CHAPTER 1

The Traffic Signal Control System: Its Pieces and How They Fit Together

Purpose

In this first chapter, we set the stage for learning about (understanding, then designing) signal timing for the traffic signal control system.

Learning Objectives

When you have completed the activities in this chapter, you will be able to

- Describe the basic components and the operation of the traffic control system
- Determine your current level of competency with traffic signal system concepts
- Describe how drivers respond to signal displays
- Identify and describe various physical components of a signalized arterial
- Assess the realism of a simulation environment by comparing it with a video of actual field operations
- Develop your ability to "see" and "observe" video and animation of traffic flow at a signalized intersection and relate these observations to traffic flow theory and principles
- Identify essential team behaviors that lead to successful completion of activities and the design project
- Explain how team behaviors support different team roles
- Develop group consensus on how the team will work with, treat, and communicate with each other
- Describe the content, scope, and organization of the *Traffic Signal Timing Manual*

Chapter Overview

This chapter begins with a *Reading* activity (Activity #1) that describes the system itself and its components and how they fit together. The basic prerequisite to a course using this book is an introductory course in transportation engineering, offered in most undergraduate programs in civil engineering. Activity #2 is designed to review some of the basic concepts that you learned in this introductory course that are relevant to traffic signal timing, identifying what you know (and don't know) about this subject. Activity #3 explores a system that you already, in many respects, know quite well: a signalized arterial. You will begin to "see" this system in a new way, using the terms and concepts commonly used by the transportation engineer. Activity #4 introduces you to the notion of seeing what is important at a signalized intersection. We often describe the experienced traffic signal engineer as having one eye on the traffic flow and one eye in the cabinet, looking at the controller and its timing processes. You will learn to use a simulation environment that includes a realistic traffic signal controller emulator. While you will use a specific simulation model and traffic controller, your work is about neither. Rather, they are both tools to help you learn about traffic operations and signal timing. It may be a surprise to you to see two activities about working in teams in a book about traffic signal timing. Yet most engineers work in teams and explicitly learning to do so is a critical skill for the transportation engineer. Activity #5 is based on three readings on team building, while Activity #6 takes you through the process of team building and creating a team agreement that will provide a context for your work as a team.

The chapter concludes with an activity (Activity #7) called *In Practice* in which you will be introduced to the *Traffic Signal Timing Manual*. This manual, developed by the Federal Highway Administration, is a compilation of guidance for signal timing. You will have other readings throughout this book from the *Traffic Signal Timing Manual* that will provide a basis for checking your understanding of traffic signal timing and the results from your design activities.

Activity List

Number and Title		Type
1	Exploring the System and Providing a Framework	*Reading*
2	What Do You Know About Traffic Signal Systems?	*Assessment*
3	Exploring the System: Driving Along an Arterial and Noting What You See	*Discovery*
4	Learning to See: The Simulation Environment in Which We Will Work	*Discovery*
5	Working Together – Team Building for Effective Learning and Design	*Discovery*
6	Team Agreement	*Design*
7	Introduction to the *Traffic Signal Timing Manual*	*In Practice*

ACTIVITY 1

Exploring the System and Proving a Framework

READING

Purpose

The purpose of this activity is to help you develop a base knowledge of the introductory concepts relating to traffic control systems.

Learning Objective

- Describe basic components and operations of the traffic control system

Deliverables

- Define the terms and variables in the Glossary
- Prepare a document that includes answers to the Critical Thinking Questions

Glossary

Provide a definition for each of the following terms and variables. Paraphrasing a formal definition (as provided by your text, instructor, or another resource) demonstrates that you understand the meaning of the term or phrase.

actuated control	
detector	
display	
fixed time control	
movement	
queue	
user	

Critical Thinking Questions

When you have completed the reading, prepare answers to the following questions.

1. In contrast to fixed time control, in what situations is actuated control appropriate?

2. Describe the interrelationships that are shown in Figure 5 and Figure 6 between the components of the traffic control system.

3. How would you measure the performance of the traffic control system and what data would you need to make these measurements?

4. What are the primary physical elements of a signalized intersection?

5. What are the discrete periods of traffic flow during one signal cycle? Briefly describe the manner in which vehicles arrive and depart during each of these periods.

6. List any other questions that you have on the reading material.

Information

The Traffic Signal Control System and Its Components

The primary purpose of a traffic signal control system is safety, to avoid conflicts by providing a time-separation between the movements of people and vehicles traveling through the intersection. An important,

but secondary purpose of the system is to provide priority to certain groups or users to achieve goals or objectives that have been established for the performance of the system.

Often the transportation engineer addresses a traffic problem for one or more arterials, with each arterial consisting of a number of individual intersections that are controlled by traffic signals. Many arterials are designed to move large numbers of users, including auto drivers, transit riders, bicyclists, and pedestrians, through the system with as few stops as possible. These coordinated systems often give priority to certain users (for example, transit riders) based on the performance objectives or desired outcomes that have been set for the system. Figure 2 shows a view of a street in downtown Portland, Oregon, that operates under a coordinated system.

Figure 2. Aerial view of a street in Portland, Oregon

At other times, the focus of the transportation engineer is the operation of an individual intersection. Figure 3 shows a signalized intersection serving three user groups: vehicles and bicyclists traveling through the intersection and pedestrians crossing the street.

Intersection traffic control can either be fixed time or actuated (see Figure 4). In fixed time or pretimed systems, the green interval and cycle length are fixed and do not vary even as traffic demand varies though there may be plans for different periods of the day. Actuated control systems respond to traffic demand by extending the green interval by a specified amount of time each time a new vehicle arrives on an approach. The green interval will last at least a minimum specified time but no longer than a pre-established maximum time. More advanced control strategies are based on adapting timing plans to changing traffic patterns during the day.

Figure 3. Intersection in Portland, Oregon

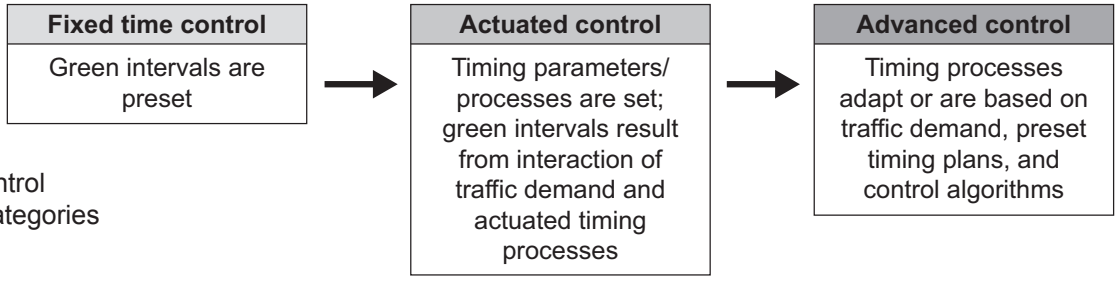

Figure 4. Traffic control system categories

The focus of this book is on the operation and design of a single intersection, operating under actuated control, serving only vehicles (or people driving passenger cars and trucks). The primary benefit of this approach is that it allows you to learn about the basic components of the operation of an actuated control system, without the complexity of considering more advanced control strategies and the needs of other users (such as transit riders or pedestrians). This focus may be criticized because of the importance of considering all modes or users, and the growing interest in providing priority to non-automobile modes at a signalized intersection. However, we believe that the benefits to you in learning the fundamentals of signal timing and operations in this context (single intersection, vehicle user) will allow you to take the next steps of considering the more complex issues of pedestrian timing, transit priority, signal coordination, and others, using the knowledge and skills gained from this book as a solid foundation. So the operating environment that you will address is a single intersection with vehicle drivers as the user class.

One way to view an actuated traffic control system is to consider the components shown in Figure 5. The inputs to the system are the level of vehicle demand and the physical geometry or layout of the intersection. The traffic control system itself is composed of four components: the users of the system, detectors or sensors, the traffic controller, and the display. These components work together in pairs, in a linear fashion, as shown in Figure 5. Each component is connected directly with two of the other subsystems, dependent on or responsive to one and directly influencing the other. These four components are, of course, affected by the geometry of the intersection itself and the volume of the users that demand service at the intersection. Sometimes signal timing can't completely address a performance problem and the only practical solution may be a change in the intersection geometry, as shown in the bottom feedback loop in Figure 5. The change in geometry could be an increase in the number of lanes.

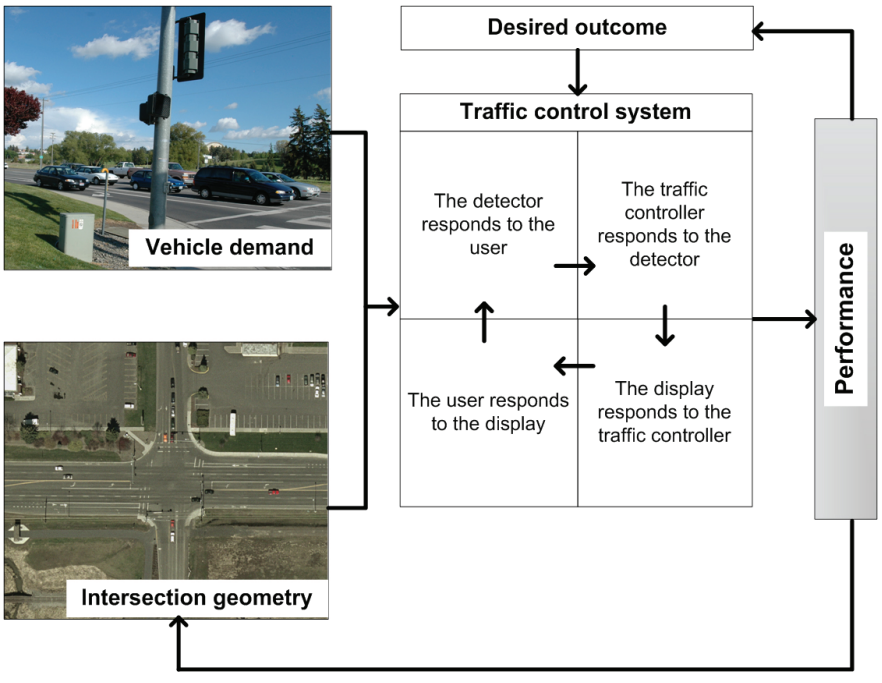

Figure 5. Traffic demand, geometry, control system, and performance

While we as engineers may be most interested in the design of the intersection itself, most people who travel through the intersection are not. They are interested in traveling through the intersection without stopping, and if they have to stop, they don't want to have to stop for long. An important part of the design process is to establish the desired outcome, or what do we want to accomplish with our design. For example, one objective could be to minimize the delay for all users, and this objective could be accomplished by limiting the maximum amount of green time that is given to each user. We can determine how well we meet the desired outcome by establishing performance measures. We measure the performance of the intersection, from the perspective of the users, based on how often people or vehicles must stop when traveling through the intersection, how long they stop, and the length of queues that form when they do stop. We define these measures as number of stops, delay, and queue length. These measures form the basis for evaluating how well the intersection performs.

Figure 6 shows an expanded view of the traffic control system and its components. Each of these components (the users, the detectors or sensors, the traffic controller, and the display) will now be discussed in greater detail.

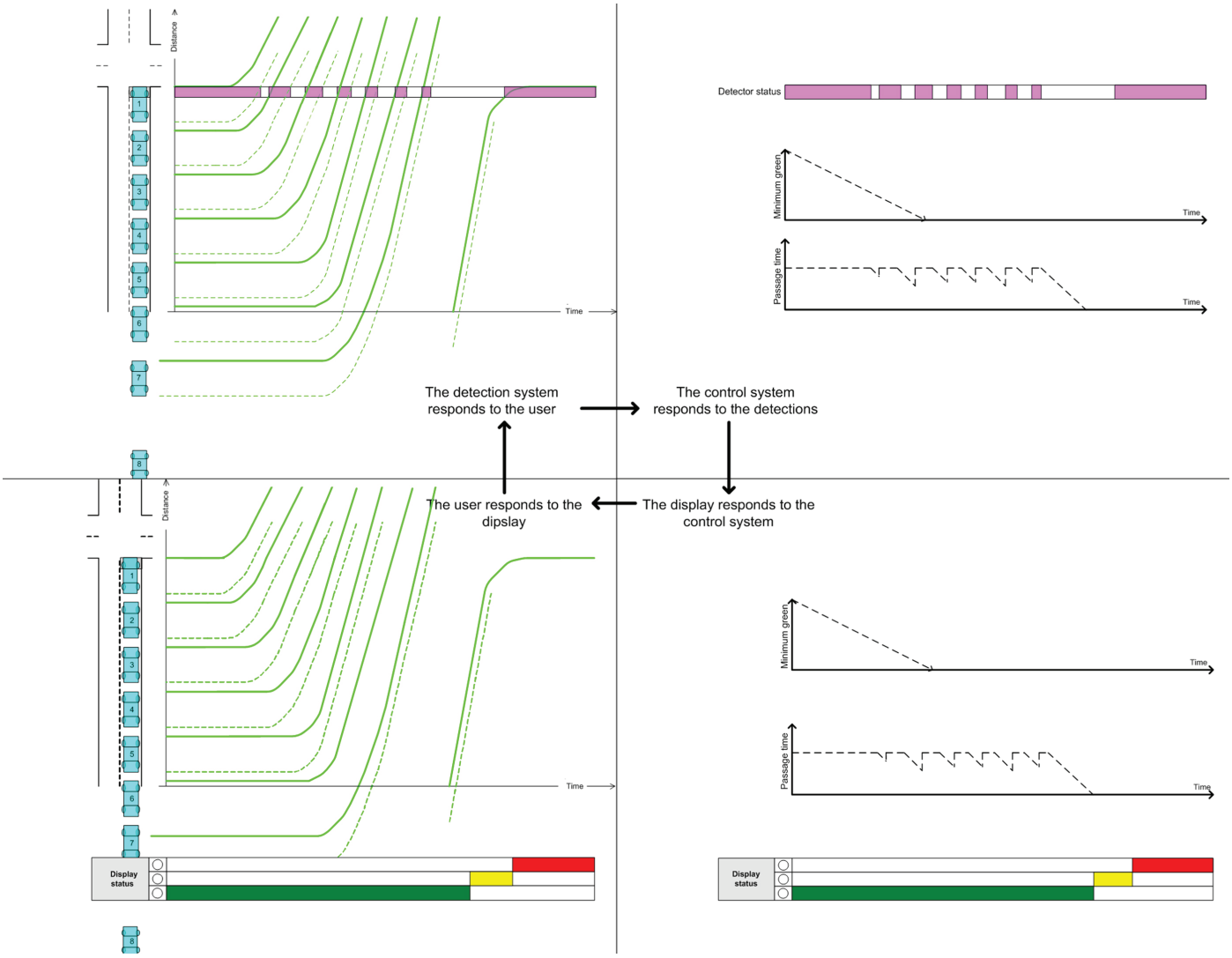

Figure 6. The traffic control system and its components

Users

A vehicle user can include the driver of a passenger car, a truck, or other commercial vehicle that desires service at (desires to travel through) the intersection. Each user category has a set of attributes such as length, width, acceleration and deceleration capabilities, and capacity that affect the operation of the intersection and its required signal timing. Users respond to the display with various possible actions, depending on the display state, the distance that the user is upstream of the intersection stop bar, the speed that the user is traveling, and other factors.

Figure 7 shows a time-space diagram that illustrates how users respond to the display. The figure shows the trajectories for the front and rear of eight vehicles in the format of a time space diagram. The first seven vehicles are part of a queue that has formed during the red interval. The vehicles respond to the change in the display (from red to green), perceiving the change, responding to the change by accelerating and traveling through the intersection. The last vehicle (vehicle 8) responds to the change in the display from green to yellow by decelerating and stopping.

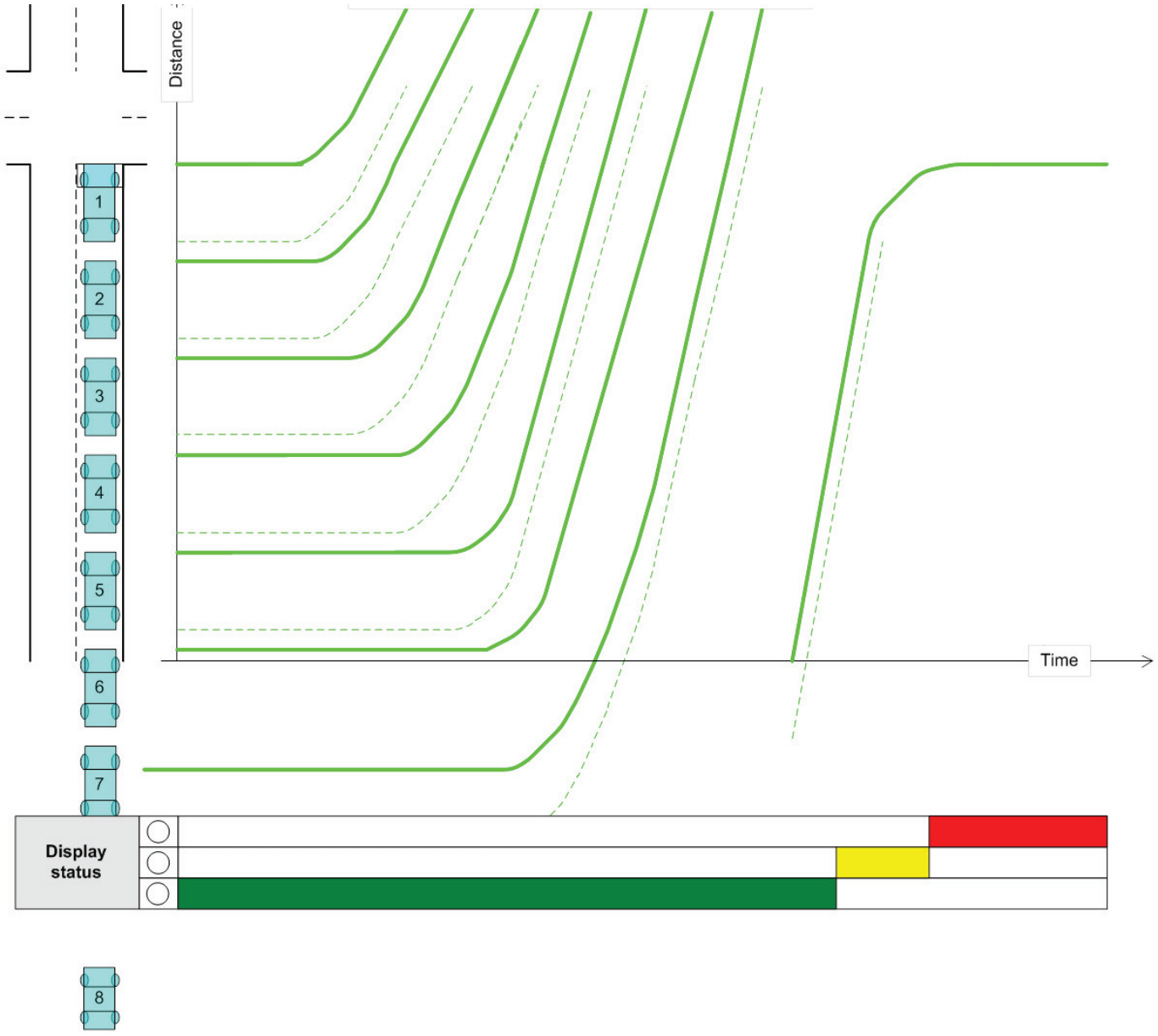

Figure 7. Users responding to the display

Detectors

There are a variety of detectors or sensors used at signalized intersections including inductive loops, video, microwave, and others. Inductive loops include pulse and presence detection types. We will focus on presence loop detectors that are "active" or send a "call" to the controller as long as a vehicle is within the detection zone.

Figure 8 shows the interaction between vehicles and the detector. The vehicle trajectories that we saw in the previous figure (showing both the front and back of each vehicle) are repeated here. The detection zone shown here is located at the intersection stop bar. We can follow the state of the detector over time. The presence of the vehicle in the detection zone is noted by the solid color. When no vehicle is present in the zone, the detector status is off and no color is shown.

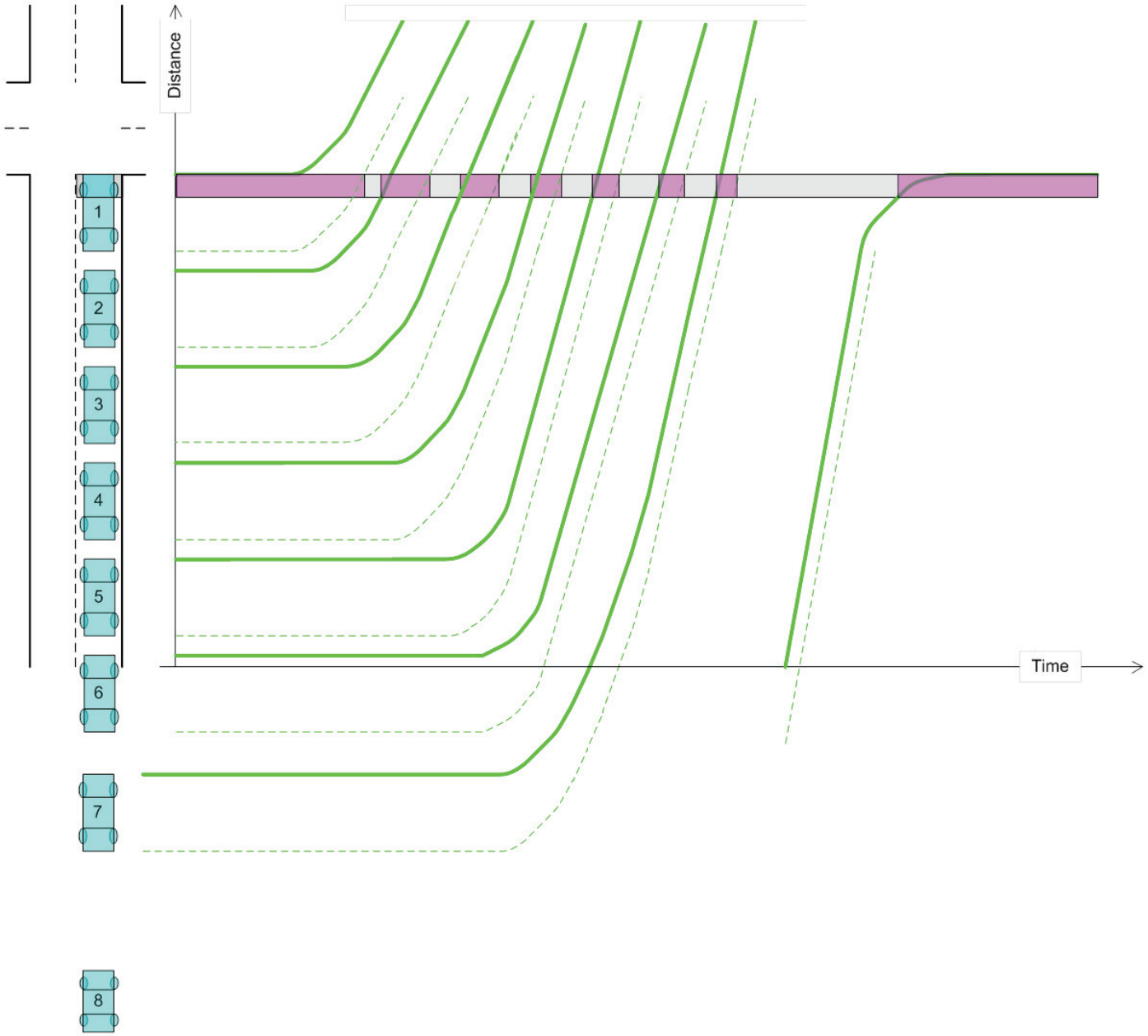

Figure 8. Detectors responding to users

Controller

The traffic controller receives calls or requests for service from the detectors. The controller determines which group of users (movements) are to be served at any given time (the order or sequence of service) and the duration that each group of users is served. The duration of service is determined by the status of a set of timing processes and a decision making framework that responds to this status to determine when service to a particular group of users will end. Examples of these timing processes are the minimum green time, the vehicle extension or passage time, and the maximum green time.

Figure 9 shows the response of two controller timing processes to the detector status. The first timing process, the minimum green timer, becomes active at the beginning of the green interval, and continues timing until the timer reaches zero and expires. In this case, there is no direct link between the detector and the timing process. The second timing process, the passage timer (sometimes called the *vehicle extension timer*), also begins timing at the beginning of the green interval but is continually reset as long as the detector is active (a vehicle is present in the detection zone). When the detection zone is not occupied, the passage timer begins to time down. The timer is reset six times in the example shown in the figure, each time representing when a vehicle enters the zone. The timer finally expires when the time that the zone is unoccupied exceeds the value of the passage time set in the controller. You will learn more about these timing processes in Chapter 4.

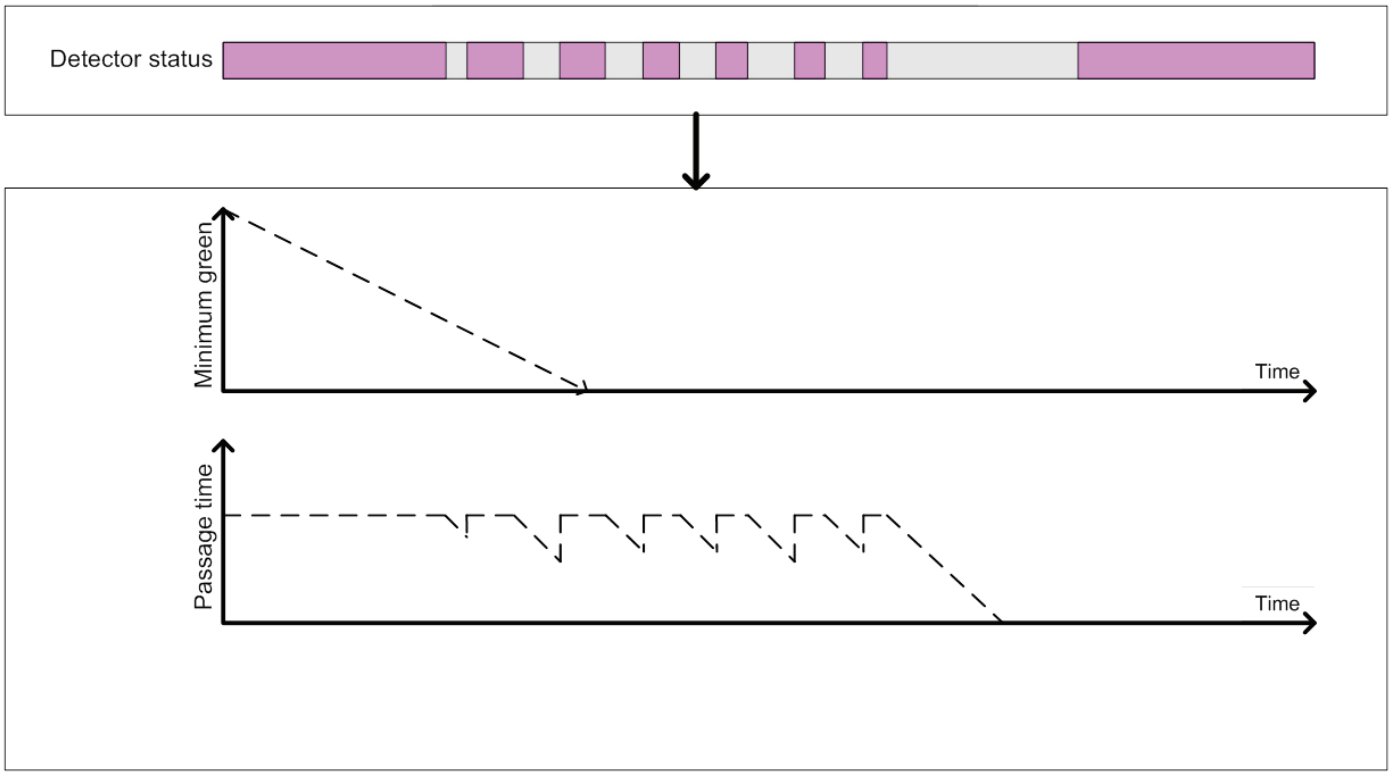

Figure 9. Controller responding to detector

Display

The display is a set of indications that provide information to users on what to do as they approach or are stopped at the intersection. The information conveyed by an indication can either be to proceed through the intersection ("go"), to exercise judgment on whether to go or stop because a change in right of way is about to occur or that the intersection needs to be cleared, or to come to a stop. The state of an indication can either be active or off. If the state is active, it can be either steady or flashing. A color is associated with the vehicle display and can be either green, yellow, or red.

Figure 10 shows an example of the response of the display to the traffic controller. Here, the green is displayed as long as both the minimum green timer and the passage timer are active. In this example, when the passage timer expires, the display changes to yellow and then to red. You will learn about these and other timing processes and how their status affects the displays later in this book.

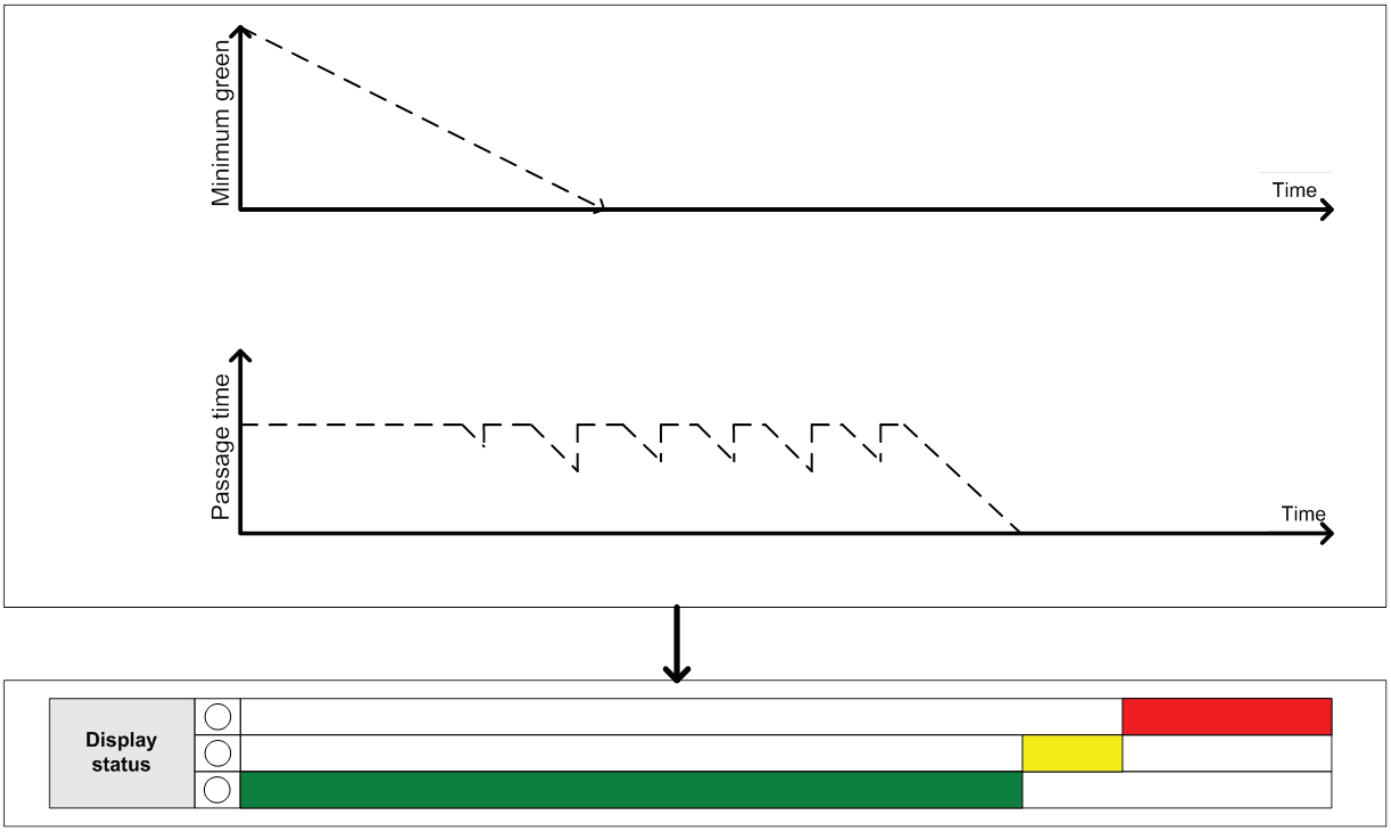

Figure 10. Display responding to the controller

We can also view these components together in one diagram, called a *traffic control process diagram*, as shown in Figure 11. You will use this diagram to follow the effects of a given traffic demand on the detectors, the traffic controller, and the display later in this book.

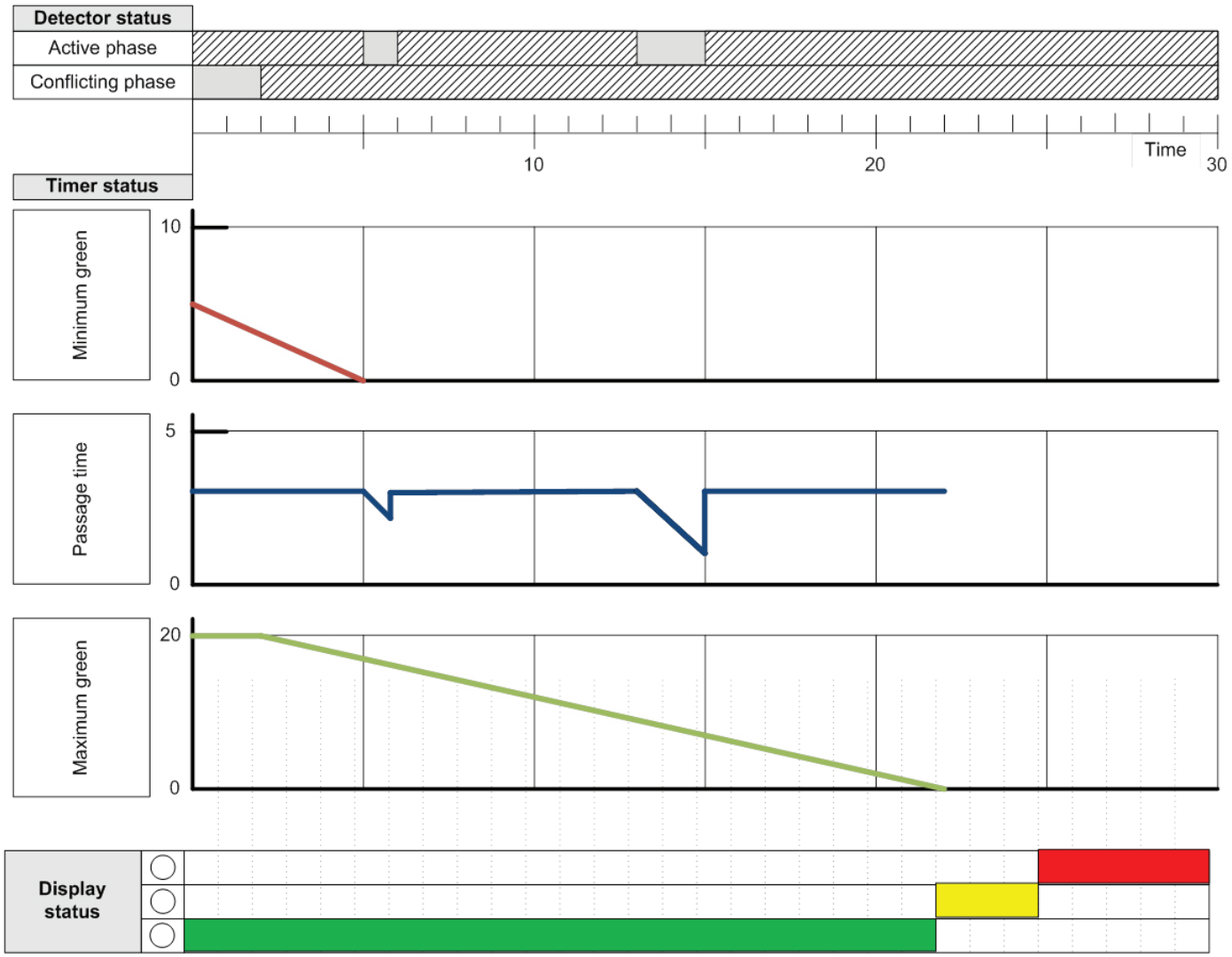

Figure 11. Traffic control process diagram

Field Observations

Let's now move to the field. You are at the intersection of State Highway 8 and Warbonnet Drive in Moscow, Idaho. What geometric information do you see in the photographs of this intersection presented Figure 12 and Figure 13?

Figure 12. Aerial view of SH 8 and Warbonnet Drive

Figure 13. Street level view of SH 8 and Warbonnet Drive

We note first the geometric layout and that it is a T-intersection. State Highway 8, the major arterial, has two through lanes on both approaches, a left turn lane, and a right turn lane on the westbound approach. Warbonnet Drive, the minor street, has two lanes on the southbound approach.

There are also several other physical components of the intersection. The vehicle displays are mounted on the mast arms above each approach as shown in Figure 14. Also visible are lighting and street signs, as well as pedestrian crosswalks and other lane striping. The cabinet, housing the traffic controller and other devices, is located on the northwest corner of the intersection and is shown in Figure 15.

Figure 14. Mast arm, lighting, signs, and signal displays

Figure 15. Cabinet housing traffic controller

Figure 16 shows the inside of a typical cabinet. The call for service from the detectors goes to the detector amplifiers, located at the top part of the cabinet. These calls are then routed to the traffic controller, where they are processed according the timing parameters and logic that have been set. Finally, the load switches set the proper display, based on the outputs from the controller.

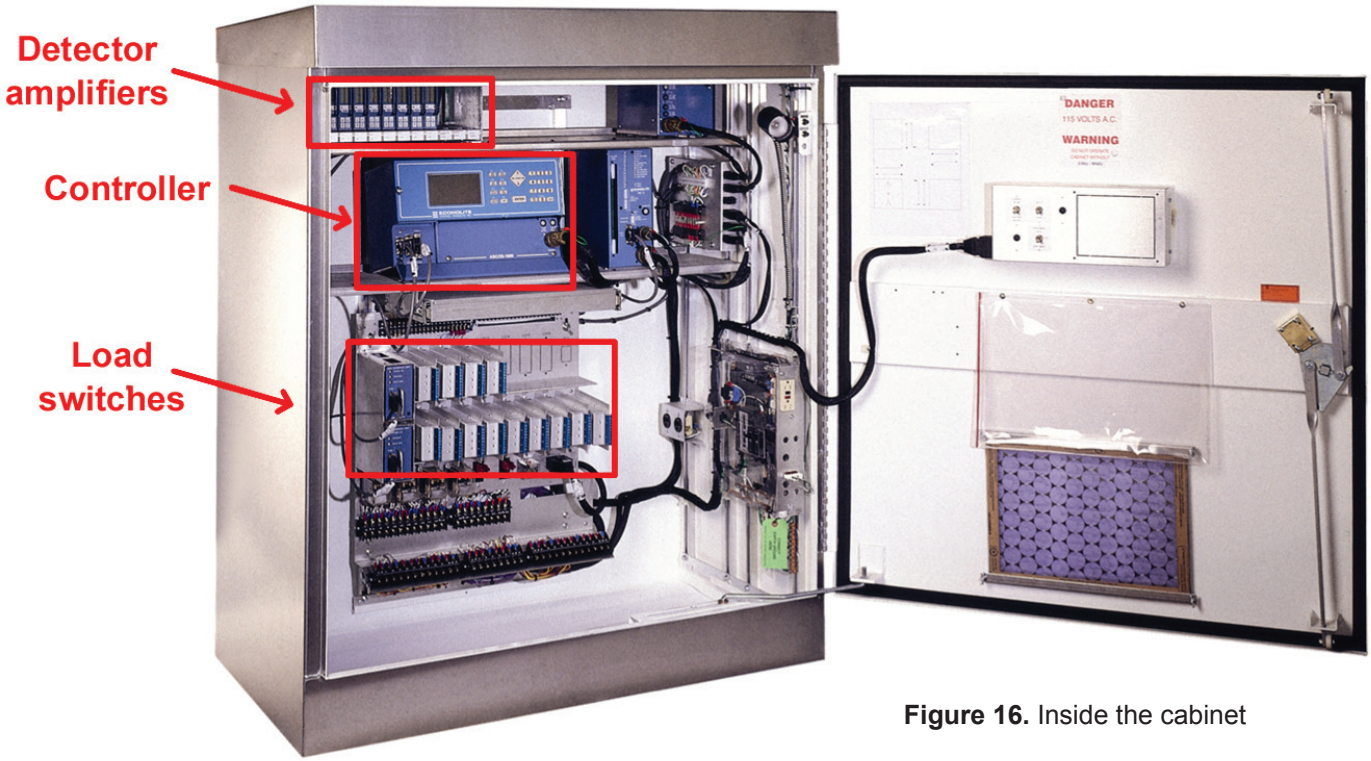

Figure 16. Inside the cabinet

Let's now focus on the flow of the vehicle users through the intersection, specifically on the westbound approach as shown in Figure 17.

Figure 17. Westbound approach and vehicle displays for eastbound lanes

Figure 18. Vehicle queue on westbound approach during red

We start observing the vehicle movements at the beginning of the red interval for the westbound approach. At the beginning of the red interval, as shown in Figure 18, vehicles respond to the red signal indication by slowing as they approach the intersection and coming to a complete stop either at the stop line or behind a vehicle in front of them. Vehicles queue up at the stop line with the queue growing as the red interval times.

Figure 19. Queue moving at beginning of green

Figure 20. Queue moving at beginning of green showing headways

When the displays change to green, vehicles begin to enter and cross the intersection (Figure 19). The driver in the first vehicle at the stop line sees the change in the signal and reacts to the change by accelerating his vehicle into and through the intersection. Drivers in the following vehicles begin the same process: they see the change in the signal, they see the vehicle in front of them begin to move, and then they begin to accelerate their vehicle into and through the intersection. As the drivers of the vehicles approach their desired speeds, the headways between the vehicles drop to a relatively constant or stable value, called the saturation flow rate. The queue that forms during red continues to be served (Figure 20).

After the queue clears, as shown in Figure 21, vehicles arrive at and leave the intersection without delay and without much change in their speeds. At some point, the signal changes from green to yellow (See Figure 22). A vehicle on the approach reacts to this change by deciding to stop. The display then changes to red so that the next set of movements can be served.

Figure 21. Vehicles arrive and leave without delay

Figure 22. Vehicle responds to yellow

In summary, the process that we've just observed through the photographs shown on the previous pages consists of four parts, each describing a response of the vehicle to the display:

- Drivers slow and stop as they arrive at the intersection during the red indication
- At the beginning of green, the queue begins to move as drivers respond to the green indication

- After the queue has cleared, vehicles respond to the green indication by arriving at the intersection and passing through without stopping
- When the yellow indication is displayed, vehicles either decide that they can safely travel through the intersection, or slow and stop in anticipation of the red indication

This flow process is one that you know well and have participated in as a driver many times. What is new is that you now have a context or framework for seeing and understanding this flow process and how it interacts with the other components of the traffic control system.

ACTIVITY 2

What Do You Know About Traffic Signal Systems?

ASSESSMENT

Purpose

The prerequisite for this course is the completion of an introductory course in transportation engineering. This activity will give you the opportunity to assess and strengthen your understanding of that critical prerequisite knowledge so that you can reliably recall and use it, even as you continue to build on it.

Learning Objectives

- Determine your current level of competency with traffic signal system concepts

Deliverable

- Prepare a document that includes your answers to the Critical Thinking Questions

Critical Thinking Questions

1. Assume that traffic arrives at a signalized intersection with uniform flow (equal space between each vehicle). At what point during the cycle will the queue length (number of vehicles in the queue) be at its maximum?

   a. At the beginning of red?
   b. At some other point during red?
   c. At the beginning of green?
   d. At some other point during green?

   [explain your answer]

2. What is the effect of long cycle lengths at a signalized intersection (as compared with shorter cycle lengths)?

   a. The delay is reduced.
   b. The delay is increased.
   c. There is no effect on delay.
   d. Other

   [explain]

3. What is the purpose of the yellow indication at a signalized intersection?

   a. To provide adequate time for a vehicle to stop.
   b. To provide adequate time for a vehicle to safely clear the intersection.
   c. Both a and b.
   d. Neither a nor b.

   [explain]

4. Which factors should be considered when determining the duration of the yellow indication?

   a. The speed of vehicles approaching the intersection.
   b. The width of the intersection.
   c. The mean length of vehicles approaching the intersection.
   d. Some combination of a, b, and c. [specify] _____

   [explain]

5. Suppose traffic signal control will replace stop sign control at an intersection. Which of the following will likely result?

   a. All movements will experience less delay with signal control.
   b. All movements will experience more delay with signal control.
   c. Some movements will experience more delay and some movements will experience less delay with signal control.

6. Suppose a platoon of ten vehicles departs from a signalized intersection when the signal display turns green. When this platoon arrives at the next signalized intersection downstream, the length of the platoon as measured from the front of the first vehicle to the end of the last vehicle will have:

   a. Changed little.
   b. Increased.
   c. Decreased.

   [explain]

7. If the green time is increased for one approach at a signalized intersection, the delay for the approach will likely:

   a. Increase.
   b. Decrease.
   c. Stay the same.

   [explain]

8. If the green time is increased for one approach at a signalized intersection, the delay for the entire intersection will likely:

   a. Increase.
   b. Decrease.
   c. Stay the same.

   [explain]

9. Prepare a sketch showing the relationship between delay and cycle length showing cycle length on the x-axis and delay on the y-axis.

10. The time that the green interval is displayed should be based on:

    a. The time required to serve the vehicles that arrived during the previous red interval.
    b. The time required to serve all vehicles that arrived during red and that continue to arrive during green.
    c. It should be fixed and not depend on traffic demand.

11. What is the purpose of a signalized intersection?

12. What is the difference between pre-timed signal control and actuated signal control? In what situations would pre-timed control be better; and in what situations would actuated control be better?

13. What measures would you consider to determine how well or poorly a signalized intersection is performing?

14. If you were standing in the field near a signalized intersection, what would you look for to determine if the intersection was performing well or performing poorly?

15. Consider that you are the traffic engineer responsible for the signal timing operation for the intersection shown in Figure 23. Citizens have called your office and complained that they often have to sit through three or more cycles during congested periods and this makes a significant difference in their travel times and fuel costs.

Figure 23. Aerial view of a signalized intersection

a. What information or data would be required to properly analyze the situation?

b. How would you quantify the performance of the signal system with the data you collect?

Student Notes:

ACTIVITY 3

Exploring the System: Driving Along an Arterial and Noting What You See

DISCOVERY

Purpose

The purpose of this activity is to give you the opportunity to drive along an arterial and note what you see. The "seeing" and the "noting" are important, as it will help you to focus on the critical parts of the system, parts that we will document and include in the models that we will develop in the activities to follow.

Learning Objectives

- Describe how drivers respond to signal displays
- Identify and describe various physical components of a signalized arterial

Required Resource

- Movie file: A03.wmv

Deliverable

- Prepare a one page report summarizing your findings

Information

Learning to discern what is important is a critical skill for the transportation engineer. For example, when you are driving down an arterial to travel to a destination, what do you look for? You want to keep a safe distance from other vehicles. You want to watch for pedestrians and bicyclists. And, you want to watch for control devices such as stop signs or traffic signals.

As a traffic engineer, you will begin to watch for other things:

- Flow rates or traffic volumes
- How the intersection is laid out and the striping of the lanes
- Information, guide, and warning signs
- Signal displays
- The controller cabinet
- How the intersection is performing (do vehicles arrive primarily during red or during green, do queues clear before the end of green, is there a queue spillback from one intersection to another, and can pedestrians safely cross the street?)

This video takes you on a tour of Lankershim Blvd, an arterial located in Los Angeles, California. The four signalized intersections in the video are near Universal Studios. The tour begins with a trip northbound through the four intersections and then returning southbound. The tour lasts a little more than four and a half minutes. Your perspective is that of the driver of the car and his passenger.

Figure 24 shows an aerial photograph of one intersection along the driver's route. Figure 25 is a diagram, showing the location of the four intersections.

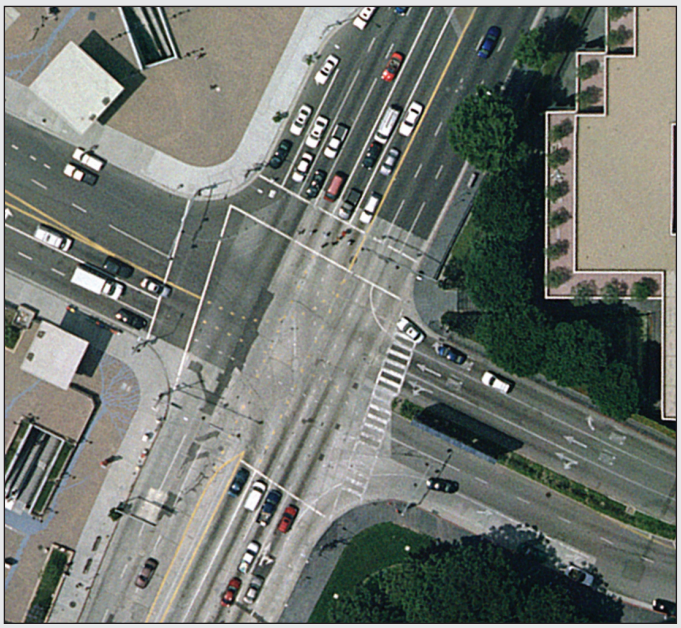

Figure 24. Lankershim Blvd study area (intersection with Campo de Cahuenga and Universal Hollywood Dr

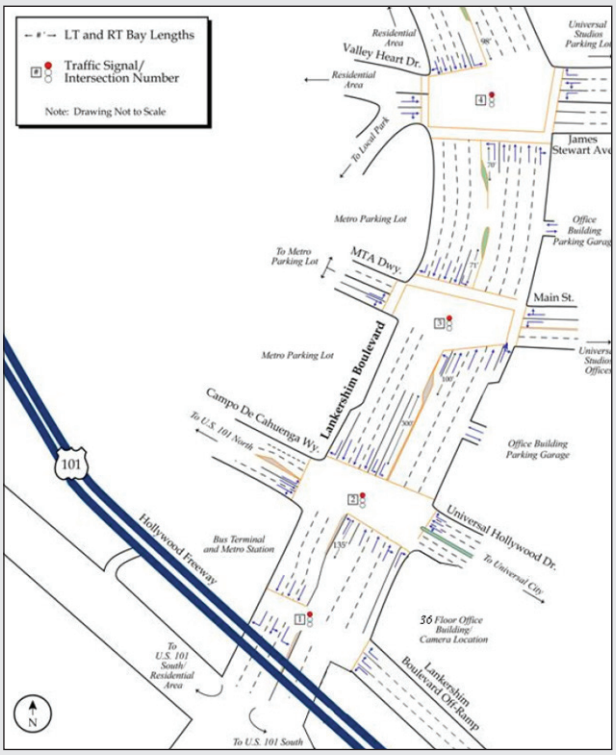

Figure 25. Lankershim Blvd study area

TASK 1

As you watch the video, remember the kinds of user responses that we discussed in Activity #1. For each intersection, record the following information:

1. The geometric layout of the approach, as seen from the perspective of the driver (user).
2. A description of each display for each of the four signalized intersections, as seen from the perspective of the driver.
3. The status of each vehicle display as the vehicle approaches and the response of the driver to the display.

ACTIVITY 4

Learning to See: The Simulation Environment in Which We Will Work

DISCOVERY

Purpose

The purpose of this activity is for you to appreciate how realistic a simulation model can be in replicating traffic flow at a real signalized intersection.

Learning Objectives

- Assess the realism of a simulation environment by comparing it with a video of actual field operations
- Develop your ability to "see" and "observe" video and animation of traffic flow at a signalized intersection and relate these observations to traffic flow theory and principles

Required Resource

- Movie file: A04.wmv

Deliverable

- Prepare a document with your answers to the Critical Thinking Questions

Critical Thinking Questions

As you begin this activity, consider the following questions. You will come back to these questions once you have completed the activity.

1. How realistic does the simulation appear to be? How realistic does a simulation model need to be? What is the basis of your conclusions?

2. Based on the information provided in the video, how do you know that a southbound vehicle has been detected?

3. Is the process of queue formation and clearance for the southbound approach similar or different to the description of traffic flow in Activity #1? Explain your answer.

4. Why does the phase end (or the display turn from green to yellow) for the southbound approach near the end of the video?

5. What other observations can you make that are relevant to the operation of the intersection?

Information

Not all models realistically duplicate traffic flow conditions found in the field. However, if a simulation model such as VISSIM is calibrated correctly, the results can closely approximate conditions that you would observe in the field. You will observe two videos, each of the intersection of State Highway 8 and Line Street in Moscow, Idaho. In this activity you will compare a field video with the simulation of the same intersection and conditions. When you start the movie file, your computer screen will look like Figure 26. The video on the left shows the VISSIM animation while the one on the right shows a video from the field showing traffic flow at the intersection.

Figure 26. Field validation video

Three detector status indicators and the phase 2 green indication are imprinted in black boxes on the video frames. When a detector is "ON," the black text box corresponding to the detector is filled with the name of the detector. The detector names are indicated in parentheses in Figure 26. When the phase 2 green is "ON," the corresponding black text box is filled with "P2," for phase 2. In Figure 26, the two circled vehicles are queued in both fields of view and are calling for service on phase 2 as can be seen by the fact that the stop bar detector is on.

Task 1

Open the movie file, A04.wmv.

Task 2

Watch the video all the way through. Keeping in mind the Critical Thinking Questions for this activity, observe the traffic flow, detection information, and display status for both the southbound approach (upper left in both the video and animation) and the eastbound approach (bottom left). Phase 2 serves the southbound approach and phase 4 serves the eastbound approach. Make notes on your observations.

Task 3

Based on the notes that you made during your observation of the video, prepare brief answers to the Critical Thinking Questions.

ACTIVITY 5

Working Together: Team Building for Effective Learning and Design

DISCOVERY

Purpose

In this activity, you will learn about effective team building and the factors that contribute to successful teams.

Learning Objectives

- Identify essential team behaviors that lead to successful completion of activities and the design project
- Explain how team behaviors support different team roles

Required Resources

- "Designing Teams and Assigning Roles," by Peter Smith
- "Teamwork Methodology," by Peter Smith, Marie Baehr, and Karl Krumsieg
- "Team Reflection," by Patricia Hare

Deliverable

- Prepare a one-page document that addresses your work in Tasks 1 and 4

Information

This activity includes three readings from the *Faculty Guidebook – A Comprehensive Tool for Improving Faculty Performance*, 4th Edition, edited by Steve Beyerlein, Carol Holmes, and Dan Apple and is used by permission. Each of the readings addresses an aspect of team building. More about the *Faculty Guidebook* is available at: www.pcrest.com

Task 1

Spend about ten minutes reading one of the three documents that has been assigned to you. Once you have completed the reading, spend another five minutes preparing a one page outline of the most important points covered in the document.

Task 2

Discuss your outline with your assigned partner. Your task is to prepare a three minute presentation on the paper that you read. The presentation should focus on what the audience should know and be able to do after hearing your presentation.

Task 3

Make your three minute presentation.

Task 4

As you listen to the other presentations, make a list of 2 to 3 key conclusions from the presentations. Confirm your conclusions with the presenters.

Student Notes:

3.4.2 Designing Teams and Assigning Roles

by Peter Smith (Mathematics & Computer Science, St. Mary's College, Emeritus)

For many faculty members, the issues surrounding team construction and management are significant. This module explores methods for implementing the use of roles in the classroom, including assigning students to teams and requiring team members to perform in roles. Because the workplace has become much more team-oriented over the past two decades, it is important that students learn to work well in teams; and students who participate in team environments are much better prepared to succeed on the job than are those without teaming experience. Although it is not yet common for business or industry to employ formal process-oriented roles for team members, graduates who have used roles frequently in undergraduate courses realize that the use of roles would dramatically improve team performance.

Why Roles are Important

Using roles helps team members to become interdependent (Johnson, Johnson, & Smith, 1991) and to be individually accountable for team success. It helps them to increase their learning skills (Apple, Duncan-Hewitt, Krumsieg, & Mount, 2000), and speed up the four stages of team development: forming (goal setting), storming (conflict resolution), norming (problem-solving), and performing (Tuckman, 1965). Roles should be rotated frequently so that each student has the opportunity to practice each role and to realize that effective learning requires that teams use all of the roles simultaneously. Rotating roles discourages dominance by one person and gives all students opportunities to practice social, communication, and leadership skills (Millis & Cottell, 1998). The roles introduced in this module are effective for enhancing team performance because each team member is empowered by his or her role to make a unique and significant contribution to the learning process.

Cooperative versus Collaborative Learning

The use of roles in learning activities is at the heart of the controversy between cooperative and collaborative learning. Although both approaches use small-group learning and encourage cooperative behavior, positive interdependence, and individual accountability, collaborative learning advocates hold that interdependence will occur naturally and that no attempt should be made to structure it. Therefore, the facilitator should not assign teams or roles, and should neither assess learning skills and performance, nor structure their development (Davidson, 1994). Cooperative learning is much more structured. The facilitator strives to ensure that the teams have diverse membership, he or she constantly assesses the skill level and performance of each student, and plans activities that will allow students to improve. When fulfilling the responsibilities of team roles, students must use many learning skills, so the facilitator has opportunities to intervene to help the individual student while ostensibly helping the team improve its performance (***3.2.3 Facilitation Methodology***).

Table 1 ***Various Team Roles and When to Use Them***

E = Essential O = Optional NA = Not Applicable

Learning Situation	*Captain*	*Recorder*	*Reflector*	*Spokes-person*	*Technology Specialist*	*Planner*	*Time Keeper*	*Skeptic*	*Optimist*	*Spy*
Cooperative Learning	E	E	E	O	O	O	O	O	O	O
Laboratory	E	E	E	NA	E	O	O	O	O	O
Project	E	E	E	O	O	E	O	O	O	O
Problem Solving	E	E	E	O	O	E	O	O	O	NA
Student Presentation	E	O	E	E	O	O	E	O	O	O
Student Teaching	E	O	E	E	O	O	E	O	O	O
Committee Work	E	E	E	E	O	E	O	O	O	NA
Department Business	E	E	O	NA	E	E	O	O	O	NA
Grant Writing	E	E	E	O	O	E	O	O	O	NA
Peer Assessment	O	E	E	E	NA	NA	O	O	O	NA

Performance Criteria for Team Roles

Captain

1. Facilitate the team process, keeping it enjoyable and rewarding for all team members.
2. Make sure each member has a role and is performing within that role.
3. Ensure that all team members can articulate and apply what has been learned.
4. Manage time, stress, and conflict.
5. Accept accountability for the overall performance of the team.
6. Contribute to the group as an active learner.

Recorder

1. Record group roles and instructions at the beginning of a task or activity.
2. During an activity, record and collect important information and data, integrating and synthesizing different points of view.
3. Document group decisions and discoveries legibly and accurately.
4. Accept accountability for the overall quality of the recorder's report.
5. Control information flow and articulate concepts in alternative forms if necessary.
6. Contribute to the group as an active learner.

Reflector

1. Assess performance, interactions, and the dynamics among team members, recording strengths, improvements, and insights ***(4.1.9 SII Method for Assessment Reporting)***.
2. Be a good listener and observer.
3. Accept accountability for the overall quality of the reflector's journal.
4. Present an oral reflector's report positively and constructively if asked to do so.
5. Intervene with suggestions and strategies for improving the team's processes.
6. Contribute to the group as an active learner.

Spokesperson

1. Speak for the team when called upon to do so.
2. Ask questions or request clarification for the team.
3. Make oral presentations to the class for the team.
4. Use the recorder's journal to share the team's discoveries and insights.
5. Collaborate periodically with the recorder.
6. Contribute to the group as an active learner.

Technology Specialist

1. Use the available technological tools for the team activity.
2. Listen, converse, and collaborate with team members; synthesize inputs, try suggestions and/or follow directions for the technology.
3. Retrieve information from various sources; manage the available resources and information.
4. Help team members understand the technology and its use.
5. Be willing to experiment, take risks, and try things.
6. Contribute to the group as an active learner.

Planner

1. Review the activity, develop a plan of action, and revise the plan to ensure task completion.
2. Monitor the team's performance against the plan and report deviations.
3. Contribute to the group as an active learner.

Timekeeper

1. Observe the time resource for the activity and/or record the time allocation announced by the facilitator.
2. Keep track of the elapsed time for various tasks and notify the captain when the agreed-upon time has expired.
3. Contribute to the group as an active learner.

Optimist

1. Focus on why things will work.
2. Keep the team in a positive frame of mind.
3. Look for ways in which team discoveries can be applied or used to the team's advantage.
4. Contribute to the group as an active learner.

Skeptic

1. Question and check the assumptions that are being made.
2. Determine the issues or reasons why quality is not being met at the expected level.
3. Be constructive in helping the team improve performance.
4. Contribute to the group as an active learner.

Spy

1. Eavesdrop on other teams during an activity to gather information and seek clarification of direction.
2. Relay information that can help the team perform better.
3. Contribute to the group as an active learner.

(Myrvaagnes, Brooks, Carroll, Smith, & Wolf, 1999)

Issues Surrounding Team Design

1. Although teams can contain any number of participants, most college and university level practitioners prefer groups of four for cooperative learning activities (Millis et al., 1998). Quads are small enough to engage each student, but large enough to provide a rich mix of ideas. Four-person teams can also be easily split into pairs for "think, pair, share" activities. Cooperative learning advocates David and Roger Johnson recommend three-person teams, and up to three of these may be necessary if the number of participants is not divisible by four. If absenteeism is a serious problem, five-person teams may be optimal, although regular attendance is vital because each student has a responsibility to contribute to the team's efforts. Sporadic attendance is a severe handicap to success with cooperative learning.

2. Project, problem-solving, committee-work, and grant-writing teams can be, and probably should be, larger than four, depending on the task to be accomplished and the number of available participants. It is best to assign permanent roles in these teams based on the strengths of the individual members because consistently high performance is more important than learning growth in these circumstances. The captain should be extremely well organized, self-confident, and able to inspire the team to excel. The recorder should be skilled at synthesizing the essential meaning from team discussion and keeping very organized records. The reflector should excel at multiprocessing and be confident enough to suggest improvements, even if they may imply substandard performance by one or more team members. The planner should be very creative and persistent, but flexible enough to accept changes in the plan as the project evolves.

3. Peer assessment and student teaching teams may well be smaller than four, perhaps as small as two, since they have sharply focused goals. All required role activities have to be accomplished, but formal role assignments may not be necessary. The work in these teams is usually divided fairly between the members.

4. Cooperative learning teams may be formed in a number of ways, such as random selection by counting off or drawing cards from a deck, student or participant selection, teacher or supervisor selection, or a combination of the last two. The goal is always to provide the greatest diversity within each team. Random teams often provide this diversity, but there is no way to ensure it. Research shows that participant-selected teams are not diverse and are unlikely to be successful (Fiechtner and Davis, 1985). Participants can suggest several people they would like to work with, and the facilitator can take these requests into account when assigning teams; the aim being to preserve diversity in gender, ethnic background, academic preparation and ability, and discipline or major. In order to gather the information needed to assign teams, many facilitators delay forming permanent teams until they can collect data sheets from students and observe them in learning situations.

5. Teams should be designed to accomplish the task for which they are formed. They can exist for short periods (e.g., formed to complete a five-minute in-class exercise), they can work together for several weeks to complete a project, or they can stay together for a whole semester or longer to provide long-term emotional and academic support (Duncan-Hewitt, 1995). Forming new groups midway through the semester gives students the chance to work with new individuals, thus providing a more realistic simulation of on-the-job teamwork. When deciding if and when to restructure the teams, it is important to carefully consider the learning needs of the participants and how well the current teams are functioning. Younger or more inexperienced students are more likely to need the support that long-term groups provide. Those close to graduation may profit from more frequent team membership changes.

6. One of the first team activities should encourage the team members to introduce themselves and learn about each others' learning styles. At this time, the team should agree to expectations or ground rules for all members.

   Suggested ground rules for team activities (Silberman, 1998):

   - Start on time with everyone present
   - Be prepared
   - Get to know members who are "different" from oneself
   - Be gender/race/ethnicity sensitive
   - Give everyone a chance to speak
   - Let others finish speaking without interrupting them
   - Be brief and to the point
   - Share the workload
   - Rotate group roles
   - Reach decisions by consensus
   - Assess team functioning periodically

Guidelines for Implementing Team Roles

1. The facilitator must check that students have assumed and rotated roles, must intervene to improve role performance, and give credit for conscientious role fulfillment via learning journal reports or other means (***4.1.4 Assessment Methodology***).

2. To ensure that reflectors improve their performance, the facilitator should take time for reflectors to share oral reports with the class, frequently in the beginning of the term and at regular intervals thereafter.

3. Students with roles other than captain, recorder, and reflector often fail to appreciate the importance of their roles. The facilitator should intervene to recognize team members who do well in these other roles or to ask the team if they would like to be informed of specific instances when using these roles would enhance performance.

4. Reflectors may withdraw from active participation in the group in order to observe and write down their assessments. The facilitator should encourage them to observe while fully participating and to take a minute at 15-20 minute intervals to jot down their assessment.

5. Recorders may complain that they are so busy writing that they have no time to think or to process what the team is doing. They need to be encouraged not to write everything down, but to synthesize the discussion in a few well-constructed sentences.

6. When the captain is very shy, introverted, or not confident, another team member is likely to take over that role. To fix this situation, the facilitator should address all team intervention questions to the captain, refer to the team using the name of the captain (unless the team has chosen another name), hold the captain responsible for time management, and attempt to make eye contact with the captain when giving positive nonverbal feedback to the team.

7. The nature of the team roles and the responsibilities of those fulfilling the different roles may well change as the team moves through stages of development. More permanent roles may be appropriate in the latter stages of team development.

Concluding Thoughts

The effort needed to establish team roles and train students in their use pays big dividends in increasing learning. Roles also help ensure fair participation in the group process by all the learners. Students who value and experience defined roles in the group process will be prepared to assume a variety of roles in the workplace and in community and extracurricular activities as well.

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3.4.3 Teamwork Methodology

by Peter Smith (Mathematics & Computer Science, St. Mary's College, Emeritus), Marie Baehr (Vice President for Academic Affairs, Coe College), and Karl Krumsieg (Vice President of Operations, Pacific Crest)

Teamwork is essential when a group of people strive to achieve a common goal. Because teamwork is a process, a methodology is needed to better understand and master performance in this area. This module presents a methodology that can benefit team performance by experts as well as novices. To demonstrate how the methodology might be practiced by people with different levels of experience, two examples are presented: one that involves a team of students, and one that involves a team of faculty members.

Need for a Teamwork Methodology

The dictionary defines *teamwork* as the joint action by a group of people in which individual interests be-come secondary to the achievement of group goals, unity, and efficiency. In other words, teamwork involves a group of people actively cooperating in an organized way to achieve a goal. The process of teamwork has become commonplace throughout organizations in all areas of society, including business and industry, health care, public service, government, and education (Commission on Accountability in Higher Education, 2005). The benefits of teamwork are numerous. When an effective teamwork process is employed, more can be accomplished with better results. Individuals working within teams also develop many beneficial skills: teaching new skills to others, learning to negotiate, exercising leadership, and working with diverse people in diverse situations; being part of a team effort in which individual members are held accountable (Millis & Cottell, 1998).

Teamwork is an individual skill: everyone in an organization must take responsibility for the performance of each team to which they are assigned; otherwise individuals can justify non-performance by blaming the team (Avery, 2001). Teamwork differs from project management in that it focuses on team formation and the behaviors and attitudes of the team members; not just the successful accomplishment of the project, goal, or product (Smith & Imbrie, 2005). Team membership calls on a participant's personal development skills (***4.2.3 Personal Development Methodology***), but it also requires individuals to establish relationships and interact with other team members. Teamwork requires leadership skills, but it is just as important for team members to be able to support the leadership of another. In fact, teams are seldom allowed to reach their full potential when they adhere to the traditional concept of a leader who makes a majority of the decisions (Maxwell, 2001). Team activities can employ a number of methodologies, such as communication, learning, problem solving, research, and design; but none of these focus on team formation and group processing. The reader is encouraged to compare the guidebook modules describing these methodologies with the Teamwork Methodology listed in Table 1 and to note differences in emphasis.

Table 1 ***Teamwork Methodology***

1. **Define the Mission:** Establish a common vision and goals for the team.
2. **Recruit Members**: Assemble the individuals to meet the needs of the team.
3. **Collect Resources**: Identify and collect resources available to the team.
4. **Build the Team**: Assign members to appropriate roles.
5. **Create and Implement Plan:** Schedule the resources for identified tasks and perform the plan.
6. **Assess Performance**: Assess the performance of the team against the plan
7. **Modify the Plan**: Make periodic improvements to the plan.
8. **Provide Closure**: Provide a final point or end; celebrate accomplishments.

A Simple Example of the Methodology

Scenario: The instructor for a capstone course in an engineering program has decided to use teams to more realistically simulate the process of project design and development. One of the project options is to design a high-impact tester to shock test circuit boards for naval warships.

1. **Define the Mission**

   Student teams must complete a high-quality drawings package for a high-impact tester that can be used by an electronics company for the eventual fabrication of this device.

2. **Recruit Members**

   The course instructor composes teams using information gained from an email questionnaire completed by students shortly before the first class session. The aim is to preserve diversity in gender, ethnic background, academic preparation, and discipline or major. The instructor must staff multiple projects, and all must have an equal likelihood for success.

3. **Collect Resources**

   The instructor identifies software tools, fabrication facilities, and working space required by each team. In this case, solid modeling software is installed on the lab computers. The lab also has meeting areas for pri-vate team meetings. The flawed and incomplete blueprints from the Navy are also available.

4. **Build the Team**

   On project assignment day, team members interview each other to discover their interests and personal goals for the course. Each team is asked to develop a shared vision of project success and to determine relevant roles that motivate each member. The team working on the impact tester sets a goal of having their design selected by the client and having their device installed within two months after the finalization of the drawing package. They select roles of project manager, document clerk, reflector, and client com-munications coordinator.

5. **Create and Implement the Plan**

   Each team creates milestones to ensure that the project is completed on time. They use insights gained from a client interview with a lead engineer at the electronics company to divide the work as fairly as possible according to ability and interest. Each team draws up a detailed plan to meet their first milestone and all team members commit to it.

6. **Assess Performance**

   The project manager periodically checks to ensure that tasks are being satisfactorily accomplished in a timely manner. He finds that two tasks require more work than was anticipated. The reflector also touches base with each team member regularly and finds that those assigned to the difficult tasks are becoming frustrated.

7. **Modify the Plan**

   At the team's next meeting they confront the problem of task difficulty. Two members who have com-pleted their tasks volunteer to help with the tasks that are falling behind schedule. They agree to distribute tasks more equitably when they plan for the next milestone.

8. **Provide Closure**

   After presenting the results of the first milestone to their client, the team goes out for pizza to celebrate a job well done and to get revved up for the next milestone.

Discussion of the Teamwork Methodology

1. **Define the Mission**

   The first step to building a team involves identifying and defining the purpose and objectives for the team. The mission influences who is recruited, what resources are needed, and what main tasks need to be performed. In some cases, teams are formed to accomplish a specific goal; in other cases, teams maintain their structure but may change the people involved.

2. **Recruit Members**

   One should identify and recruit people who believe in, and are committed to, the stated mission. These individuals should define their goals and objectives, share their reasons for involvement, and indicate how their participation can strengthen the performance of the team.

3. **Collect Resources**

   The mission statement influences what resources are required to meet the team's goals and objectives. One should identify the available resources and determine what additional resources need be obtained. Examples of a team's resources include the team members and their skills, financial assets, information, computers, physical equipment and facilities, time, and the team members' individual resources that they are willing to contribute for the team's use.

4. **Build the Team**

   It is important that team building occurs at this point and continues throughout the process. Participants must build shared ownership of the team's goals and objectives, and all must believe that these are worthwhile and attainable. By assigning roles with job descriptions, one enhances the team's accountability, performance, and unity while helping to facilitate team goals. Depending on the purpose and length of the team's mission, roles should be periodically rotated so that everyone can gain experience and improve skills in different areas.

5. **Create and Implement the Plan**

   The process of creating the plan need not be democratic; however, it is important that all members accept responsibility for implementing it. Successful completion of the plan depends on "buy in," or acceptance, by all team members. It is important that as the team implements the plan, all members perform according to their roles. The team captain is responsible for team's overall performance.

6. **Assess Performance**

   Each member's performance should be regularly assessed according to the criteria set for each role. The team as a whole should also be regularly assessed as it works toward meeting its goals and objectives. By assessing during the early stages of the plan (as well as on a regular basis), it is possible to determine what is working and what needs to be changed.

7. **Modify the Plan**

   The plan of action should be updated as dictated by the situation and/or by the team's performance. Changes and modifications can be made for both the short term and long term. In addition to modifying the plan, one may also change the situation by shifting roles within the team, adding new team members, obtaining additional resources, or by changing the goals and objectives.

8. **Provide Closure**

   All team members should know when the plan is completed or the objectives have been met. Both individual and team accomplishments should be acknowledged and celebrated.

Another Example of the Methodology

Scenario: A college needs to replace its Director of Information Technology. The Academic Dean assigns a search committee to this task.

1. **Define the Mission**

   The mission is to find an outstanding candidate for the position of IT director and to prepare a report for the dean.

2. **Recruit Members**

   The dean consults the department heads of those areas that interact most closely with IT and asks them to recommend persons under them who will be competent and committed to the search com-mittee process. She suggests that potential search committee members submit written statements de-scribing what they hope to contribute to the search process. The dean consults the department heads of Business Affairs, Human Resources, Registrar, Admissions, and the Library; and faculty from Math, Science, and Business. She asks the math faculty representative to chair the committee, and together they select the other members. The dean sends appointment letters to each.

3. **Collect Resources**

   The Educause organization has a national clearinghouse to advertise for IT directors. There are some other technical journals and trade publications like Compuworld that accept advertising. The college will pay for these ads as well as travel and housing expenses to bring three candidates to campus for interviews. The Business Affairs Office offers their conference room for meetings and the services of their secretary to take minutes.

4. **Build the Team**

   At the first team meeting the members share their goals and accept the following roles and tasks which they all agree will accomplish the search committee's mission. Peter represents the math department. He will act as team leader. He facilitates team meetings and manages time resources. He checks to make sure that each team member accomplishes his or her job, and he helps the team stay focused on its objectives. Debby is the Human Resources Director and Researcher. She agrees to schedule candidates' interviews, and to arrange their travel and lodging. She identifies the references provided on each candidate's application, and sets up phone contacts with them. She also arranges phone interviews with each candidate, and discusses the salary and benefits packages with them. Mary, the Admissions Director, ensures that the candidates are committed to the support of student recruitment. She also coordinates campus tours and student lunches with the on-campus interviews. Alice, the Registrar, makes sure that the candidates are aware of the difficulties presented by in-house registration software and the lack of a system of computerized class scheduling. She also informs the candidates of the IT concerns of the administrative and reports their responses back to the team. Jill, represents the business department, and acts as the team's reflector. She assesses the process of the team, offering regular feedback about the team's performance, including their strengths, areas in need of improvement, and insights. She also serves as mediator to help resolve conflicts that arise among team members. Les, the Business Affairs Manager, assesses the candidates' fiscal knowledge and ability to work with Financial Aid as well as their commitment to include business functions, especially billing and payroll, into an integrated networked IT system. John, the Development Office Representative, observes the candidates during their on-site interview visits, watching how they deal with college personnel who have little IT savvy but significant IT needs. He is particularly interested in the candidates' creativity in problem solving. Dick represents the science department faculty. He as-sesses the candidates' level

of commitment to working towards IT literacy among students, and their interest in utilizing work study students in the IT department. Dick also constructs an efficient process for narrowing the candidates.

5. **Create and Implement the Plan**

   The team meets and, after brainstorming goals and objectives, agrees on several project goals, and objectives having to do with their overall work process. Their goals are to select the three best candidates to bring to campus for interviews, to choose the best of the three to recommend to the Academic Dean, and to complete this process within two months. They agree on a project implementation plan. They begin by reading the written applications and rejecting the candidates who are clearly unsuitable. They interview each remaining candidate by phone with at least two committee members participating in each call. They agree to use Dick's plan for narrowing the pool of candidates. They check the references of those candidates who made the cut, and, if they still have more than three, select the best three for on-campus interviews. Debbie arranges travel and lodging for each finalist, and sets up a full-day interview schedule span-ning a two-week period, during which all constituencies will be included in the interview process. They schedule a final meeting to identify the best candidate and prepare a report for the dean, followed by a ca-tered lunch to celebrate a job well done.

6. **Assess Performance**

   After the application deadline, the team meets weekly to monitor progress on the project as well as the team's process. At the first meeting they eliminate five candidates who clearly do not have the qualifications for the job. The team completes the phone interviews in record time. By the second meeting they are ready to apply Dick's weighted voting process to the remaining candidates. There is a clear separation between the top five candidates and the others. Debby is swamped trying to check references for these five.

7. **Modify the Plan**

   Peter asks different members of the team to call the references, three members to each call. Also, a different group from the committee talks to each of the remaining candidates until each member has talked to each candidate. Even though this takes an additional two weeks, the search process is still on schedule. After all of the interviews have taken place, the committee is able to eliminate two candidates from consid-eration and everyone believes that the decision process has been fair.

8. **Provide Closure**

   The on-campus interviews are very revealing. In the opinion of all participating constituencies one candidate is clearly superior (Debby gathers this information using a standard questionnaire to solicit feedback from everyone involved). The committee decides that if the dean rejects this choice or if the desired candidate turns down the offer, the search should be reopened. After completing the report to the dean well within the two-month time frame, the committee celebrates its work with catered lunch, and then disbands. Fortunately, the dean agrees with the committee's choice and the candidate accepts the position and does an outstanding job for the college for the next ten years.

Concluding Thoughts

Teamwork is a process that challenges each team member to accept accountability for accomplishing the team's goals and for actively contributing his or her utmost to enhance team synergy; potential team members should not accept membership on a team if they cannot make this commitment. This methodology provides a blueprint for bringing every team performance to the highest level so that participation becomes a growth experience for all. It is important to remember that, in many cases, team performance will be degraded if team members focus only on the product the team is expected to produce without paying attention to the process of team formation, interaction, and closure. Try implementing this methodology during your next teamwork experience. While your teammates may be skeptical initially, they will likely appreciate the improved teamwork that this structure will produce.

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3.4.4 Team Reflection

by Patricia Hare (Dean of Developmental Programs, Brevard Community College)

To attain optimum productivity in team projects and cooperative learning situations, it is critical that team members spend some portion of their time thinking critically about the effectiveness of their work as a team. *Team reflection* is a process in which team members bring closure to their work or learning experience, and focus on ways to increase future learning and performance. Ideally this should use no more than 5% of a group's actual performance time. Ideally team reflection uses an assessment-oriented approach, analyzing personal and team happenings against important criteria, and producing action plans that can add value to future performances.

Nature of Reflective Practice

What separates humans from animals is our ability to examine our world carefully, to think about our surroundings, and to think about our own thinking. Thinking about what we were thinking, doing, or feeling is known as *critical thinking* or *reflection* (Chaffee, 2004). Experts tell us that when we reflect, we must allow space (with no distractions), silence, and time to ponder and to self-assess (Ferrett, 2006). Reflection is a cornerstone of purposeful learning and of critical thought.

Donald Schön distinguishes between two different types of reflection: reflection-in-action and reflection-on-action. *Reflection-in-action* is "thinking on our feet." We observe our experience, paying attention to what might be unfolding, connecting with our feelings, and building new understandings to inform our actions in that experience. *Reflection-on-action* involves thinking about our experience after it has happened, to think about why we acted as we did during the experience, to consider what was happening individually or in a group, and to explore circumstances that might have been present.

Reflective practice, whether it is in action or on action, is a habit, structure, or routine for examining individual and group experiences. It can vary in depth, frequency, and length depending on its purpose (Amulya). Reflective practice can be based on finding solutions (***3.3.4 Problem-Based Learning***), habitually journaling personal experiences (***4.2.3 Personal Development Methodology***), or making deliberate improvements in quality (***4.1.4 Assessment Methodology***).

Role for Assessment

When one practices reflection with a mindset toward assessment, one focuses on helping performers improve the quality of their future performances rather than simply analyzing and evaluating past events (***4.1.2 Distinctions Between Assessment and Evaluation***). Assessment is assessee-centered and is guided by appropriate performance criteria (***4.1.7 Writing Performance Criteria for Individuals and Teams***). For the assessment to be effective, the assessor and the assessee must trust and respect each other, and the assessee must be prepared to act on the assessment feedback (***4.1.8 Issues in Choosing Performance Criteria***). Models such as the ***SII Method for Assessment Reporting (4.1.9)*** provide a structure for identifying strengths in performance, including explanations for why they were strengths; for prioritizing improvements, including descriptions of how they might be implemented; and for generating insights about knowledge construction, problem solving, or personal development that have value in other contexts. Formal aids such as a reflection journal, periodic reflector reports, and team worksheets can recover important data associated with an individual or team performance that makes assessment feedback more specific and therefore more useful (Apple, 2000).

Team reflection is an excellent process to start developing team assessment skills. Use of peer reporting leads to dialogue between peers and others involved in the learning process. Each member takes a turn recounting a key event, accepting feedback and analyzing it, making assumptions and connections, and formulating questions that emerge in the process. This practice allows the group to explore assumptions and connections across multiple perspectives. One advantage of team reflection is that reflections emerge from collective work that is frequently connected to or aligned with team values. Based on what the team learns through reflective thinking and sharing, the team can assess whether they have met their own performance criteria and can generate action plans to improve future performances.

Team-based reflection forces students or team members to think at higher levels in Bloom's taxonomy (***2.2.1 Bloom's Taxonomy—Expanding its Meaning***). Reflective practice is enhanced by active listening, questioning, discussing, and storytelling. Team reflection that results in high-quality assessment feedback can be promoted by assigning and using the role of team reflector (***3.4.2***

Table 1 ***Criteria for an Oral Reflector's Report***

The report should
• Be loud and clear enough for all to hear
• Be concluded within 30 seconds (unless specific otherwise)
• Identify one strength of the team's performance and explain why it is a strength
• Identify one area for improvement on which the team can focus, and explain how the team can make this improvement
• Provide one insight gained about the learning process, and explain the significance of the insight

Table 2 ***Criteria for a Written Reflector's Report***

The report should
• Be concise
• Prioritize information
• Relate to the focus area of performance
• Refer to key skills used by the team
• Address affective issues
• Be clear
• Be accurate
• Cite specific examples to support assessment results
• Provide supporting documentation in the *Learning Assessment Journal*

Designing Teams and Assigning Roles). The reflector should keep a journal in which to record team strengths, improvements, and insights. This person should report his or her findings in a positive and constructive manner (reflection-on-action), and also intervene during teamwork sessions with suggestions and strategies for improving the teams' processes (reflection-in-action). The reflector role should be rotated among team members.

Tools for Team Reflection

A number of tools for stimulating team reflection are available. One tool is the reflector's journal mentioned above. Entries are made in real time and are grounded in the knowledge gained through the experience. The *Learning Assessment Journal* contains reflector report forms and weekly reflector report forms which provide excellent prompts for reflection-in-action and reflection-on-action (Apple, 2000). Findings can be summarized and acknowledged in two ways: in oral reflectors' reports and in written reflectors' reports. Criteria for these reports are given in Tables 1 and 2.

Reflective journaling can be used in online discussions about an event or an experience that is shared by the online team. Members engage in discussions, reflecting on what they have discovered in the experience or the event. Problem-based reflective practices and assessment can also be conducted online, with reflections written in discussion boards. Members can then assess what they have learned during these sessions.

Concluding Thoughts

Reflective practices can add significant value to cooperative learning as well as student and faculty projects (Rodrique-Dehmer, 2007). Implementing reflective practices in a team environment will certainly take more time initially. However, faculty who make the commitment to use reflection on a formal and regular basis, both in their classes and in their committee work, find that the benefits of team learning, productivity, and participant satisfaction significantly outweigh the initial time investment.

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ACTIVITY 6

Design Team Agreement

DESIGN

Purpose

Forming a team is a non-trivial task. Each member of a team has different expectations, experiences, and ways of working that have to be blended and negotiated with other team members. One of the readings from Activity #5 defines teamwork as "... the joint action by a group of people in which individual interests become secondary to the achievement of group goals, unity, and efficiency." Since much of the work done in engineering practice today is based on working effectively in teams, the experiences that you gain in learning how to do this will be valuable ones.

Learning Objective

- Develop group consensus on how the team will work with, treat, and communicate with each other.

Required Resources

- "Designing Teams and Assigning Role", by Peter Smith
- "Teamwork Methodology", by Peter Smith, Marie Baehr, and Karl Krumsieg
- "Team Reflection", by Patricia Hare

Deliverables

- Prepare a document with your team's answers to the Critical Thinking Questions
- Prepare and sign the team agreement

Critical Thinking Questions

1. How do you want to be treated by your group?

2. What do you expect from each group member during a group meeting?

3. How do you intend to communicate with each other and by what means?

4. How do you intend to keep records of work conducted by the group and by individuals within the group?

5. How do you intend to resolve disputes or conflicts?

6. When do you intend to regularly meet outside of normal class hours?

7. How do you intend to divide work tasks among group members?

8. How do you intend to assess the performance of the group and its members?

Task 1

Assemble into your assigned group. Reflect on the reading that you completed in Activity #5 and the two presentations that you listened to. Answer the Critical Thinking Questions and discuss them with your group.

Task 2

Prepare a one-page document that addresses the issues listed above. The document should be in the form of a "team agreement" that starts with "We agree to …" and that is signed by each team member.

ACTIVITY 7

Introduction to the Traffic Signal Timing Manual

Purpose

The purpose of this activity is to give you the opportunity to explore the basic reference used by practitioners in this field, the *Traffic Signal Timing Manual*.

Learning Objective

- Describe the content, scope, and organization of the *Traffic Signal Timing Manual*

Required Resource

- *Traffic Signal Timing Manual*

Deliverables

Prepare a document that includes

- Answers to the Critical Thinking Questions
- Completed Concept Map

Link to Practice

Your instructor will assign a reading from the *Traffic Signal Timing Manual*.

Critical Thinking Questions

When you have completed the reading, prepare answers to the following questions:

1. What is the purpose of the *Traffic Signal Timing Manual*?

2. List each of the chapters in the manual and briefly describe the purpose of each.

3. Which of the chapters do you think are most pertinent to the work that you will be doing during this class?

4. What is the difference between a policy and a standard?

5. What defines a signal timing policy?

6. Find the section of the *Traffic Signal Timing Manual* that deals with the signal timing design process. Target two aspects of the signal timing design process where your understanding could be strengthened. Write a critical thinking question for each of these two aspects. Provide answers to these questions.

7. What are some of the interesting or important findings of the National Signal Timing study and why do you find them interesting or important?

8. How does policy support the design of the traffic control system?

9. In addition to the examples of signal timing policy application described in your reading of the *Traffic Signal Timing Manual*, find one other example based on a search of the Internet. Briefly describe it and provide the URL.

10. What are some advanced traffic control concepts that are described in the *Traffic Signal Timing Manual*? List and define three of these concepts.

In My Practice...

by Tom Urbanik

Traffic signal timing has several aspects ranging from a simple signalized intersection to traffic signals adjacent to railroad grade crossings. While the timing engineer may work regularly on isolated and coordinated intersections, occasionally a special problem may arise that the engineer has not worked on such as railroad preemption of a traffic signal. The *Traffic Signal Timing Manual* has practical guidance which the signal timing engineer can use to determine the requirements for operating the traffic signal. It should be noted that there may be situations that are too complex for the timing engineer to comfortably address. By referring to the *Traffic Signal Timing Manual*, the engineer may conclude that they are not comfortable with tackling the problem, but can become knowledgeable enough to seek the appropriate assistance to create a safe and efficient solution.

CONCEPT MAP

Terms and variables that should appear in your map are listed below.

actuated control	detector	fixed time control	queue
controller	display	movement	user