential elements: schematics, yield studies, comprehensive plan amendments, rezoning, special use permits, special exceptions, renderings, and environmental constraint analysis.

- **Schematics.** These detailed descriptions include everything about a project. For example, building schematics might include floor plans, furniture, budgets for equipment, energy efficiency plans, and even narrative descriptions of each space.
- **Yield studies.** These address the potential yield of a given resource.
  Comprehensive plan amendments. Amendments of this nature are necessary for projects that do not fit within the current plan for a city.
- **Rezoning.** This can be costly but is necessary when a project is planned for a location where the zoning is not appropriate for its use.
- **Special use permits.** These permits can be an alternative to rezoning and allow a property to be used for something other than the use for which it is zoned.
- **Special exceptions.** Similar to permits, these exceptions allow a project to be exempt from the rules that would normally apply.
- **Renderings.** Drawings of the project include facades, land use, landscaping, etc.
- **Environmental constraint analysis.** Addresses any environmental restrictions on the land or area affected by the project in question.

**Engineering/Material Testing:**

During the implementation of any engineering design, certain materials will be used to complete the project. These materials might include concrete, steel, specified soils, or plastics. There are millions of materials that may be specified in an engineering design. During the design phase, certain materials and their required qualities were included in the specifications.

When a material is purchased and brought into a project, it has to be tested to make sure it meets the requirements listed in the engineering design specifications. For example, concrete for foundations needs to be mixed to withstand certain amounts of ground movement, steel beams must be able to support a certain weight, or the soils of a construction site must be compacted to a certain density. All of these items need to be tested to make sure they conform to the design specifications.

Many materials have national design standards and they come from the manufacturer with a certification that the materials meet a certain standard. Other materials are tested in a laboratory.

**Engineering Evaluation/ Analysis/Modeling:**

“Evaluation” is to judge or determine the significance, worth, or quality of something.

“Analysis” is the process of breaking down something into its parts to learn what they do and how they relate to one another.

“Modeling” is the act of creating a standard or example for imitation or comparison.

Taken together, these terms are the foundation upon which good engineering design rests. Any project must be evaluated (judged) to make sure it is relevant, cost effective and worthwhile. Once an

evaluation is made, the project is broken down into its component parts to make sure there is a clear understanding of how everything works and fits together. Finally, a model or a representation is made, to show the construction or appearance of a completed project.

**Construction Observation/Monitoring/Review:**

After all of the detailed work and mathematic calculations you included in your engineering design, it is important that the project is actually completed as specified. This requires that an engineer physically go to the construction site and observe what is being done. During construction observation, you will make certain that all materials have been tested to make sure they comply with the specifications and ensure the project is being constructed in accordance with the design parameters.

**Teaching of Advanced Engineering Subjects**

Teaching at a university counts toward part of your engineering experience. The credit is only given if you are teaching 300 and 400 level courses. You will still need two years of non-teaching experience to qualify for the Principles and Practice of Engineering examination.

**QA/QC/Peer Review**

“Quality Assurance” refers to the engineering activities implemented in a system so that requirements for a product or service will be fulfilled. It is the systematic measurement, comparison with a standard, monitoring of processes and an associated feedback loop that prevents errors. “Quality Control” is focused on actual production of a product.

Two principles included in QA/QC are: "Fit for purpose", the product should be suitable for the intended purpose; and "Right first time", mistakes should be eliminated. QA/QC includes management of the quality of raw materials, assemblies, products and components, services related to production, and management, production and inspection processes.

“Peer Review” is the evaluation by an engineer of the work by one or more other engineers (peers). Peer review is done to maintain standards of quality and improve performance.

**Business Management**

As you progress in your career, you may become more involved with the management of your company. Business Management includes the activities associated with running a company, such as controlling, leading, monitoring, organizing, and planning. As a general rule, business management does not count towards fulfilling your experience requirements for registration.

**Project Management**

**Project management** is the discipline of planning, organizing, motivating, and controlling resources to achieve specific goals. The primary challenge of project management is to achieve all of the project goals and objectives while honoring constraints. The primary constraints are scope, time, quality and budget.

## Conclusion

Thanks for taking the time to read this information. I hope you found it helpful. Additional information is available on our web site and new information is posted often. If you have any questions at all, please contact the Board office. Again, congratulations on passing the Fundamentals examination. Good luck in your career.

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