SMS on Wheels

BY THOMAS ANTHONY

For several years, we have sought to explain the safety management system (SMS) concept using the mental model of pillars. Yet, SMS still remains a mystery to many. This is not a reflection on SMS itself but rather on the ways we have sought to explain it.

Peter M. Senge, a senior lecturer at the Massachusetts Institute of Technology and founding chair of the Society for Organization Learning, explains the function of mental models as follows:[1]

> *None of us can carry an organization in our minds. … What we carry in our heads are images, assumptions and stories. … Our mental models determine not only how we make sense of the world, but how we take action.*

Our mental model of SMS is important not only because it organizes our understanding of SMS but because it directs the action we take and how we move forward with SMS.

With this in mind, let's take a look at the mental model created by the image

A new spin on understanding safety management systems.

of pillars (Figure 1). Pillars are singular supportive components of structures such as buildings and temples. They are strong and often clearly identifiable. These positive characteristics of pillars are what led to their widespread use as a mental model for SMS. But, there are other characteristics of pillars that do not fit the concept of SMS. Pillars are static. They are not dynamic; they do not characterize motion or change. While they may be beautiful in structures such as the Parthenon, their function is to support something else. They do not describe the structure as a whole.

For these reasons, the mental model of pillars has taken us just so far with regard to understanding SMS.

What mental model works better? Wheels. SMS is like a system of wheels or gears, each of which causes the others to turn. Without each one functioning, none of them can turn. This mental model conjures a system in which each element influences the others and in which all the elements must work together for the system to function.

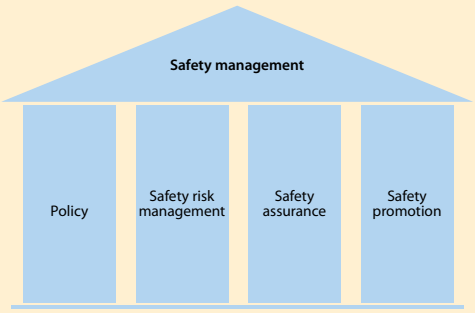
The three wheels of SMS are:

- Hazard identification;
- Risk analysis and assessment; and,
- Risk mitigation by involved management.

Hazard Identification

The first wheel represents all activities of an SMS whereby we collect information and data that help us identify hazards (Figure 2). These activities include hazard reporting systems available to all employees,

Pillars Model of SMS



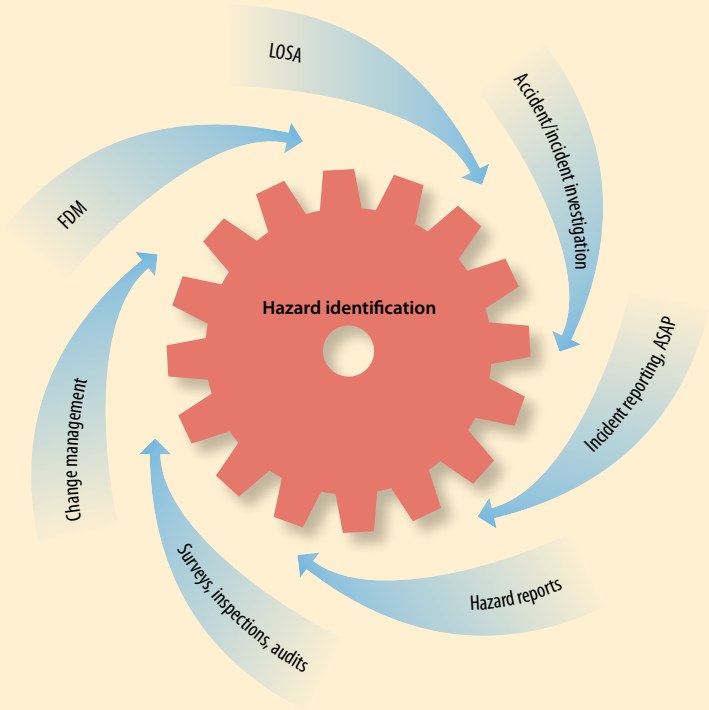
SMS = safety management system

Source: U.S. Federal Aviation Administration/Susan Reed

Figure 1

incident reporting systems such as an aviation safety action program (ASAP), the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS) or the U.K.

Hazard Identification, the First Wheel



ASAP = aviation safety action program FDM = flight data monitoring
LOSA = line operations safety audit

Source: Thomas Anthony/Susan Reed

Figure 2

Confidential Human Factors Incident Reporting Programme (CHIRP), and flight data monitoring systems such as flight operational quality assurance (FOQA) programs.

Activities that collect information on hazards include surveys, inspections, tests and audits, such as the line operations safety audit (LOSA). These are conducted to identify hazards resulting from operations or performance that do not comply with established standards. The standards may be regulations, approved procedures or company procedures. There is little room for argument that noncompliant performance represents anything other than a hazard. In his research, David Huntzinger, now vice president of safety and security for Baldwin Aviation, has found that 60 percent of fatal accidents involved at least one instance of intentional noncompliance with procedure. Additionally, investigations are conducted to identify hazards that contribute to aviation accidents and incidents.

Finally, the hazard identification wheel includes the change management process. James Reason, professor of psychology at the University of Manchester, states, "Change in one guise or another is a regular feature of error-producing situations." Aviation is inherently a dynamic and ever-changing industry that is constantly producing hazards even as it strives to reduce them.

All the activities that are part of the hazard identification wheel provide data on conditions that could result in accidents, incidents or loss in aviation operations. How important are these data-collection processes? Daniel Maurino, chief of the International Civil Aviation Organization (ICAO) Integrated Safety Management Section, stated it succinctly: "Without data, you don't have an SMS."

In judging whether an organization has adequate hazard identification channels, we can ask: Are there hazard reporting procedures available for all elements of the organization in which actions may create a hazard that contributes to the accident/incident causation chain?

In short, the hazard identification wheel is the SMS stage that includes all the processes we use to *collect* hazard information.

Risk Analysis and Assessment

The second wheel of the SMS model comprises an essentially different type of activity from hazard identification. In the risk analysis and assessment stage, we *process* the data that have been acquired in the first stage (Figure 3).

We begin by validating the hazard data to ascertain that the data are true and to gauge the extent to which the hazards exist. Then we analyze the information according to two criteria:

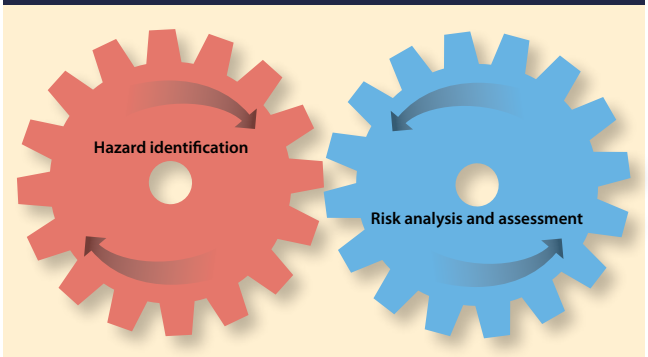
- How severe will the losses be if this hazard occurs?
- How likely is it that the hazard will occur?

So that this risk assessment is done properly, two more conditions must be met. First, a standard by which hazards are assessed is developed and adopted by the organization. This means that all hazards are assessed using the same measure. This is accomplished when an organization develops a risk assessment matrix upon which to base its decisions regarding *likelihood* and *severity*. Second, however, is the necessity that the organization devote to the risk assessment process individuals who possess the knowledge and expertise necessary to make reasonable and knowledgeable assessments.

The risk assessment matrix is not a "file and forget" tool. It must be applied by high-performing and responsible individuals with expertise from each of the major areas of the organization. Why not say "all major *operational* areas of the organization"? Because hazards can be created by the budget department, the training department and by human resources. Hazards created by staff offices can be just as deadly as those created by flight operations. Several accident investigations have pointed out that management and administrative practices can present hazards that contribute to the accident causation sequence. Thus, individuals representing all major areas of the organization must participate, as part of the "Safety Action Group," in risk analysis and assessment.

Just as risk assessment depends on hazard identification for data, it also depends on the third wheel, risk mitigation by involved management, to make available high-functioning and valuable employees to participate in the

Processing the Data



Source: Thomas Anthony/Susan Reed

Figure 3

risk assessment process. Additionally, to achieve consistently balanced and objective assessments of risk, a management official with authority over the entire organization should serve as the safety advisor, or head of the Safety Action Group. The safety advisor is well placed as the secretary of the Safety Action Group to provide expertise, organization and guidance.

While the discussion of safety management in ICAO Annex 6, *Operation of Aircraft*, and Annex 14, *Aerodromes*, emphasizes top management's *accountability* for safety, what has been missing from the SMS discussion thus far is that participation in the Safety Action Group risk analysis and assessment process also presents a valuable *opportunity* for management. It is the opportunity to learn about issues that could have the most profound effect upon that particular organization: safety hazards.

Peter Senge, in his book *The Fifth Discipline*, shows how mental models determine how we see our organization, its mission and our role within the organization. Senge points to a study conducted by Royal Dutch Shell in 1982 which found that of the corporations that made up the Fortune 500 in 1970, one-third of them no longer existed in 1982. The reason for their extinction was in large part due to mental models that did not adapt to changing conditions.

To avoid the same fate, organizations must evolve to become *learning organizations*. Participation by top management in the Safety Action Group is an opportunity for shared learning among all significant elements of the organization. There is no quicker step on the route to extinction for an aircraft operator than a major accident. Beyond this, participation in the risk assessment process presents an opportunity to develop a shared vision that has safety as a core element. It becomes a mechanism of learning for management, line and staff.

In applying the risk assessment matrix in large organizations that produce a great deal of data, it is desirable to use an automated information system to quantify and classify the hazard data and make initial assessments of risk.

Nevertheless, while it is important to classify and quantify the data being reviewed in the risk assessment process, a measure of judgment and perspective must be applied to the data. As an example, the number of aircraft hijackings that occurred in North America from 1991 to August 2001 was zero. Was it correct then to conclude at the end of that nearly 10-year period that the risk of a hijacking was near zero and therefore no additional mitigation measures were necessary? No, the 9/11 hijackings proved that such a conclusion was not appropriate. This level of judgment and perspective is best provided by management, that portion of the organization with responsibility over the entire organization.

Involved-Management Action

ICAO Annex 6, Part 1, Section 3.2.5, has it exactly right in stating:

> *A safety management system shall clearly define lines of safety accountability throughout the operator's organization, including a direct accountability for safety on the part of senior management.*

Likewise, U.S. Federal Aviation Administration (FAA) Advisory Circular 120-92, Paragraph 8.b.(3), recognizes the essential character of management involvement and participation in the SMS process:

> *Management must plan, organize, direct and control employees' activities, and allocate resources to make safety controls effective. A key factor in both quality and safety management is top management's personal, material involvement in quality and safety activities.*

Management involvement in the safety process is the essential difference between today's SMS and the risk assessment processes of the past. It is through SMS that safety is granted full consideration among the other principal issues that demand top management's attention.

The third wheel in our SMS mental model is the stage in which action is taken to mitigate unacceptable risk as determined in the previous stage (Figure 4, p. 44). There are two preconditions for this stage to be effective. First, the same experienced and knowledgeable individuals must be involved in determining what mitigations will be (a) effective and (b) reasonable to implement. The second precondition is the involvement of top management, because top management has the power to allocate resources for the mitigations and has authority across all competing priorities of the organization.

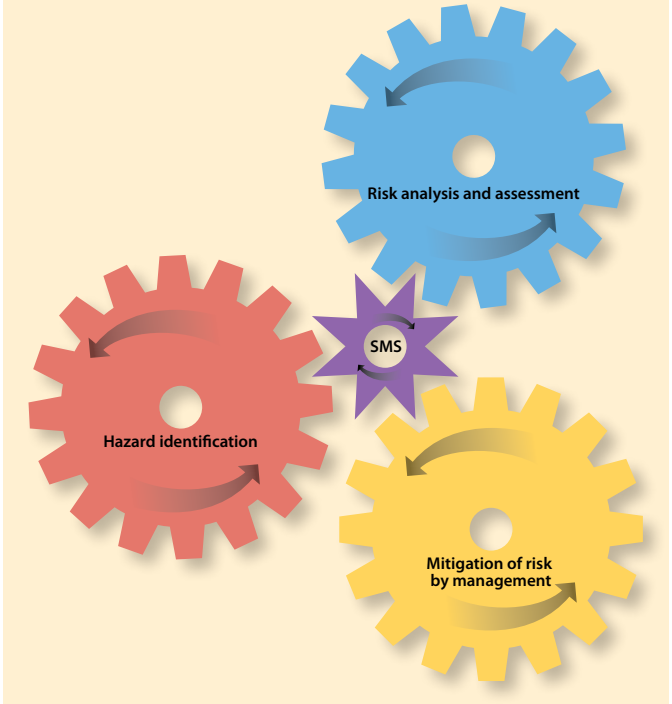
The third wheel transmits the actions required to mitigate the hazards to the organization.

Lubri-Communication

For a system composed of wheels or gears to continue to operate, lubrication is required. In SMS, this lubrication is communication. Without the free flow of meaningful communication, the system will come to a grinding halt. *Communication* means not simply data, but the meaningful back-and-forth sharing of hazard and risk information.

Management has a special role in creating an organization that encourages the communication of hazard information. This is done by establishing a *reporting culture* and a *learning culture*. A reporting culture ensures a realistic flow of hazard information and data. A learning culture ensures that hazard/risk information generates

Management, the Driving Wheel



SMS = safety management system

Source: Thomas Anthony/Susan Reed

Figure 4

reasonable mitigation measures and that the organization internalizes what it has learned. A learning culture underwrites a viable organization. A learning culture is always asking, Why?

Management establishes a reporting culture both by authoring a safety policy statement that supports SMS and by advocacy and personal example. This means the modeling of behaviors, by example, that encourage the free flow of hazard information. A reporting culture cannot be established or sustained in an environment characterized by fear and reprisal.

Although an organization may possess all the component parts of an SMS, the system will have no positive effect unless there is communication. Communication is influenced by mental models. As Senge says, "Two people with different mental models can observe the same event and describe it differently." The perceptions differ because they are viewing the event from the perspectives of two different mental models.

In SMS, the communication intrinsic to the risk assessment stage and the risk mitigation stage forces representatives of different elements of an organization to analyze hazards from a single basic perspective: *safety*. In this way, the SMS process stimulates the development of a shared mental model of safety within an organization.

Moving Forward

Wheels are made for movement. They are dynamic. They imply progress. They can interact with other wheels, create motion and keep turning. They are the means of moving forward.

The three wheels of SMS work in coordination with each other to produce effective organizational responses to hazards that are inherent and evolving in the aviation environment. The three wheels work together to *collect* hazard information, to *analyze* it in order to ascertain risk and then to *act* upon this assessment in mitigating unacceptable risk. All components of an SMS fit into one of these three primary functions: collect, analyze and act.

For an effective SMS to continue operating, management must create, encourage and support a reporting culture and a learning culture within its organization. Management is the key. It is the driving wheel of the SMS, enabling the rest of the system to create risk mitigation measures.

Beyond the four safety management pillars shown in Figure 1, ICAO Annex 6 and Annex 14 identify the following five *standards* requiring that an SMS:

- Identifies safety hazards;
- Ensures remedial action necessary to maintain an acceptable level of safety;
- Provides for continuous monitoring and regular assessment;
- Aims to make continuous improvement; and,
- Clearly defines lines of safety accountability, including direct accountability for safety for senior management.

The wheels model integrates all these pillars and standards into three basic functions. It has the advantage of making a clear distinction between the *collection* activities and the *analysis* activities — that is, the hazard identification stage and the risk analysis and assessment stage. And it emphasizes the role of involved management as the driving wheel of SMS.

Thomas Anthony is director of the Aviation Safety and Security Program at the Viterbi School of Engineering, University of Southern California.

Note

1. Senge, Peter M. *The Fifth Discipline: The Art & Practice of the Learning Organization.* New York: Doubleday/Currency, 2006.