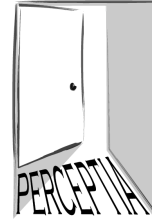# Perceptia Press

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The Technical Matrix

Robert W. Long III

Brian Cullen

Sample

Notice of liability

About the authors

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Brian Cullen is an associate professor at Nagoya Institute of Technology. He teaches courses on scientific English, CALL, culture, and sound media. He has written many textbooks and released a number of music CDs. His homepage is: www.briancullen.net.

Acknowledgments

Visit the website for more.

Foreword

The Technical Matrix is a textbook for engineering students who are studying English and want to learn some basic terms and ideas that are related to mechanical, chemical and civil engineering. The technical English that is presented is mostly based on material in Wikipedia, an Internet encyclopedia. Each chapter presents real-world information in the form of dialogues, readings or email exchanges. These are followed by comprehension tasks to help the students to understand the material and language tasks to enable them use the language in their own writing and speaking. The Technical Matrix provides ample material for one university semester or the activities can easily be adapted to suit a one year course. There are also additional materials available on the Perceptia Press website. These resources are indicated throughout the textbook with the icon *Visit the website for more*.

www.perceptiapress.com

Contents - Topics

Sample

Student engineering word list

This list contains 100 of the most frequently used words in engineering texts as determined by Olga Moudraia of Lancaster University. These words can be used in many different ways, so be sure to look for example sentences in your dictionary and texts. Ten of these words are targeted in each unit of this textbook.

1. act/ react
2. air / aero-
3. all
4. also
5. angle
6. apply
7. area
8. assume
9. axis
10. base / basic
11. beam
12. body
13. calculate
14. case
15. center
16. change
17. chapter
18. component
19. consider
20. constant
21. cut
22. define
23. design
24. determine
25. diameter
26. different
27. dimension
28. direction
29. draw
30. element
31. end
32. energy
33. equation
34. equilibrium
35. example
36. expression
37. figure / configure
38. find
39. flow
40. fluid
41. follow
42. force
43. form
44. free
45. friction
46. give
47. high
48. know
49. length / long
50. line
51. load
52. low
53. machine
54. make
55. mass
56. material
57. maximum
58. metal
59. method
60. moment
61. move / remove
62. number
63. obtain
64. other / another
65. part
66. pipe
67. placement
68. plane
69. point
70. position
71. pressure
72. problem
73. process
74. produce
75. put
76. require
77. result
78. rotate
79. section
80. shear
81. show
82. solution
83. state
84. steel
85. stress
86. structure
87. surface
88. system
89. temperature
90. time
91. type
92. unit
93. use
94. value
95. vary
96. velocity
97. view
98. water
99. work
100. write

Explaining your studies

Chemical engineering p. 10	Corrosion
Network engineering p. 11	Local area networks
Mechanical engineering p. 12	Fluid mechanics
Civil engineering p. 13	Structural analysis
Electrical engineering p. 14	Electrical resistance

Self-introduction and background
1. What is your name, and what branch of engineering are you studying?
2. How did you become interested in this area?
3. What are some common topics that you have to know in this area of engineering?

Specific questions
4. What particular things are you learning now?
5. What is your most interesting subject?
6. What kinds of classes are you now taking?
7. Which class will be the most difficult?

Today's readings
8. What do you know about the reading topic (choose the topic for your specialization on pages 10-14)?
9. Do you think this topic is fairly important?
10. What do you think is the most important topic in your field now?

Other fields of engineering
11. How much do you know about chemical engineering?
12. Have you read much about civil or electrical engineering?
13. Which branch of engineering do you think is the most difficult?
14. Have you talked to any engineers who are now working? What have they told you?

Here's a useful tip—If you don't know much about the topic of a reading in this textbook, you can look it up in your own language on Wikipedia or another website. That will help you to understand the English much better.

Explaining your studies

There are many types of engineering. See how many you can add to this list:

Civil engineering   Mechanical engineering   Electronic engineering

....
....
....
....
....

Any of these types of engineering can be sub-divided further. It is important to know of the many sub-disciplines in your field of engineering, and of the many areas and interests that are in each sub-discipline. Ask your professors, or use the Internet to find out about your own area of engineering. Fill in as much information as you can.

My branch of engineering: ....

Sub-discipline	Topics of interest

Visit the website for more.

Useful language: Definitions

We use definitions frequently in science and engineering. Why do we do this? In everyday speech, it is not important if two people do not use a word to mean exactly the same thing. But in engineering, it can be a huge problem.

Here are some examples of definitions of engineers.
- A civil engineer is a person who designs or supervises construction projects such as roads or dams.
- A chemical engineer is a person who applies the principles of chemistry to solve problems in areas such as manufacturing products and regulating water supply.

Write more definitions for different kinds of engineer.

....

....

....

Definitions: Define your subjects

Here are some definitions of subjects studied in engineering schools.
- <u>Fluid mechanics</u> is the study of the movement of fluids. One application of fluid mechanics is in controlling the flow of liquid in pumps and refrigerators.
- <u>Materials Science</u> is based on the physics and chemistry of the solid state and includes all aspects of engineering materials, including metals and their alloys, ceramic materials such as glasses, bricks, and porcelain insulators, polymers such as plastics and rubbers together with semiconducting and composite material. Material science is important because it helps us to design stronger and safer materials.

Define your subjects using similar language.

....

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....

Presentation: Explaining your studies

When you make a presentation, organizing your ideas is very important. Choose one engineering subject that you are studying now or have studied in the past. Then write four sentences about this. Every presentation usually follows a standard format. You need a beginning, a middle, and an end.

Beginning

Good morning everyone. Today I would like to talk about ....
....

Middle

.... really interests me because ....
In this subject, we learn about ....
.... These are important because ....
....
....

End

Thank you. Do you have any questions?

Make your presentation to the members of your class or group.

Useful Language
My favorite subject is... because...
I really respect Professor... because...
In the future, I would like to...

1 >> CORROSION

Specialized vocabulary

Check that you understand the following words and phrases which appear in the text.

applied coating	crystallites	exposure	pit
bacteria	deterioration	fundamental nature	polymer
boundary	discoloration	intrinsic properties	reaction
chemoautotrophs	dissolution	microorganism	substance
crack	electrochemical	oxidation	ultraviolet light

Dialogue 1: Definition

Sam: Excuse me, professor. Could you help me out for a minute?

Technician: Sure. Ah, I see you're working on Professor Suzuki's lecture on corrosion. It's difficult!

Sam: Yes, there are some parts I don't understand. To begin with, how would you define *corrosion*?

Technician: Corrosion is the deterioration of intrinsic properties in a material due to reactions with its environment.

Sam: Could you give an example?

Technician: Sure. One common example of electrochemical corrosion is the weakening of steel due to oxidation of the iron atoms. This type of damage usually affects metallic materials, and typically produces oxides or salts of the original metal.

Sam: What does "deterioration of intrinsic properties" mean?

Technician: It means a weakening of the properties within the material or metal. Corrosion also includes the dissolution of ceramic materials and discoloration and weakening of polymers by the sun's ultraviolet light.

Sam: In the lecture, the professor said that most alloys corrode merely from exposure to moisture in the air.

Technician: Well that's true, but the process can also be strongly affected by exposure to certain substances.

Sam: Does corrosion usually affect the entire surface of a metal?

Technician: It can be concentrated locally to form a pit or crack, or it can extend across a wide area to produce general deterioration.

Dialogue 2: Kinds of corrosion

Sam: Could you explain intergranular corrosion?

Technician: Intergranular corrosion or IGC is where the boundaries of crystallites of a material are more susceptible to corrosion than their insides. In contrast, pitting corrosion, or pitting, is extremely localized corrosion that leads to small holes in the metal.

Sam: Are there any other kinds of important corrosion that I should know about?

Technician: Another kind is called microbial or bacterial corrosion. This is caused by microorganisms and can affect both metals and non-metallic materials.

Dialogue 3: Resistance to corrosion

Sam: Thanks. That's very helpful. One last thing.

Technician: Sure. I'm happy to help out.

Sam: With regard to corrosion, are there differences between metals?

Technician: Of course! Some metals are more resistant to corrosion than others, either due to the fundamental nature of the electrochemical processes involved or how a particular effect could form on that material.

Sam: Are there any ways to stop corrosion?

Technician: Yes. The most common anti-corrosion treatments are applied coatings such as plating, painting, and applying enamel. These work by providing a barrier of corrosion-resistant material between the damaging environment and the structural material.

1 >> LOCAL AREA NETWORKS

Specialized vocabulary

Check that you understand the following words and phrases which appear in the text.

analog	diverse	leased lines	spontaneous
concept	gathering	local area	switched Ethernet
confusion	implementation	network protocol	temporary
data rates	incompatible	proliferation	to standardize
defining characteristics	LAN	resources	wi-fi

Dialogue 1: What is a LAN?

Professor: Alright Paul, let's see how much you remember from the lectures. Do you know what a LAN is?

Paul: Oh yes... it's a local area network. In other words, it is a computer network covering a small local area, like a home, office, or small group of buildings such as a university. Most current LANs are based on switched Ethernet or Wi-Fi technology running at 10,000 Mbit/s or 1 gigabit per second.

Professor: That's good. What are the defining characteristics of a LAN?

Paul: Well, LANs are often contrasted to WANs. The defining characteristics of LANs are: (a) much higher data rates, (b) smaller geographic range—at most a few kilometers—and (c) they don't use leased telecommunication lines. A LAN usually does not refer to data running over local analog telephone lines, as on a private branch exchange (PBX).

Professor: Are there any significant problems with LANs?

Paul: Well, although it sounds great in theory, in reality, the concept of LANs was harmed by the large number of incompatible network protocols. This led to confusion over how to best share resources.

Professor: Oh yes indeed, there has been terrible confusion! Each vendor seems to have their own type of network card, cabling, protocol, and network operating system.

Paul: Yes, it's a bit of a mess. I hope some proper standards emerge eventually.

Dialogue 2: LAN party

Professor: Here's another question, Paul. What is a LAN party?

Paul: It's a temporary, sometimes spontaneous gathering of people together with their computers. They can be of various sizes, from as small as two people way up to over 5,000 people. Small parties can form spontaneously, but large ones usually require planning and preparation by an organizing team.

Professor: So, that's what they would use at Internet cafes?

Paul: No, but the term *LAN party* is sometimes incorrectly applied to game centers and Internet cafes. Some people say that LAN parties have become somewhat of a tool for corporations such as Bawls and Alienware to sell or demonstrate their products.

Professor: I'm not sure about that, but you certainly remember your stuff!

Dialogue 3: The ethernet

Professor: One final question, Paul. What is meant by the term *ethernet*?

Paul: This refers to a family of frame-based computer networking technologies for local area networks. The name comes from the physical concept of *ether* which was widely used in the 19th century. It defines a number of standards for the physical layer, two means of network access at the Media Access Control (MAC) layer, and a common addressing format.

Professor: Has the ethernet been standardized?

Paul: It has been standardized as IEEEs 802.3 which means the Institute of Electrical and Electronics Engineers or IEEE (pronounced as eye-triple-e).

1 >> FLUID MECHANICS

Specialized vocabulary
Check that you understand the following words and phrases which appear in the text.

application	fluids	moment	shear stress
deformation	gas	Newtonian fluid	static equilibrium
density	ideal fluid	petroleum	subdiscipline
derivative	internal resistance	pipeline	velocity
empirical	isotropic	plasticity	viscosity
to establish	liquid	rheology	weather patterns

Dialogue 1: Static pressure in fluids
Sarah: Excuse me, how would you define fluid mechanics?
Professor: It is the subdiscipline of continuum mechanics that studies fluids, that is, liquids and gases.
Sarah: How is it different from usual mechanics?
Professor: Well, due to an inability to resist deformation, fluids exert pressure normal to any contacting surface. Also, when the fluid is at rest or static, the pressure is isotropic—it acts with equal magnitude in all directions.

Dialogue 2: Fluid dynamics
Sarah: Right, I understand the basic idea now, but what are the primary uses of fluid dynamics?
Professor: It has a wide range of applications, including calculating forces and moments on aircraft, determining the mass flow rate of petroleum through pipelines, and predicting weather patterns. The mathematical structure of fluid dynamics underlies these practical disciplines, and embraces empirical and semi-empirical laws.
Sarah: What is involved in that mathematical structure?
Professor: Solving a fluid dynamics problem typically involves calculating various properties of the fluid, such as velocity, pressure, density, and temperature, as functions of space and time.

Dialogue 3: Rheology
Sarah: Right, I understand so far. Could you help me by defining *rheology*?
Professor: Rheology is the study of the deformation and flow of matter under the influence of an applied stress.
Sarah: What is it used for?
Professor: One of the tasks of rheology is to empirically establish the relationships between deformations and stresses. It unites the seemingly unrelated fields of plasticity and non-Newtonian fluids by recognizing that both these types of materials are unable to support a shear stress in static equilibrium.

Dialogue 4: Viscosity
Sarah: One more question... what is *viscosity*?
Professor: Viscosity is a measure of the resistance of a fluid to deform under shear stress. It is commonly perceived as *thickness*, or resistance to pouring. Viscosity describes a fluid's internal resistance to flow and may be thought of as a measure of fluid friction.
Sarah: So, what is an ideal fluid? I thought they were fluids that had zero viscosity.
Professor: All real fluids, except superfluids, have some resistance to shear stress, but a fluid with no resistance to shear stress is known as an ideal fluid.

1 >> STRUCTURAL ANALYSIS

Specialized vocabulary

Check that you understand the following words and phrases which appear in the text.

algebra	to derive	geometry	stiffness
assembly	differential equation	internal force	stress
cantilever	elasticity	linear	structural analysis
component	evaluation	methods of analysis	structural load
deflection	finite element	node	support conditions
deformation	flexibility	portal frame	truss

Dialogue 1: Structural analysis

Professor: Okay, Larry, let's see how much you remember. What is meant by structural analysis?

Larry: Structural analysis is the computation of deformations, deflections, and internal forces or stresses within structures, either for design or for performance evaluation of existing structures.

Professor: Good answer! But what kind of data needs to be gathered to carry out a structural analysis?

Larry: Structural analysis needs data such as structural loads, the structure's geometry and support conditions, and the materials' properties.

Dialogue 2: Methods of analysis

Professor: Now, let's move on to methods of analysis. Can you tell me about this area?

Larry: The method of mechanics of materials is limited to very simple structural elements under relatively simple loading conditions.

Professor: So, in conjunction with the methods of analysis, what field would you use to analyze entire systems?

Larry: It can be used in conjunction with statics for joints for truss analysis, moment distribution for small rigid frames, and portal frame and cantilever method for large rigid frames.

Dialogue 3: Finite element methods

Professor: Can you explain finite element methods?

Larry: They model a structure as an assembly of elements or components connected in various ways. Thus, a continuous system such as a plate or shell is modeled as a discrete system with a finite number of elements interconnected at a finite number of nodes.

Professor: Then, how can we establish an element's stiffness or flexibility relation?

Larry: To do this, we can use the elasticity approach for more complex two- and three-dimensional elements. The analytical and computational development are best carried out by matrix algebra.

Dialogue 4: Elasticity methods

Professor: I need you to tell me more about elasticity methods. What do you know?

Larry: They are generally available for an elastic solid of any shape. The solutions are derived from the equations of linear elasticity, a system of 15 partial differential equations.

Professor: Good work.

1 >> ELECTRICAL RESISTANCE

Specialized vocabulary

Check that you understand the following words and phrases which appear in the text.

circuit	electric current	lattice	slope resistance
cross-sectional area	electrical resistance	ohm	thermal motion
degree	electron	potential difference	to oppose
drift	equivalent	resistor	voltage

Email message 1: What is electrical resistance?

From: dave@dotea.com Subject: Question about Electrical Resistance Date: Tue, 25 Feb 16:13 To: jroland@beaujois.com	Hey John, I was doing a report for Dr. Franken about electrical resistance, and I realized that I know almost nothing about it. Can you help? --Dave
From: jroland@beaujois.com Subject: Re: Question about Electrical Resistance Date: Tue, 25 Feb 16:33 To: dave@dotea.com	Sure Dave, Electrical resistance is a measure of the degree to which an object opposes the passage of an electric current. The SI unit is the ohm. Its reciprocal quantity is electrical conductance measured in siemens. Also, John, it is really important to know that the quantity of resistance in an electric circuit determines the amount of current flowing in the circuit for any given voltage applied. In other words, R equals V over I, where R is the resistance of the object in ohms, V is the potential difference across the object in volts, and I is the current passing through the object in amperes. --John

Email message 2: Resistance in metals

From: dave@dotea.com Subject: Resistance in metals Date: Tue, 25 Feb 16:50 To: jroland@beaujois.com	John, Could you tell me a little about electrical resistance in metals? I'm not sure how the electrons affect it. --Dave
From: jroland@beaujois.com Subject: Re: Resistance in metals Date: Tue, 25 Feb 18:43 To: dave@dotea.com	Dave, A metal consists of a lattice of atoms, each with a shell of electrons. When a voltage is applied across it, electrons drift from one end of the conductor to the other under the influence of the electric field. --John
From: dave@dotea.com Subject: Thermal motion Date: Tue, 25 Feb 19:53 To: jroland@beaujois.com	John, But what about the thermal motion of ions? Is that important, too? --Dave
From: jroland@beaujois.com Subject: Re: Thermal motion Date: Tue, 25 Feb 21:09 To: dave@dotea.com	Dave In a metal, the thermal motion of ions is the primary source of scattering of electrons, and therefore it is the prime cause of metal resistance. The larger the cross-sectional area of the conductor, the more electrons are available to carry the current, so the lower the resistance. --John

Email message 3: Differential resistance

From: dave@dotea.com Subject: Differential resistance Date: Wed, 26 Feb 10:17 To: jroland@beaujois.com	John, You said that while resistance may depend on voltage and current, differential resistance, incremental resistance or slope resistance is defined as the slope of the V-I graph at a particular point, thus: R = dV/dI. Correct? --Dave
From: jroland@beaujois.com Subject: Re: Differential resistance Date: Wed, 26 Feb 12:42 To: dave@dotea.com	Dave, Yes, that is correct. This quantity is sometimes called simply resistance, although the two definitions are equivalent only for an ohmic component such as an ideal resistor. --John

Reading tasks

1. Based on your reading, answer the questions in the table.

	Questions	Expressions
Chemical engineering	1. What is IGC? 2. What does pitting corrosion cause? 3. What can be applied to a material to reduce corrosion? 4. What causes microbial or bacterial corrosion? 5. Why do metals differ in their resistance to corrosion?	● I see you're working on... ● One common example of... ● With regard to...
Network engineering	1. Where are you likely to find LAN systems? 2. How big is a LAN party? 3. Are LAN parties permanent? 4. What is the standard for ethernet? 5. Define *ethernet*.	● ... defining characteristics... ● In reality,... ● ... come in various sizes...
Mechanical engineering	1. What are some of the applications of fluid mechanics? 2. What is one of the tasks of rheology? 3. What is involved in the solution of a fluid dynamics problem? 4. How do fluids exert pressure? 5. What is rheology?	● One of the tasks of... ● ... under the influence of... ● ... is commonly perceived as...
Civil engineering	1. What is structural analysis? 2. How is the method of mechanics of materials limited? 3. What does the finite element model do? 4. What kind of input data does structural analysis need? 5. What are the equations of linear elasticity?	● To do this,... ● In conjunction with... ● ... are derived from...
Electrical engineering	1. What happens when a voltage is applied across the metal? 2. What is the SI unit of electrical resistance? 3. For any given voltage, what does the quantity of resistance determine? 4. What does a metal consist of? 5. What is the main reason for the scattering of electrons?	● ... is a measure of... ● ... I realized that... ● It is very important to know...

2. Write two of your own questions based on the information in the text. Test your classmates.

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....

3. Find and underline the expressions in the readings. Use each expression in your own original sentence.

Digging deeper

Look back at the readings and write two questions that you would like the text to have answered.

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Ask your classmates if they know the answers. Search the Internet if necessary.

Visit the website for more.

Explaining your topic

In your notebook, make notes or a mindmap to represent the important information in the reading. If possible, find someone who is studying a different engineering major. Take turns using your mindmaps to explain what you learned in the reading. Make notes below on what you learned from your partner.

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Discuss with a partner:

- Was this topic interesting?
- How much of this information did you already know?
- Do you think this topic is important? Why or why not?

Talking points

Research one of these topics on the Internet. Make notes and then talk about it for two minutes.

Chemical engineering	1. Thermodynamics	2. Chemical synthesis	
	3. Oxidations	4. Reactive distillation	
	5. Reductions	6. Thermochemicals	
	7. Alkylations	8. Other:	
Network engineering	1. Automata theory	2. Distributed computing	
	3. Computability theory	4. Parallel computing	
	5. Computational complexity theory	6. Network security	
	7. Compilers	8. Signal Processing	
Mechanical engineering	1. Mechanics	2. Structural failure analysis	
	3. Kinematics	4. Thermodynamics	
	5. Drafting	6. Heat transfer	
	7. Energy conversion	8. Nanotechnology	
Civil engineering	1. Structural analysis	2. Forensic engineering	
	3. Structural design	4. Seismic engineering	
	5. Hydrologic design	6. Geodetic surveying	
	7. Regression and correlation analyses	8. Other:	
Electrical engineering	1. Electrical field	2. Electrical potential	
	3. Electrical charge	4. Electrical current	
	5. Electrical energy	6. Electrical power	
	7. Electrical potential	8. Other:	

Common engineering vocabulary

Find examples of sentences using these words in a dictionary, a scientific paper, or on the Internet.

beam	body	to calculate	case	center
change	chapter	component	to consider	constant

UNIT >> 2

Companies in the field

Chemical engineering p. 20	Bonding
Network engineering p. 21	Peer-to-peer networking
Mechanical engineering p. 22	Mechatronics
Civil engineering p. 23	Seismic engineering
Electrical engineering p. 24	Electrostatics

Sample

Knowledge about engineering companies
1. What are some famous companies in your area of engineering?
2. Do these companies have branches overseas, too?
3. What kind of work do they do?
4. Have you ever looked at the websites of engineering companies?
5. Is it better to work for a small company or a large corporation?

Questions about the last unit's and today's readings
6. What did you learn about in the last unit of this textbook?
7. What do you know about the topic of the reading in this unit? (Choose your specialization from pages 20-24)
8. Do you think this topic is important?

Setting up a company
9. Do you know anyone who has started their own company?
10. Would you like to set up your own company?
11. If you set up a company, what would it do?