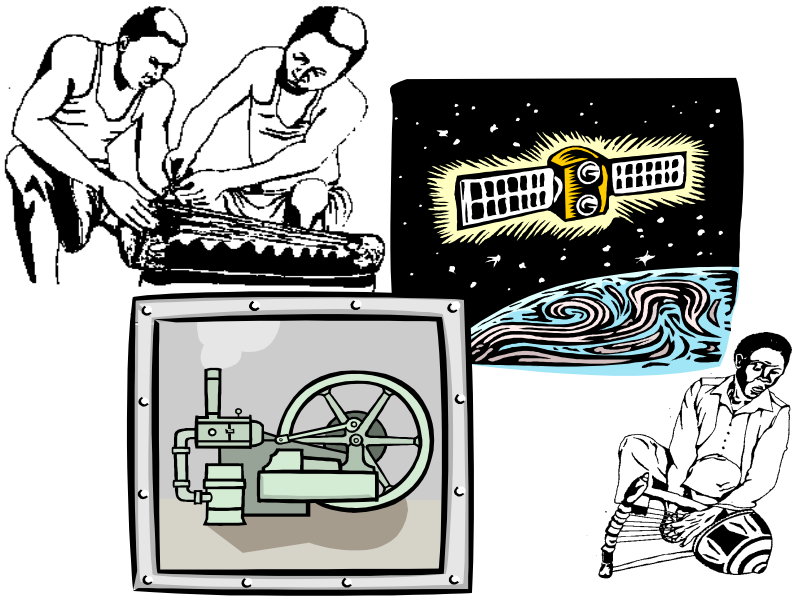
Unit 1

What is technology?

Module 1
Technological systems

Instructor guide



Activity objective

The purpose of this activity is to help students begin to understand the nature of technology and its systems.

Module instructions

Introduction

All technology involves systems. Systems take a variety of inputs and process them in some way, usually by an interaction of subsystems, and then they generate a set of outputs • some of which are desired and some of which are unwanted by-products. All of this occurs within a context or environment. At various points during the process • and at the end of the process • effective systems use feedback and assessment systems to generate information about how well the purpose for which the system was designed is being achieved.

Key content highlights

What is technology? Simply put, technology is the extension of our human capability, in order to satisfy our needs or wants.

Technology involves systems, sometimes very simple ones, and at other times very complex ones, and everything else in between.

Systems are human-developed organizations of subsystems and/or components that interact to achieve a goal. Systems use feedback to better achieve their goal(s).

Systems are hierarchical. They exist in the context of supra-systems which can also be considered to form the system environment.

Systems consist of subsystems and/or components that work together to achieve the system's goal.

Materials required

Supplies
Graph paper, pencils.

Equipment
None.

Instructional resources
Any technology textbook available, such as: J. Gradwell and M. Welch, *Technology: Shaping our World*, South Holland, Ill., Goodheart-Willcox, 1991; also examples of technological systems found in the school or neighbourhood.

Management / Logistics

Related Instructional units:
Technology Activity Module (TAM) 2: 'Technology Resources and Constraints'

Evaluation / Grading
Assess the thoroughness with which students identify all the essential aspects of the system (as given in the instructor's lesson) and their ability to identify examples of technology, both simple and complex • and in particular indigenous examples from the students' daily life.

Suggested schedule / Time
One class period for the instructor lesson followed by two periods of student practice and discussion in identifying and analysing technological systems. Allow students a day for a homework assignment in identifying technological systems from their home life.

Key instructional suggestions

Safety
When observing real systems, students should wear appropriate clothes, protection and maintain a safe distance.

Motivation
Help students understand the importance of technology and systems in terms of their enhanced ability to understand the world around them, and perhaps even for employment, comfort and recreation. This lesson will enhance the students' ability to learn unfamiliar technology and apply it to their lives.

Prerequisite information
None.

Demonstrations
Identify examples of technology in the students' experience.
Identify and analyse examples of systems in the students' experience.
Analyse a cooking stove and an automobile as examples of a system.

Attitudes
Importance of being thorough (not overlooking something).
Importance of being neat when sketching.

Summary and review
Technology extends human capability. Technology is used to serve human needs or wants. All technologies involve systems. Systems are developed to address a goal and consist of subsystems that work together. Feedback is used to control a system. Systems operate in environments.

Glossary

Component	A part of a larger system, often considered to be a part of a subsystem.
Environment	The context that houses a system. Also called the supra-system.
Feedback	Some information, signal or measure that tells a person, system or subsystem how well the goal is being achieved, or how well the process is working.
Goal	The reason for which the system or process was developed. The desired result.
Hierarchy	A relationship based on something. For example, size: a supra-system consists of one or more systems. Each of these systems consists of one or more subsystems. Each of these subsystems contain one or more components, etc.
Inputs	Resources available to the system or subsystem.
Outputs	Products or forces that are generated by systems or subsystems.
Resources	Any energy, material, information or person available to a system or subsystem.
Subsystem	A smaller system that acts as a component of a larger system.
Supra-system	The larger system or environment that houses a specific system.
System	Human developed organizations of subsystems and/or components that interact to achieve a goal.
Technology	Technology is the extension of our human capability in order to satisfy our needs or wants.

Date: _____ **Class:** _____ **Name:** _____

Technology Activity Module 1
Technological systems

Post-test

Instructions: *Work by yourself, and without using any notes, books or help, answer each question carefully*.

Sketch a diagram that shows at least five of the major systems of an automobile engine.

Using your own words, define the following terms as in your instructor's lesson:

Technology _____

System _____

Environment _____

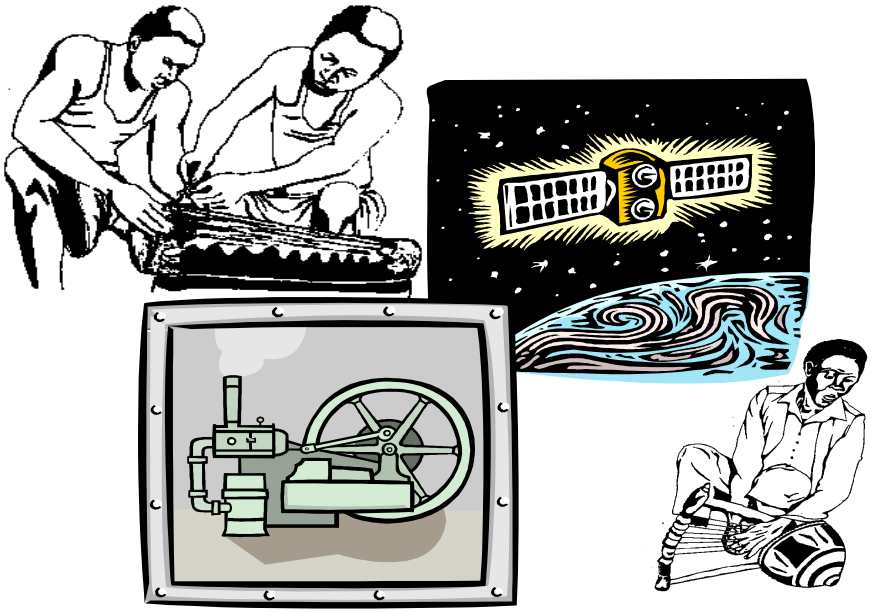
Subsystem _____

Goal _____

Feedback _____

Module 1
Technological systems

Student guide



Module overview

All technology involves systems. Systems take a variety of inputs and process them in some way, usually by an interaction of subsystems, and then they generate a set of outputs • some of which are desired and some of which are unwanted by-products. All of this occurs within a context or environment. At various points during the process • and at the end of the process • effective systems use feedback and assessment systems to generate information about how well the purpose for which the system was designed is being achieved.

Objectives

This activity will give you some practice in identifying and analysing systems that people use for technology. Typically, this involves processing of materials, communicating or converting energy and power.

Importance

Everything we do requires the use of technological systems. This happens when we play, study, work • or even at home. Think about things you want to do. Does that not require using systems? For example, systems to transport you from here to there such as a car. Or perhaps systems to entertain you, for example radio or television, or musical instruments. Or perhaps

even material processing systems such as agriculture, food preservation and preparation; or construction systems that produce homes and bridges; or even the systems that employ us in our factories.

Key information

Class presentations and demonstrations
Overview of technology.
Technology systems.
Technology systems analysis.

Safety
When your instructor assigns the systems analysis activity, be careful not to endanger yourself as you work to identify the system components. Always do an analysis of system inputs and outputs to learn what goes into a system and thereby get some sense of how much potential energy there exists that might possibly hurt you.

Student activity
Before beginning work on these activities it is recommended that you read: Gradwell and Welch's book entitled *Technology: Shaping our World*, op. cit., in particular the early chapters that outline what technology is, and how to conduct a systems analysis.

Materials required

Supplies
Graph paper, pencil.

Hand-outs / Instructional resources
J. Gradwell and M. Welch, *Technology: Shaping our World*, South Holland, Ill., Goodheart-Willcox, 1991.

Activity sequence

1. Participate in your instructor's start-up activities and presentation for this module. Follow all instructions, e.g. reading the assigned material, and by reviewing the steps of procedure.
2. Do Activity 1: Generate a list of simple and more complicated examples of technology.
3. Do Activity 2: Generate a systems analysis of a technological system and sketch the system.
4. Review and summarize what you have learned.
5. Complete the post-assessment procedure.

Activity 1: Generate a list of simple and more complicated examples of technology

Generate a list of simple and more complicated examples of technology. Try to find at least one example from each of the following areas of human activity:

Human activity area	*Simple example*	*Complex example*
Food		
Clothing		
Work		
Play		
School		
Government		
Family		

Pick any two of these systems and identify the goal for which that system was developed.

Activity 2: Develop a systems analysis of a technological system

Working in groups of from two to four students, generate a systems analysis of any of the systems you identified in Activity 1, or any of the examples given below:

A construction system such as a road building or paving machine.
A manufacturing system such as a foundry or factory.
A communication system such as a radio or television or telephone.
A food processing system such as a stove.
A transportation system such as a bicycle.
An energy conversion system such as a windmill, a generator or an automobile engine.

This systems analysis is to include:

The name of the system

The purpose of the system

The inputs to the system

The system's outputs

The subsystems or components of the system _____

_____

The feedback used by the system _____

_____

The environment/context housing the system _____

_____

Then sketch a diagram that shows all of the items that you listed in the above section, and that also shows their relationships. Be sure to label each item.

For extra credit . . .

Activity 3: Develop a technology synthesis to design a system

Take any collection of system components and assemble them to make a new system.

1. Specify the goal for the technological system to be designed.
2. Sketch the overall configuration of the system to be designed.
3. Graphically show the relationships of the subsystems to one another.
4. Describe how the system you designed should work.
5. Evaluate whether the system you designed is likely to achieve the goal or design specifications stated in Step 1.

Technology Activity Module 1: Summary

Review and summary activities

Compare your system analysis to that of other students.
Ask them if they think you missed identifying any key components/subsystems of your system.
Is your system sketch clear to the other students?

Review questions • Check your comprehension!

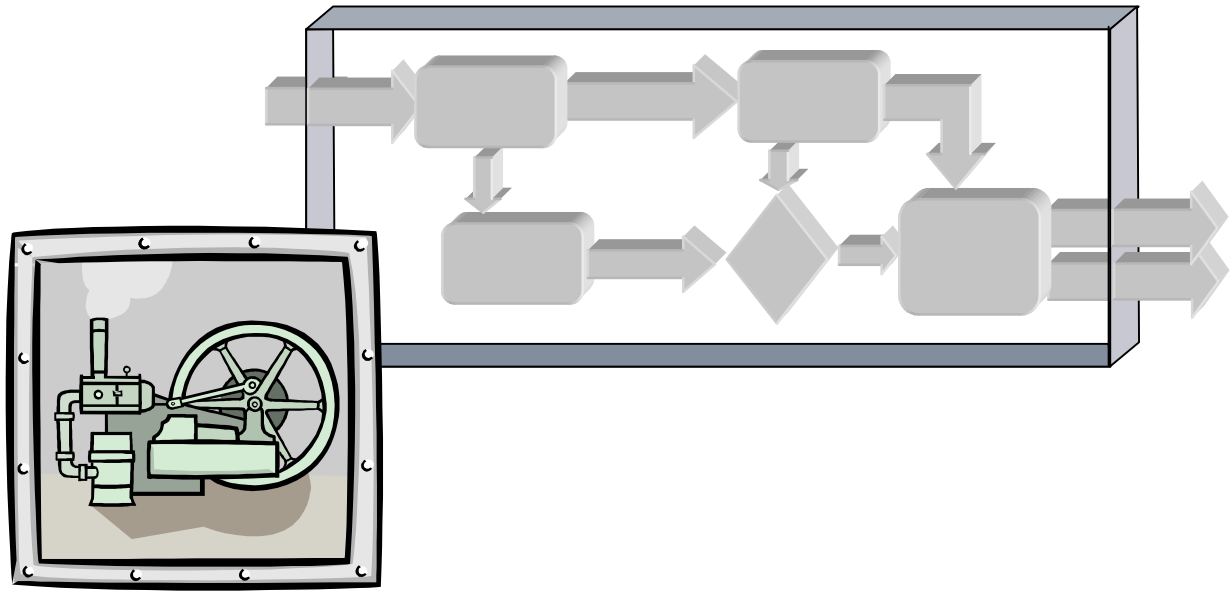
What occurs when humans want to solve a technological problem?
What affects the relationship between system components?
Why do we have technological systems?

Technology Activity Module 1: Post-assessment

1. Take the post-test that your instructor will give you.
2. Have the instructor evaluate your post-test and discuss any problems it identifies.
3. Correct your post-test.
4. If your results demonstrate mastery, go on to Technology Activity Module 2 or other activity assigned by your instructor. If you are less than completely successful, see your instructor and plan what to do to raise your level of mastery.

Module 2
Technological resources and constraints

Instructor guide



Activity objective

The purpose of this activity is to help students begin to understand the fact that technological systems employ a variety of human, informational, material and energy resources to accomplish their purposes. Additionally, technological systems are constrained by various real and imagined forces and resource limitations. Finally, it is important for students to become aware that technological systems have intended and unintended outcomes, and that these usually have positive and negative dimensions.

Module instructions

Introduction

After establishing the nature of systems in Technology Activity Module 1 (TAM 1), the instructor now needs to help students evolve their thinking to focus on system inputs, outputs, resources and constraints. Things are just not as simple as TAM 1 presented.

Every system uses resources, some of which are apparent and others which may not be quite so obvious. Furthermore, all systems encounter constraints that ultimately affect their operations. Again, some of these constraints may be obvious, while others not at all so. The primary outcome of this module should be that students become able to carefully identify key system resources and constraints for technological systems.

Key content highlights

Technological systems all employ resources to accomplish their purpose. These resources can be people, information, material or energy. Often systems employ a combination of these. Subsystems also use such resources, often getting them from another subsystem.

The resources used by a system or subsystem are usually called inputs. The resources or products generated by a system or subsystem are usually called outputs. From this, it can be seen that the outputs of some systems or subsystems become the inputs of a subsequent system or subsystem.

All technological systems encounter constraints. Sometimes, for example, there is just not enough of a particular resource to be had, for example water during a drought or skilled people in times of rapid expansion. Energy, material and information could also be lacking.

Sometimes constraints are based on laws, or what might be deemed socially acceptable or unacceptable. For example, today, any form of discrimination favouring one race over another is considered unacceptable. Our societies impose constraints limiting pollution, energy use, work hours and many other things.

Systems may use resources that are material, energy or information in nature. Examples of these include, respectively, steel, electricity and knowledge. The resources used by a technological system may be obvious, such as gasoline fuel, an energy resource used by cars. Of course, systems may also use resources that are not at all obvious: for example, the car uses air as a material resource, but this is not readily apparent. If we were to consider the car and driver system moving down a road, another not immediately obvious resource is the knowledge of the driver as to what the road signs mean, and how to operate the particular vehicle he/she is driving.

Similarly, when thinking about technological systems, one must consider how the resources and systems operations are constrained or restricted. This occurs to all systems. Some of the constraints are physical (i.e. material or energy) and some are informational, i.e. social values, laws, attitudes, knowledge, etc. As with resources, some constraints are obvious and some are hidden or not obvious.

As students work on this module, it will be helpful to have them remember what they did and learned in Module 1 and then convert their understanding of a technological system into a graphic model. If they do not understand some parts of their model, that is normal; they should just represent these unknowns with a ‘black box’.

To understand technological systems, students must understand the nature of systems, and then technology’s resources, inputs, outputs and constraints.

Materials required

Supplies
Graph paper, pencils.

Equipment
Drafting equipment or software, if available.
Instructional resources
Any technology textbook available, such as: J. Gradwell and M. Welch, *Technology: Shaping our World*, South Holland, Ill., Goodheart-Willcox, 1991; also examples of technological systems found in the school or neighbourhood.

Management / Logistics

Related instructional units:
Technology Activity Module 1 (TAM 1): 'Technological Systems'.

Evaluation / Grading
Assess the thoroughness with which students identify the key inputs, outputs and resources of their systems. Assess their ability to identify example constraints affecting their selected technological system. Finally, be certain to assess each student's ability to identify and evaluate the positive and negative consequences of technology. This latter assessment should be given most weight in the grade for this TAM.

Suggested schedule / Time
The instructor could effectively let the students begin working on their activities right away and only then follow it with a summary lesson. One class period for the initial activity followed by one for the instructor's presentation will launch this TAM well. Then, two periods of student practice and discussion in identifying and analysing technological system constraints, and another for student activity on the consequences of technology. This TAM should be concluded by a final instructor day for a lesson summarizing system resources, constraints and, above all, emphasizing technology assessment in terms of positive and negative consequences of technology deployment. Allow students a day for a homework assignment in identifying technological systems from their home life.

Key instructional suggestions

Safety
When observing real systems, students should wear appropriate clothes, protection and maintain a safe distance.

Motivation
Help students understand the importance of resources to technology systems and of outputs to understanding the functioning of subsystems. Reinforce, again, the link between technological understanding and the students' ability to understand the world around them, and perhaps even for employment, comfort and recreation. This lesson will also enhance student ability to learn unfamiliar technology and apply it to their lives. Resource and constraint related understandings are generally very important to technological problem-solving/trouble-shooting.

Prerequisite information
Technology Activity Module 1 (TAM 1): 'Technological Systems'.

Demonstrations
Identify examples of technology in the students' experience.
Identify examples of technology systems and subsystem inputs (resources) and outputs, using examples from the students' experience.
Identify and analyse examples of system constraints from the students' experience.
Analyse various local examples of technological systems and highlight possible positive and negative consequences.
Identify, analyse and discuss examples of resources used by these systems.
Identify, analyse and discuss examples of constraints affecting these systems.

Reanalyse the cooking stove and automobile examples of systems generated by Module 1, and this time augment the analysis with lists and descriptions of both resources and constraints of these systems.

Attitudes

Importance of being thorough (not overlooking something).
Emphasize the importance of criticizing (i.e. not just blindly accepting) technology.
Importance of being neat when sketching.
Importance of consulting others – in particular experts.
Importance of reflection, i.e. making sense out of something oneself.

Summary and review

Technology extends human capability. Technology is used to serve human needs or wants. All technologies involve systems. Systems are developed to address a goal and consist of subsystems that work together. Feedback is used to control a system. Systems operate in environments.

Technology systems and subsystems employ resources as inputs. The outputs of technology systems and subsystems often become the inputs of downstream systems or subsystems. All technological systems face constraints that may be physical, real and/or social and legal. Some constraints are even imaginary.

All systems employ resources that can take the form of materials, energy and information. Resources may be obvious or not readily apparent. Resources are used by the overall system, yet each subsystem that makes up the overall system also makes individual use of some or all the resources. All systems and subsystems face constraints that also may be informational, material or energy in basis.

All technology must be assessed in terms of both its positive and negative consequences. Technologists must be careful to look for unintended consequences and not just focus on intended ones. Overall judgements about the impact of technology depend on the weighting of numerous criteria. Different weightings produce different judgements.

Glossary

Black box	An unknown portion of a system that, while we know it exists, we do not know its components. We do, however, know (or at least could speculate) the inputs and outputs to the black box.
Constraint	A restriction, lack of resource, or other factor that prevents a system from being as efficient or effective or as extensively deployed as might be desired.
Energy	The ability to do work.
Information	Data or knowledge about something. This is another resource.
Intended consequences	Outcomes that are envisioned or planned for. Typically the target goals for which the technological system was designed.
Laws	Formal actions passed by the legislative authority of a nation, region or locality.
Legal	Pertaining to laws and regulations.
Material	Any substance such as air, water, metal, non-metal, agricultural item, natural resource and the like.
Regulations	Formal interpretations of a law by administrators. Usually regulations add detail to the laws, but must operate with the intent of the law. Some regulations are also established by international and/or national standards setting groups.
Resources	Any energy, material, information or person available to a system or subsystem.
Social	Having to do with groups of people: for example, how they interact, their laws and regulations, etc.
Society	A group of people acting together
Unintended consequences	Outcomes that are not envisioned or planned for. Typically these are the by-products of the main technology, or are social in nature.

Date: _____ **Class:** _____ **Name:** _____

Technology Activity Module 2
Technological resources and constraints

Post-test 1

Instructions: *Fill in the blanks of the form below by working independently and without using books or notes.*

Provide a definition and an example of each of the following for the electrical system that supplies your home.

Term/concept	*Definition*	*Example*
Constraint		
Society		
Energy		
Material		
Information		
Intended consequences		
Unintended consequences		

As a take-home test question, write a one-page paper describing the positive and negative, intended and unintended consequences of a technology used by one of your family in their work.

Post-test 2

Instructions: *Write in the answer to each question:*

1. Define what resources are in the context of technological systems.

2. Name a technological system, and then give some examples of obvious resources required by that system.

3. Identify at least one non-obvious resource for the system you named in Question 2.

4. Define what a constraint is in the context of a technological system.

5. Give an example of a technological system's

   a. Material constraint:

   b. Energy constraint:

   c. Information constraint:

   d. Social constraint:

6. On a sheet of graph paper, draw a systems model of a technological system that involves at least three subsystems, and

   a. Identify on the drawing each resource needed by the overall system:

   b. Identify the constraints faced by that overall system:

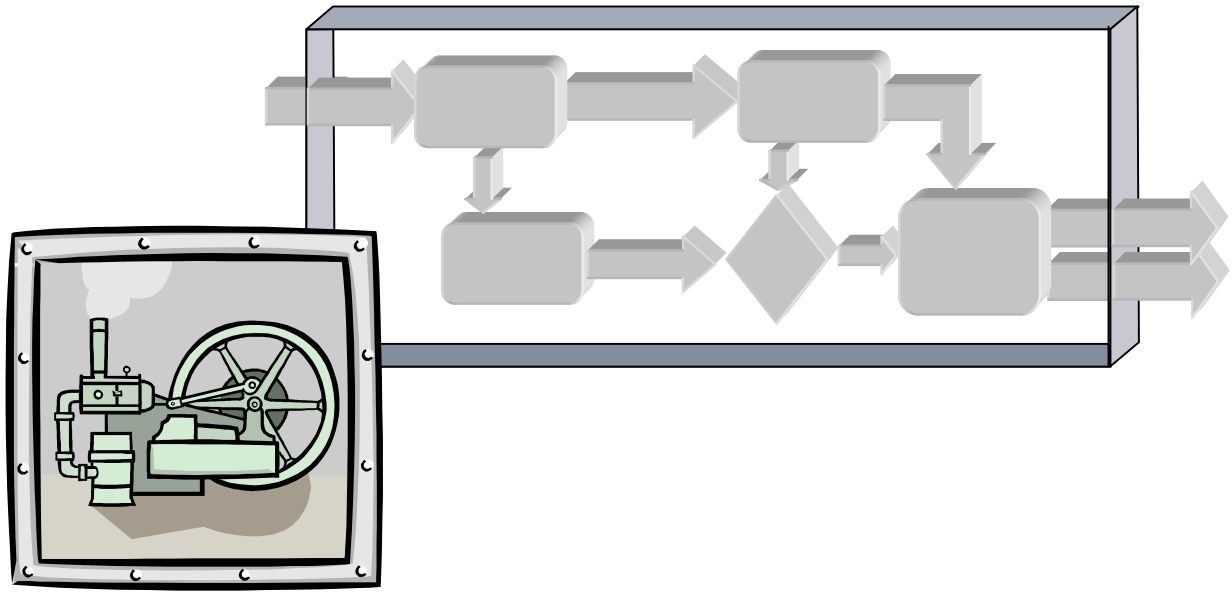
7. For each subsystem on your drawing

   a. Show on the drawing each resource needed by each subsystem:

   b. Identify the constraints faced by each subsystem:

Module 2
Technological resources and constraints

Student guide



Module overview

Building on TAM 1's introduction of the system's nature of technology, this new module will extend your understanding of technology with three important ideas: (a) all technology systems and subsystems have inputs and outputs, and these are the resources and products of the system; (b) all technological systems face constraints of one kind or another; and (c) all technological systems have intended and unintended outcomes that are both positive and negative.

Every system uses resources, some of which are apparent, and others which may not be quite so obvious. Furthermore, all systems encounter constraints that ultimately affect their operations. Again, some of these constraints may be obvious while others not at all so. The primary outcome of this module should be that students become able to carefully identify key system resources and constraints for technological systems.

Systems may use resources that are material, energy or information in nature. Examples of these include, respectively, steel, electricity and knowledge. The resources used by a technological system may be obvious, such as gasoline fuel, an energy resource used by cars. Of course, systems may also use resources that are not at all obvious: for example the car uses air as a material resource, but this is not readily apparent. If we were to consider the car and driver system moving down a road, another not immediately obvious resource is the

knowledge of the driver as to what the road signs mean and how to operate the particular vehicle he/she is driving.

Similarly, when thinking about technological systems, one must consider how the resources and systems operations are constrained or restricted. This occurs to all systems. Some of the constraints are physical (i.e. material or energy) and some are informational, i.e. social values, laws, attitudes, knowledge, etc. As with resources, some constraints are obvious, and some are hidden or not obvious.

As students work on this module, it will be helpful to have them remember what they did and learned in Module 1 and then convert their understanding of a technological system into a graphic model. If they do not understand some parts of their model, that is normal; they should just represent these unknowns with a 'black box'.

Objectives

This module will teach you two very important concepts about technological systems. The first is about what resources are, and how to think about them. The second is what technological system constraints are, and how to use them in increasing your understanding of such systems.

This activity will introduce some very important ideas needed to fully understand technology. You will learn to identify the inputs and outputs of technological systems and subsystems. Then you will explore the concept of constraints and how they affect what you can do with technology. Finally, you will begin developing the most important of all technological skills, namely that of assessing technology.

Importance

Knowing about technology's systems is not enough to understand it; in no way is this sufficient. All systems have to use inputs, otherwise where would they get the energy needed to operate, and the material needed to make their products? Without information inputs, how would they know what to do? Even more important, almost all systems require people in some way.

All systems require some form of control, some way of keeping the system from going wrong. These things do not just happen. They must be engineered into a system. Furthermore, from your own experience, you will already have seen that technology's impacts can be both positive and negative. For example, the automobile, which has enabled so many people to transport themselves considerable distances, has had very positive consequences. However, we know that automobile accidents and pollution are also consequences of this technology. Neither were what we wanted or envisioned when we first developed the car.

But, why is it even important to know about technological system resources and constraints? Simply put, a knowledge of technological system resources is absolutely essential to designing, using and trouble-shooting such systems. For example, if you did not know that automobiles require gasoline as a resource, how would you know to fill the tank if the car stopped working?

Similarly, technological system constraints are important in order to understand how efficiently and effectively these systems are operating. What keeps a system from overworking and/or breaking? Why might a system or subsystem be less than optimal? Perhaps because of certain regulations such as pollution requirements or physical laws. For example, one cannot get more energy out of a system than what one puts into it – and usually one gets far less because of losses.

The context for this module is that of technological systems as established in TAM 1. All technology consists of systems and the more sophisticated the technology, the more systems are interlinked and interdependent. For these reasons, a solid understanding of resources and constraints is important.

This module will help you understand how to control technology and how to assess it.

Key information

Class presentations and demonstrations
Review of technology systems and systems analysis.
Identifying resources, the inputs and outputs of systems and subsystems.
Obvious and non-obvious resources required by technology systems and subsystems.
The nature of technological system constraints.
Obvious and non-obvious constraints faced by technology systems and subsystems.
Assessing the consequences of technological systems.

Safety
When your instructor assigns the systems analysis activity, be careful not to endanger yourself as you work to identify the system components.
Always do an analysis of system inputs and outputs to learn what goes into a system, and thereby get some sense of how much potential energy there exists to possibly hurt you.
When analysing systems, avoid putting your hands near moving parts.
Be certain that electrical systems are unplugged and discharged before working on them.
Wear appropriate protective equipment when near systems that can injure; for example, wear goggles around grinding and welding equipment, and wear a respirator around dusty or chemical equipment.

Student activity
Before beginning work on these activities it is recommended that you read: Gradwell and Welch's book entitled *Technology: Shaping our World*, op. cit., in particular the early chapters that outline what technology is, and how to conduct a systems analysis.

Materials required

Supplies
Graph paper, pencil.

Equipment
Drafting equipment or software if available.

Hand-outs / Instructional resources
J. Gradwell and M. Welch, *Technology: Shaping our World*, South Holland, Ill., Goodheart-Willcox, 1991; also examples of technological systems as in the school or neighbourhood

Activity sequence

Participate in your instructor's start-up activities and presentation for this module. Follow all instructions, e.g. reading the assigned material, and by reviewing the steps of procedure.
1. Do Activity 1(a): 'Identifying Resources, the Inputs and Outputs of Systems and Subsystems', or
   Do Activity 1(b) 'Identifying Technological System Resources'.
2. Do Activity 2: 'Identifying Technological System Constraints'.
3. Do Activity 3: 'Assessing the Consequences of Technological Systems'.
4. Do Activity 4: 'Calculate Resource Efficiencies of Technological Systems'.
5. Review and summarize.
6. Complete post-assessment procedure.

Activity 1(a): Identifying resources, the inputs and outputs of systems and subsystems

1. Working in groups of two or three, develop a systems analysis of an automobile engine. Describe each subsystem and state the purpose of each subsystem. Generate a sketch that shows these subsystems and their relationship to the other subsystems.
2. Identify the inputs and outputs of each subsystem and list them in the following table.

Subsystem	*Inputs*	*Outputs*
Example: Lubrication subsystem	Rotational motion from the distributor's drive shaft Oil from the crankcase	Pressurized oil Heat Sound

3. Each group then presents its list of automobile engine subsystems analysis to the class and, together, all students generate one comprehensive list of all subsystems. The instructor will correct any misimpressions or errors.
4. For each subsystem then listed on the board, students compile a comprehensive list of all inputs and outputs of the subsystem. In doing this, students refer to their diagram showing subsystem relationships so that when one subsystem feeds into another subsystem, all resources are accounted for.
5. What happens to the outputs of one subsystem that does not serve as an input to the next subsystem? Where do these outputs go?

Activity 1(b): Identifying technological system resources: Plan of procedure

1. Identify a moderately complicated technological system in which you and three classmates are interested, and from which you can locate some information.
2. In groups of three or four, draw a large wall-chart technology systems analysis of this system, being sure to identify its major subsystems.
3. List on the systems analysis chart the overall system resource inputs and outputs. Be certain to include both obvious and non-obvious inputs/resources. The test of your accuracy in this would be that the system would operate with only the resources listed; if it cannot, you have missed something!
4. On this same wall-chart, identify and list the resources being used by each of the system's major subsystems. The check of your accuracy is that, taken together, all subsystem resources must have been listed as a resource for the overall system. If not, and if you are sure that a resource is required by a subsystem, revise the lists you generated in Step 3.
5. Try to come up with reasonable estimates of the amount of each resource (as listed in Steps 3 and 4) required for a given amount of output.
6. Present each chart to your class and invite your classmates and the instructors in your school to critique your work. The objective is to enlist as much help as possible (including industrial or business people willing to help), in detailing and validating your work.

Activity 2: Identifying technological system constraints

1. If possible, go on a field trip with your instructor to a local garage or automobile dealership and interview key personnel to get answers to the following questions; if a field trip is not possible, use books and magazines supplemented by interviews of family members to answer these questions:
   A. How does fuel efficiency (miles or kilometres per gallon or litre) affect engine use and popularity?
   B. Are there any government regulations that apply to automobile engines?
   C. How available are spare parts for various engines?
   D. Why are some engines more expensive than others?
   E. Can all engines be serviced locally? Why or why not?
   F. What makes one engine better than another?
   G. Why does not everyone use the best engine?
   H. What constraints or limitations on use do various engines have?
2. After getting these questions answered, come back to the school and discuss the answers you secured. Develop a comprehensive list of automobile engine constraints. Link each constraint to one of the engine's systems or subsystems.

Alternatively:

1. Form new groups of three or four classmates, and have each group pick one of the technology systems analysis charts that the class has prepared in Activity 1.
2. Create a wall-chart table that identifies the overall system's major constraints being certain to list some in each category: material, energy, information and social. Be certain to include both obvious and non-obvious constraints.
3. Repeat Step 2 for each subsystem in your overall technological system. List the overall system resource inputs and outputs on the systems analysis chart.

4. Present each chart to your class and invite your classmates and the instructors in your school to critique your work. The objective is to enlist as much help as possible (including industrial or business people willing to help), in detailing and validating your work.

Activity 3: Conducting a technology assessment

1. In small groups of three or four students, pick any one system and name it, and then list that system's outputs. Be sure to list all outputs, not just the desired or obvious ones. For example, does your system give off heat, noise or pollution?
2. Identify which of these outputs are intended and which are unintended.
3. Also note whether the use of the system has any social or other consequences or impacts. For example, the widespread use of cars might cause the unemployment of bus drivers.
4. Conduct a class discussion about each system and its outputs, and the consequences of these outputs. Have the class discussion:
   A. Confirm that all outputs have been listed.
   B. Confirm that all outputs are properly classified as intended or unintended.
   C. List the system's positive and negative effects on the environment/context housing it.
   D. Confirm that all social consequences have been identified.
   E. Consider whether, overall, the effect of employing the technology in question is positive or negative. End this consideration with a vote, by secret ballot, asking each student to indicate on a slip of paper his/her summary judgement as to whether the technology has had an overall positive or negative effect.
   F. Discuss why so many technologies are seen to have serious negative characteristics.

Activity 4: Calculate resource efficiencies of technological systems: Plan of procedure

1. Using your technological system wall chart, and working in the same groups as you did for Step 2, interact with your instructor, and with the school's mathematics and science teachers, to quantify the numbers you listed for each resource for both the overall system and each subsystem.
2. The check of your accuracy is that, taken together, all subsystem resources equal those of the resources listed for the overall system. If not, work with your instructors to better your estimates.
3. Now develop a sense of the technological system's output. What kind are they, and how large are they. Quantify your output amounts and validate them using consultant teachers and industrial people.
4. Develop a sense of the efficiencies of your system by inserting input (resource) and output amounts into the following expression:

$$\frac{\text{Output amounts and units}}{\text{Input amounts and units}} = \text{Efficiency}$$

For example, in the case of a car:

$$\frac{\text{120 kilometres driven}}{\text{6 litres of petrol required}} = \text{20 kilometres per litre}$$

5. Be certain to consider the nature of the units you place into this expression. When they are the same, you can calculate real efficiencies. For example, if you knew a lighting system required 30 watts of energy (electricity) but that it gave off only 20 watts (equivalent) of light, the system would be 66.7% efficient.

$$\frac{20}{30} = \frac{x}{100} \qquad x = 66.7\%$$

= 66.7

Now, calculate the efficiency of your technological system and show all steps and assumptions/estimates in your calculation.

6. Have your classmates and your instructor check your calculations.

Activity 5: Debate technological system constraints: Plan of procedure

1. Working as a whole class, pick one of the technological system analysis charts that most of the class is interested in.
2. Divide the class into two groups.
3. Have one group identify the positive constraints and consequences of the technological system as a whole.
4. Have the other group identify the negative constraints and consequences of the technological system as a whole.
5. Conduct a teacher-moderated debate of the positive group versus the negative group.
   A. The positive group should be arguing that the system is beneficial and therefore should be faced with fewer constraints.
   B. The negative group should be pointing out the negative consequences of the technological system and should therefore be arguing for greater numbers and severities of constraints.

Technology Activity Module 2: Summary

Review and summary activities

Meet with students from a social studies, history or science class, and discuss your three activities and your results. Are their opinions the same as your classes or not? Why is this the case?

If you encountered any words or terms that you did not understand, ask your instructor to explain their meaning.

Discuss how resources and constraints relate to one another.

Compile a list of all the items listed as a resource across all the technological systems analysed by your classmates.

Compile a list of all the items listed as a constraint across all the technological systems analysed by your classmates.

Review questions • Check your comprehension!

Why do we often overlook system inputs and outputs?
Is it common that one subsystem's outputs become the inputs of another subsystem?
Can a technological system face societal constraints?
Which constraints are more easily overcome, technical or societal ones?
Who performs technology assessments for a nation?
What are some unintended negative consequences of using technology?
What are some intended positive consequences of using technology?
What three categories of resources exist?
What four categories of constraints exist?
Why are constraints both good and bad?

Technology Activity Module 2: Post-assessment

1. Complete the review questions in the previous section.
2. As a homework assignment, write a one-page paper on the positive and negative consequences of using a technology that your family uses at home. Be sure to discuss this paper with family members and include in it their ideas as well as yours. Come to school prepared to make a short oral presentation in front of the class to share the highlights of your paper.
3. Have the instructor evaluate your paper and discuss how to improve your writing.
4. If your instructor assigns a post-test for this TAM, be sure to take it.
5. If your results demonstrate mastery, go on to TAM 3, or do any other activity assigned by your instructor. If less than completely successful, see your instructor and plan what to do to raise your level of mastery.