Sources of Schedule Risk

Schedule risks are second most numerous in the PERIL database after scope risks, representing almost a third of the records. They fall into three categories: *delays*, *estimates*, and *dependencies*. Delay risks were most numerous; these are defined as schedule slips due to factors that are at least nominally under the control of the project. Estimate risks were on average the most damaging of the schedule risks; these are cases of inadequate durations assigned to project activities. Schedule dependency risks, also significant, relate to project slippage due to factors outside the project. (These dependencies all relate to timing—dependency problems primarily caused by deliverable requirements are grouped with the scope change risks). Each root-cause category is further divided into subcategories:

Schedule Root-Cause Subcategories	Definition	Count	Cumulative Impact (Weeks)	Average Impact (Weeks)
Estimates: Learning Curve	New work assumed to be easier than it turned out to be	21	207	9.9
Dependency: Legal	A shift in legal, regulatory, or standards	7	53	7.6
Estimates: Deadline	Top-down imposed deadlines that are unrealistic	9	64	7.1
Dependency: Project	Project interdependency delay in programs	17	119	7.0
Delay: Information	Slip due to unavailability of specification or other needed data	26	176	6.8
Dependency: Infrastructure	Infrastructure not ready or support not available (printing, IT, shipping, etc.)	17	90	5.3
Estimates: Judgment	Poor estimating process or inadequate analysis	19	99	5.2
Delay: Parts	Delay waiting for needed deliverable component	38	189	5.0

Delay: Hardware	Needed equipment arrives late or fails	23	98	4.3
Delay: Decision	Slip due to untimely decision for escalation, approval, phase exit	15	46	3.1

The overall impact of these schedule risk subcategories is summarized in Figure 4-1. The subcategory with the largest total impact was estimating new work, but several other subcategories were not far behind.

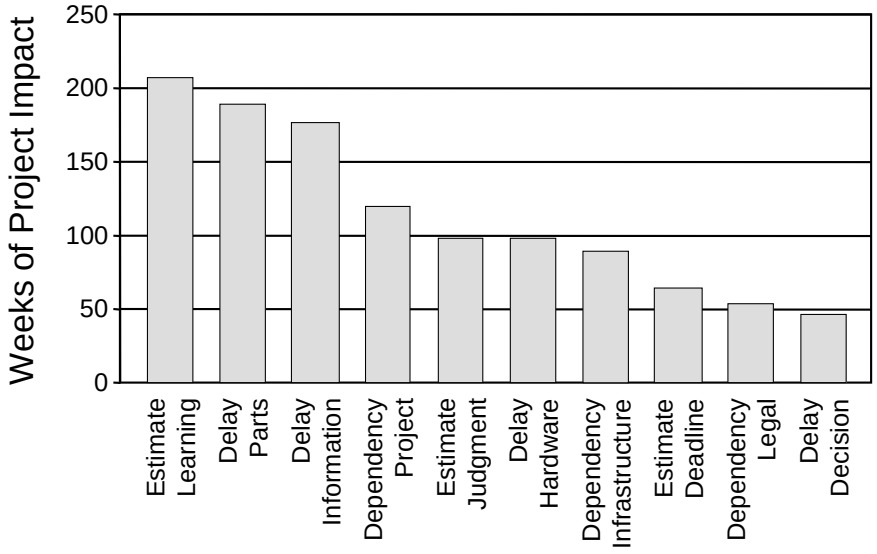

Figure 4-1: Total Project Impact by Schedule Root-Cause Subcategories

Delay risks

Delay risks represent over half of the schedule risks, and nearly a sixth of all the risks in the PERIL database. Impact from delays had the lowest average of any other subcategory in the database, but it was still over one month. Types of delay risk in the PERIL database include *parts*, *information*, *hardware*, and *decisions*.

Parts that were required to complete the project deliverable were the most frequently reported source of delay, with an average schedule impact of five weeks. Delivery and

availability problems were common sources for this delay, but there were also quite a few issues involving international shipping, including customs, paperwork, and related concerns. Delays also resulted from parts that arrived on time but were found to be defective. The time required to replace or repair components that did not work properly was a significant source of project slip.

Information needed by the project represented over a quarter of the cases of in the delay category. These were also the most damaging on average, representing an average of nearly seven weeks of project slip. Some of the information delay was due to time differences between parts of distributed global teams. Losing one or more days on a regular basis was common, due to communication time lags and misunderstandings were common. In other cases, access to information was poor, or delivery of needed reports was interrupted.

Hardware needed to perform project work including systems and other equipment that was late caused about one quarter of the delay risks. Risks in this subcategory averaged over one month for delay.

Slow **decisions** also caused project slippage. Roughly one sixth of the delay examples were due to managers or other stakeholders who did not act as quickly as necessary to keep the project on schedule. Sometimes the cause was poor access to the decision makers, or their lack of interest in the project. For other projects, delays were the result of extended debates, discussions, or indecision. Projects facing these issues lost nearly three weeks on average waiting for a response to a project request.

Potential delay risks may be difficult to anticipate, and many of them seem to be legitimately "unknown" risks. Thorough analysis of the input requirements at each stage of the project plan, however, will highlight many of them.

Estimating risks

Of all the types of schedule risk found in technical projects, estimating is the most visible. When you ask project managers what their biggest difficulties are, estimating is high on, if not on top of, the list. Despite this, the number of incidents in the PERIL database is not too large, about 8 percent of the records, and only about a quarter of the total schedule risks. The average impact of the estimating risks is only slightly above that of the PERIL database as a whole. One frequently cited issue with estimating in technical projects is the relatively rapid change in the work. The standard advice is that good estimates rely on history, but when the environment is in constant flux, history may not seem all that useful (more on this later in the chapter). The estimating risk subcategories relate to *learning curves*, *judgment*, and *imposed deadlines*.

Learning curve issues were the most common type of estimating risk. Their impact was well above the average for the database, nearly ten weeks. The quality of the estimates when new technology or new people (or even worse, both) are involved is not good. The portions of project work that require staff to do things they have never done before are

always risky, and although thorough analysis of the work can show which parts of the project plan are most exposed, good estimating is difficult.

Judgment in estimating was the next most common estimating problem in the PERIL database. For most of these cases, the estimates were very overoptimistic. Some of these estimates were too short by factors of three or four. Dealing with this source of estimating risk requires thorough planning, with appropriate understanding and decomposition of the work, so that the effort and steps required are known. It also requires good record keeping. Metrics and project data archives are invaluable in creating future estimates that are more consistent with reality than past estimates have been, even for projects where things change rapidly. Having *some* data always beats having to guess. Another powerful tool in revealing and combating optimistic estimates is worst-case analysis. Not only will the answer to the question "What might go wrong?" reveal something about the likely duration, it will also uncover new potential sources of risk.

Imposed deadlines were the third subcategory of estimating risks. While these estimates were poor, the root cause was outside the project. Technical projects frequently have aggressive deadlines set in advance with little or no input from the project team. Even when the project plan shows the deadline to be unrealistic, the objective is retained. These projects are often doomed from the start.

Dependency risks

Dependency risks were about a fifth of the schedule risks. The impact from schedule dependency risks is a bit below the average for the PERIL database as a whole, averaging over six weeks of slip per incident. There are three dependency risk subcategories: *other projects*, *infrastructure factors*, and *legal issues*.

Other projects with shared dependencies were not only the most numerous of the dependency risks, they also are quite damaging, with an average of seven weeks. In larger projects (often classified as programs), a number of smaller projects interact and link to each other. In addition to providing each other with information and deliverables that meet well-defined specifications (which is a scope risk exposure), each project within a larger program must also synchronize the timing of schedule dependencies to avoid being slowed down by (or slowing) other projects. Managing all these connections is difficult in complex programs, and the amount of damage increases with time; many of these risks in the PERIL database were noticed only late in the project. Even for the interfaces that were defined in advance, delay was fairly common due to the uncertainty in each project and the high likelihood that at least one of the interconnected projects would encounter some sort of difficulty. With so many possible failure modes, it is all but certain that something will go wrong. Analysis of the connections and interfaces between projects is a key aspect of program management, and many of the risks faced by the projects become visible through interface management techniques.

Infrastructure dependencies also interfered with project schedules in the PERIL database. The frequency of these problems was equal to the project dependencies, but the impact was less on average, at slightly more than 5 weeks. These situations included interruption of technical services, such as computer systems or networks required by the project, and inadequate access to resources such as help desks, system support, and people who understood older but necessary applications. Several projects were delayed by maintenance outages that were not known to the project team even though they had been scheduled in advance.

Legal and regulatory dependencies were also problematic. Though the number of cases was less than 20 percent of the dependency risks, the average impact was highest for this subcategory at almost 8 weeks. Legal and paperwork requirements for international shipments can cause problems when they change abruptly. Monitoring for planned or possible changes can forewarn of many potential regulatory problems.

Black swans

The worst 20 percent of the risks in the PERIL database are deemed "black swans." These "large-impact, hard-to-predict, rare events" caused at least three months of schedule slip, and 30 of these most damaging 127 risks were schedule risks. As with the "black swans" as a whole, the most severe of the schedule risks account for slightly more than one-half of the total measured impact. The details are:

Schedule Risks		Total Impact (Weeks)	"Black Swan" Impact (Weeks)	"Black Swan" Percentage
Delay	Decision	46	0	0%
	Hardware	98	26	27%
	Information	176	91	52%
	Parts	189	88	47%
Dependency	Infrastructure	90	42	47%
	Legal	53	24	45%
	Project	119	82	69%
Estimates	Deadline	64	30	47%

	Judgment	99	44	44%
	Learning	207	150	72%
Totals		1,141	577	51%

As can be seen in the table, the "black swan" schedule risks were distributed relatively evenly, with a slight edge to **estimating** risks. There were 13 estimating risks, with 8 related to learning curve issues. The learning curve category of estimating risks also was dominated by these sizeable impact risks. Well over two thirds of the learning-curve risk were caused by cases such as the following:

- Complexity of new software was significantly underestimated.
- Development team was staffed with no regard for business knowledge.
- Neophyte project staff was inexperienced and had inadequate training.
- Key developer proved to be incompetent.
- Remote team did not have the expertise for key intermediate testing.

There were three cases of major project slippage due to estimating judgment, all related to inordinately optimistic assessment of project work.

Two "black swan" risks were caused by imposed deadlines:

- Adding project staff failed to cut the schedule in half.
- Commitments for a construction project were based on promises to customers, not planning.

Schedule **delays** in the PERIL database accounted for another ten "black swans." Half of them were caused by late information, including these:

- Merging of multiple standards was required for reorganization, and lack of common definitions delayed the data conversion project.
- Software was developed in a country where a war broke out, limiting travel and inhibiting teleconferencing, so that needed information was always late.

- Poorly defined procedures for acceptance, quality, and communications inhibited distributed development.

- Legacy application that was to be modified had no documentation; reconstructing the original code was very time consuming.

Four more significant risks were due to delayed parts:

- A component ordered was too long for international shipment, so it was cut and shipped in pieces. What arrived was useful only as raw material and replacing it was very expensive.

- The required quantity of a new integrated circuit chip was unavailable, resulting in a major delay in delivery.

- A critical software component was delivered late.

- Insufficient material was sent to the contract lab to complete testing.

One "black swan" was hardware related, caused by a shipment of required servers that got stuck in customs. None of the "black swan" risks were due to tardy decision making, showing that even the slowest managers can eventually make up their minds.

"Black swan" **dependency** risks were even less numerous, with a total of seven. There were four "black swan" risks associated with programs in the PERIL database:

- The manager of a related project allowed stakeholders to make frequent scope changes causing ripple effects and delay.

- Interdependencies in complex program were detected late.

- The scope of work between related projects was poorly coordinated.

- Firmware needed for key project component was dropped by another project.

The two most significant **infrastructure** examples were:

- Development platforms had 6-month validations; when a project slipped, required recertification delayed it further.

- The operating environment was upgraded to a new version, requiring rework and significant overhead.

There was also one project that encountered regulatory delay because of a process change that required an unexpected lengthy recertification.