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special
report

Engineering Aptitudes: There's An Engineer in You!

What does it take to be an engineer? The answer may be simpler than you think. Some basic aptitudes combined with interest and a willingness to work at it... and you're there.

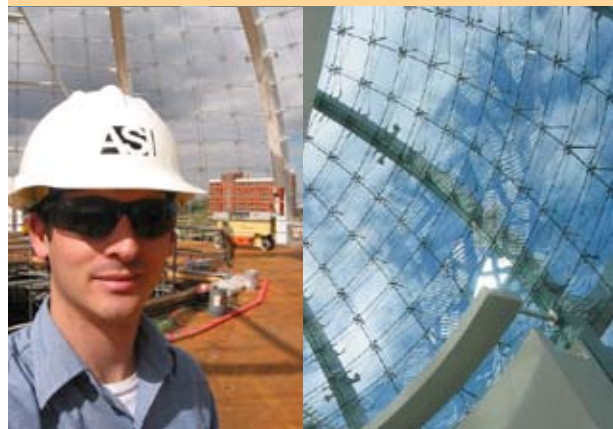
The Johnson O'Connor Research Foundation has conducted a number of studies on engineers going back as early as 1938. Engineering, like other fields, tends to attract people with similar aptitude patterns. People who enjoy engineering and are successful in it tend to share common traits. The dominant engineering aptitude is structural visualization - the ability to visualize 3D objects in your mind. Analytical reasoning, mathematical ability, and to a lesser extent, memory for design are the other aptitudes that correlate with satisfaction and success in engineering.

Structural Visualization— *Can you visualize 3D objects in your head?*

The aptitude that allows you to visualize 3D objects in your mind's eye is called structural visualization. Over the years, structural visualization has proven to be the most consistent aptitude found among engineers. Virtually all engineering specialties draw upon this core aptitude. People with structural visualization can envision how pieces of a 3D puzzle fit together or how something drawn as a blueprint will look when it's finished. Structural visualization is not in your hand's ability to fit the pieces together, but rather in your mind's ability to visualize objects from different perspectives, rotate them in your mind, and envision how the pieces fit together. Don't assume that you have structural visualization because you're good at making models though. You may find that, given good directions to follow, your manual dexterity is what you are using rather than structural visualization.

This aptitude also provides the ability to classify pieces and understand how they relate to the whole, which is useful in many engineering tasks. Johnson O'Connor uses two tests to assess structural visu-

This article reports findings from the Johnson O'Connor Research Foundation, a nonprofit scientific research and educational organization. Russell Burke, director of the foundation's Washington, D.C. office, provided much of the background and analytical content. The foundation has been studying aptitudes and testing individuals since 1922. Its goal is to study human abilities and to provide people with a knowledge of their aptitudes that will help them in making decisions about school and work. The foundation is the outgrowth of a testing program begun by Johnson O'Connor, an engineer with the General Electric Company. The program was so successful that the families and friends of the employees asked to be tested. In 1939, Mr. O'Connor incorporated as an independent, nonprofit scientific research and educational organization. Since Mr. O'Connor was himself an engineer, some of the foundation's earliest work focused on engineering aptitudes. For more information, please visit, www.jocrf.org.



Architectural Engineering—JETS Pre-Engineering Times, 12/05

alization. In the first test, subjects put together 3D blocks that have been jigsawed into wiggly-shaped pieces (hence, "Wiggly Blocks") to solve a puzzle. In the second test, subjects are shown a diagram of holes punched in a folded piece of paper and are asked to predict where the holes will be when the paper is opened. Of interest, Johnson O'Connor also notes that a high score in this aptitude correlates with a high score on the mathematics portion of the Scholastic Assessment Test (SAT).

Analytical Reasoning

Are you good at organizing information and at word problems?

This aptitude is all about understanding processes and how they work - a critical skill needed by engineers. Analytical reasoning allows individuals to organize concepts, arrange ideas in a logical sequence, and classify things. It also helps you organize information to solve word problems in math, set up a science experiment, and plan work.

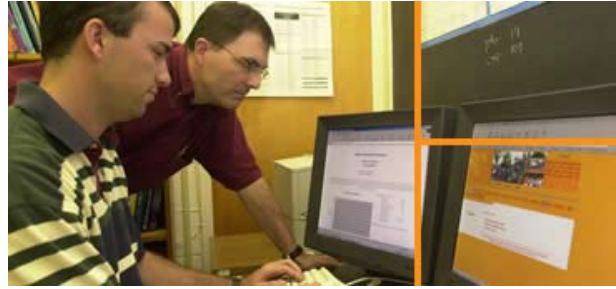
Memory for Design

Memory for design is helpful in architecture and the design aspects of engineering. Memory for design is tested by looking for 12 seconds at a collection of straight lines running at different angles - some running parallel and some connecting. The design is abstract, resembling no identifiable shape. On a sheet of paper, subjects then try to connect the dots to form the same design from memory. This aptitude is valuable in designing structures and other facilities or products such as engines, machinery, and equipment.

Mathematical Ability

Success in geometry, trigonometry, and calculus is a key to success in an engineering education. Some students who score low in math because of their inability to “do the math”—the computation portion of the task—get discouraged and think engineering is not for them. Because of the heavy dependence on computers, computational ability/speed is not as important to a working engineer as it used to be.

Today, engineers use computer models and other resources to do the actual number crunching. What’s critical is the ability to understand and apply the core math principles to engineering problems. Understanding the concepts behind the math and being able to set up the problems are actually more critical to success in the field. This ability depends more on **structural visualization and analytical reasoning** than the ability to perform the actual calculations. Students who don’t score as high in math may still find engineering a good career fit, they will just have to work harder in this area of academic study. Conversely, students who have good grades in math, but don’t have structural visualization and analytical reasoning, may be better suited to applying their math skills to fields such as financial analysis, economics, marketing research, social or physical sciences, or computer programming.



Software Engineering—[JETS Pre-Engineering Times, 05/06](#)

Even within the engineering field, there is a range of mathematical ability required for success. Software engineers as a group have the highest scores on mathematical tests, achieving particularly high scores on number series. Electrical engineers also tend to score higher in math. Number series tests ask subjects to find the pattern in a string of numbers in order to complete the sequence. This aptitude is useful to engineers in statistical analysis tasks.

Number memory, the ability to remember numbers, can be useful in certain fields of engineering. Electrical engineers and civil engineers tend to test high in number memory. Most other fields of engineering show no real difference in this test from the general

population, with one-third scoring below average.

In one study of a group of engineers, half of the group tested in the top 25 percent for math aptitude. Two-thirds of the group tested in the top half.



Civil Engineering—[JETS Pre-Engineering Times, 02/06](#)

For insight into your current level of readiness for the mathematical and other analytical components of an engineering program consider taking the JETS Assess academic survey. This self-administered evaluation enables students to determine their current level of preparation in engineering basic skills subjects—applied mathematics, science, and reasoning. For more information on JETS Assess, [click here](#).

Other Aptitudes to Consider

To date, Johnson O'Connor has identified more than two dozen aptitudes. Here are a few additional aptitudes that may be worth taking into account when considering a career in engineering.

- **Clerical Skills.** Electrical engineers tested much higher in visual perception/clerical skills than engineers as a whole. It may be an advantage in the proofreading and computation they have to do.
- **Auditory aptitudes.** Aptitudes such as pitch discrimination are valuable for sound or acoustic engineering.
- **Observation,** the ability to spot and remember details, small changes, or irregularities, can be valuable in engineering. Civil engineers tend to test high in observation.

What's an aptitude?

Courtesy of the Johnson O'Connor Web site.

Aptitudes are natural talents, special abilities for doing, or learning to do, certain kinds of things. Manual dexterity, musical ability, structural visualization, and memory for numbers are examples of such aptitudes. In a comprehensive battery of proprietary tests the foundation measures these and many other aptitudes. These measured traits are highly stable over long-term periods.

Every occupation—whether it is engineering, medicine, law, or management—uses certain aptitudes. The work you are most likely to enjoy and be successful in is work that uses your aptitudes. For example, if you are an engineer but possess aptitudes not used in engineering, your work might seem unrewarding. If you lack the engineering aptitudes, your work may be difficult or unpleasant.

Aptitude testing is one tool for career selection. It can help you find where your aptitudes lie, what type of work uses those aptitudes, and why certain occupations may be more rewarding for you than others.

For more information about Johnson O'Connor and aptitude testing, visit their web site at www.jocrf.org.

- **Idea Flow.** Some people are full of ideas, thoughts, plans, and projects. This aptitude, called ideaphoria, is valuable in such fields as sales, advertising, journalism, and teaching. Engineering, on the other hand, demands concentration—the ability to do complicated tasks without being distracted. This doesn't mean that engineers aren't creative; however, a constant flow of ideas may be distracting. People with structural visualization who

have a high idea flow may find a better fit in engineering sales, writing about engineering topics, marketing to engineers, or teaching engineering.

TEAM+S The JETS TEAMS competition can provide experience in solving problems in teams. For more information on the JETS TEAMS competition, [click here](#).

Do you prefer work of an individual nature or working as part of a team?

Engineering has shifted from a profession of individuals working independently to one requiring teams of individuals with special expertise working together on complex tasks. Just think of the movie "Apollo 13" and Gene Kranz' engineering team who had to create an air filter out of random items already in the module and determine which systems to shut down and in which order to have enough power left to return the module safely to earth. Today most engineering projects are so complicated that they require specialists from multiple disciplines to achieve the desired result.

The Johnson O'Connor test for this attribute determines if a person has an objective or subjective personality. Subjective personalities are

What if?

What if you don't have structural visualization? While Johnson O'Connor studies clearly show that this is the most important aptitude for engineering, like many fields today, engineering has become so broad that there are areas where structural visualization may not be essential. One successful environmental engineer, who tested high in clerical ability (graphoria) and low in structural visualization, went to work for a regulatory agency. Here his efficiency and skill at paperwork combined with his engineering knowledge provided for success. Another example of an engineer without the need for structural visualization is a software engineer manning a help desk. Structural visualization isn't required here either.

What if you have high structural visualization and low clerical skills? This combination is typically seen in the mechanical whiz that has difficulty in school. Clerical ability is measured by rapidly checking columns of figures, indicating the speed of eye movements and eye focusing. It measures visual perceptual speed. A strong aptitude in this area leads to clerical efficiency and is the most important aptitude for professions like accounting. Because schooling requires a large amount of paperwork, students with low clerical ability are at a disadvantage. However, if they knuckle down and persevere through the formal education, they will find they are over the hurdle and may function very well in the engineering field. Students with low graphoria will find they do better in schools with small classroom sizes and a higher ratio of boys to girls. Since girls average higher in clerical aptitude than boys, attending a school with a high ratio of boys to girls would also be advantageous for the low graphoria student.

Other Clues...

Taking the time to think about things you love to do most will provide important clues about the best career fit for you. You may find that while you enjoy lots of different activities, many utilize the same underlying aptitudes. Ask yourself what is it about the activities you enjoy that make them interesting or fun for you. For example, if you like drawing things in 3D or building structures, an underlying commonality is structural visualization. If you like solving puzzles, or organizing collections of things, this may indicate analytical reasoning.

Interests vs. Aptitudes

Just because you have strong structural visualization doesn't necessarily mean you have to be an engineer. What's most important is using your aptitudes in a career that will be satisfying for you. If you'd rather spend time on a guitar, look to see if you have aptitudes that support a career in music and see if that works for you.

The Bottom Line—Aptitudes vs. Knowledge

During the past 80 years, Johnson O'Connor has learned a great deal about aptitudes. In addition to knowledge of what specific aptitudes are and patterns of aptitudes and the careers they best fit, the foundation has learned that having aptitudes alone can never make you successful. Only knowledge coupled with aptitudes can lead to career success. Perhaps even more importantly, they have learned that idle aptitudes cause more trouble than ones you lack. Put another way, finding yourself in a career that does not utilize the aptitudes you have may



Ocean Engineering—JETS Pre-Engineering Times, 04/06

make that career choice unsatisfying for you. The idle aptitudes may distract from your ability to do the job or be satisfied in that line of work. People often find an outlet for aptitudes not used in their work in hobbies. One of the most difficult challenges is for people who have more aptitudes than any single kind of work can provide. These people often wind up jumping from job to job in search of satisfaction. One way to handle this dilemma is to work for a small company where you will have to "wear many hats" or dedicate yourself to a cause which requires you to work on many aspects of an issue.



Manufacturing Engineering—[JETS Pre-Engineering Times, 09/06](#)

If you choose a field that uses the aptitudes you have but also seems to call for others you don't have, you might have to work harder to compensate for the missing or lower aptitudes, but may find it worth the effort because the activities that challenge the aptitudes you do have are so rewarding.

Designing Computer Games

Think designing computer games is all about fun? Guess again. Designing computer games requires complicated mathematical algorithms to make them work. It's a lot like playing a mental game of 3D chess. Computer game designers share with electrical engineers and software engineers a use of number memory, computational speed, and number series.

Are you a Scientist or Engineer?

One brother always liked taking things apart. He wanted to understand what made them work. The other brother liked putting them back together. He wanted to see if he could make them work better. The first brother is an example of a true scientist - engaged in basic research about what makes things tick. The second brother exemplifies the engineer. His tinkering is aimed at finding better ways to do things. Both science and engineering are important. Which are you?

Keep in mind that career success is built on finding the right field based on your pattern of aptitudes, then adding specific knowledge. To be successful in your chosen field requires building your knowledge base in that field. To rise to the top of your company or profession requires one more thing - general knowledge. This manifests itself in the extent of your vocabulary. A large vocabulary not only enhances your ability to communicate clearly and precisely, it expands your understanding of the world by adding concepts represented by the new words. Johnson O'Connor has found a direct correlation between vocabulary and how far an individual rises within an organization. Presidents of companies score among the highest in vocabulary of those who have been tested.

For maximum career success, choose a career that fits your aptitude pattern and your interests, get the best education you can to build your knowledge base, and supplement this specialized knowledge with general knowledge and a strong English vocabulary.

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