

4: Risk

By William A. Kitch and John W. Tulac

4.1. *What is risk?*

An engineer might define risk as a quantitative value using a formula. However, a lawyer would view this approach as too narrow. Risk is also qualitative in nature. Risk springs not only from averaged or calculated results, but from deviations from the average or norm, from the outliers at the far reaches of the tails, and from outcomes never even imagined. Peter Bernstein's *Against the Gods, The Remarkable Story of Risk* is an excellent reference for engineers and businesspeople alike.

The purpose of this article is to develop a framework to use to identify, evaluate and manage risks. Those who can manage risk will be able to seize opportunities from those who depend upon luck or chance.

4.2. *Components of Risk*

There are many definitions for risk. However, most definitions contain the following components:

- Danger: cost, loss, or damage
- Uncertainty: probability, possibility, statistical chance
- Opportunity: potential benefits

We will develop our formal definition of risk later using these components.

4.3. *Process of Risk Management*

If we are going to successfully manage risks, we need a process we can follow to ensure our risk

management is effective. We will be using the following process:

1. Identification
2. Evaluation: qualitative or quantitative
3. Allocation: determining who has the best ability to manage a specific risk
4. Mitigation: techniques to determine, minimize and prevent harm or loss including:
 - Insurance: professional, business, legal
 - Preventive law
 - Compliance planning

We will now discuss the steps in the process.

4.4. *Identification*

Identification is the most critical step in the risk management process. If we fail to identify a key risk, the rest of our planning process may be meaningless. We can spend all the time we want evaluating a risk, but if we fail to evaluate the important risks, our work will have little value.

It will be impossible to identify risk if you do not know what your goals and objectives are. Therefore before trying to identify your risk, you must first clearly articulate your goals and objectives.

Once you have finished defining your goals and objectives, list the key steps or processes that will be needed to achieve your goals. Then list all the key players in the processes. Now you're ready to identify your risks. Simply make a list of all the actions or things that could happen which would prevent you from achieving your goals. This is a brainstorming

William A. Kitch and John W. Tulac, "Risk." Copyright © William A. Kitch and John W. Tulac. Permission to reprint granted by the authors.

time. Don't toss out a risk because it sounds silly or you don't think it will really happen. Just identify the potential negative things and write them down. We will evaluate the risks in the next step.

Risk analysis bridges tort law and contract law. Tort law defines responsibilities and liabilities arising out of risk and imposes duties. Contract law allocates responsibilities and liabilities regarding risk.

4.5. Evaluation

Once we have a comprehensive list of risks we can start the evaluation process. It is important that we use a systematic and consistent method to evaluate the risks. We can use subjective measurements to evaluate the risks so long as we apply our measurements in a systematic manner.

4.5.1. Measuring Risk

If we are going to make logical decisions about how to manage risk, we must first be able to measure risk. Mathematically, risk is defined as

$$R = P_f \times C_f \quad (4.1)$$

where

R is the numerical risk
 P_f is the probability of failure and
 C_f is the cost of failure, in dollars

People often confuse risk with the probability of failure or with the cost of failure. According to Equation 4.1, risk, R , is a combination of both the probability and cost of failure. This is a very important concept. There are some things that have a very high cost (like death) but which are very unlikely. An example might be being caught in a bombing on the Cal Poly Pomona campus. The cost of such an event could be your life, but the probability of this event is very low, therefore the risk is relatively low. Another type of event that can have a very low risk is something that is very likely, but which carries with it little cost. For example if you park on campus without purchasing a pass, the probability of getting a ticket is fairly high. However the cost of the ticket is relatively low (at least compared with many other costs associated with owning and operating an automobile). You

may still wish to avoid this risk by purchasing a pass and that's the whole point of risk assessment. If you can quantify your risk in terms of a likely cost, then you can determine whether or not it is worthwhile to pay for actions that can reduce your risk.

In some business it is possible to make very good measures of the actual probability and cost of events and use these measures to compute accurate values for the risk of events. Insurance companies do this all the time. That is the only way that can set premiums and make money. However, it is often impossible or too costly to get accurate measurements of the probabilities and/or costs of events. When you can't quantitatively measure risk, a qualitative measurement of risk is usually possible. While qualitative risk measurement is less accurate than quantitative risk measurement, it can still be a valuable tool in managing risk

4.5.2. Qualitative Risk Measurement: Risk Matrix

One simple and effective method of qualitative risk measurement is to build a risk matrix. Let's describe the process using an example. Suppose we want to evaluate the risk of parking on campus. The first step would be to define our goals and objectives. For our example we will assume our goals are to find a safe parking place that allows us to get to class on time and stay within our budget.

Next we need to list every event that would cause failure or be a problem when attempting to park on campus. That list might look something like this:

1. Can't find a place in time and are late to class
2. Can't find a place in time and are late to an exam
3. Car is damaged in parking lot
4. Car is stolen from parking lot
5. Receive a ticket for illegal parking
6. Forget where you parked and are late getting home

The next step is to make up a qualitative scale for the probability of each event happening and a qualitative scale for the cost of an event should it happen. Let's use the following scales

Probability:

- a) Unlikely: Probably happens less than once a year

- b) Likely: Probably happens once a month
- c) Very Likely: Probably happens once a week or more often

Cost:

- a) Low: Painless, wouldn't even count the cost
- b) Moderate: Ouch, that's costly, but won't break the bank
- c) High: Oh no, I can't afford that

Now for each of our events we rate its probability and cost.

Event	Probability	Cost
1) Late to class	Very Likely	Low
2) Late to exam	Likely	Moderate
3) Car damage	Likely	Moderate
4) Car stolen	Unlikely	High
5) Get ticket	Likely	Moderate
6) Late getting home	Unlikely	Low

We now evaluate the risk by plotting the events on a risk matrix. The risk matrix is simply a two dimensional figure with the probability listed on one axis and cost on the other axis. Figure 4.1 depicts a risk matrix for our example.

In the risk matrix, events that lie in the upper right hand portion of the matrix are the riskiest events. Those that lie in the lower left hand portion are the least risky. In this example we have arbitrarily divided the risk into the five levels shown. Using our example we would categorize our risks as shown in Table 4.1.

Using this analysis method we discover that our highest risk is being late to an exam. If we simply evaluated the risk based on cost, we might have said that getting our car stolen was the biggest risk. But that's not the case; while it has the biggest cost it also has a low probability. Also note that being late for an exam and class both have high probability, but one has a larger cost and is therefore more risky.

When evaluating risk it is important to include both cost and probability. Risk is a combination of the two. It is also important to use a systematic method to evaluate risk. Finally, we don't need exact numbers on

cost and risk to perform an evaluation. Even a simple qualitative evaluation like the risk matrix can help us to identify and manage risks.

4.5.3. Allocation

Risk allocation is the process of identifying which person or party has the best ability to manage each risk and who benefits if a risk is avoided. We then assign risk based on a party's ability to manage and benefit from the management of that risk.

As we look at each risk we will find that they generally fall into one of the following cases.

- a) One party has ability to both manage the risk and benefit from managing it
- b) One party has the ability to manage the risk but another party is the main beneficiary
- c) The management and benefits associated with a risk are shared among two or more parties
- d) No one has control over the risk

Table 4.1: Tabulated risks from example

Risk Level	Events
Very High	None
High	1) Late to class, 2) Late to exam
Moderate	3) Car damage, 4) Car stolen
Low	5) Get ticket
Very Low	6) Late getting home

It should be obvious in case-a that the risk should be assigned to the party who can manage and benefit from the risk. In case-b we should try and change processes to align the management and benefit. Many risks fall into case-c and they must be spread appropriately among the responsible parties. Case-d is a situation where our only ability to manage the risk may be to pay someone to take the risk for us by buying insurance.

In our example, the risks associated with Events 1, 2, 5, and 6 clearly belong to the person parking the

car, since that person has the ability to manage these risks and will benefit if they are managed. The parker has some control over Events 3 and 4, but much of the risk of these events is beyond the control of the parker.

4.5.4. Mitigation

Now that we have identified, evaluated and assigned our risks it is time to develop mitigations which will allow us to control and manage our risks. We will use our example to illustrate this process.

The most important risk for us to manage is our highest risk: missing an exam, Event 2. There are two obvious mitigations for this risk.

1. Allow extra travel time to campus on exam days
2. Buy a parking pass so we can park close to campus

Notice that these two mitigations will also manage the risk of being late to a regular class, Event 1, and the risk of getting a ticket, Event 5.

We have two other moderate risks that we should mitigate: Event 3–Car damage, and Event 4–Stolen car. We have some ability to manage these risks by choosing safer parking spots, locking our car, and not leaving valuables in our car, but much of the risk is not under our control. This is a case where buying insurance might be a good way to mitigate our risk.

Your mitigation doesn't end when you devised your mitigations. If you don't implement your mitigations they won't do you any good. It is critical that you establish processes and procedures to ensure your mitigations are properly implemented. For example, our mitigation to leave early for campus on exam days won't do any good if we forget or don't know when we have an exam. Our implementation plan for this mitigation might be to put all our exams in our iPhone at the beginning of each quarter with an alarm the day before the exam. This will help ensure we leave in time to park and get to our exams.

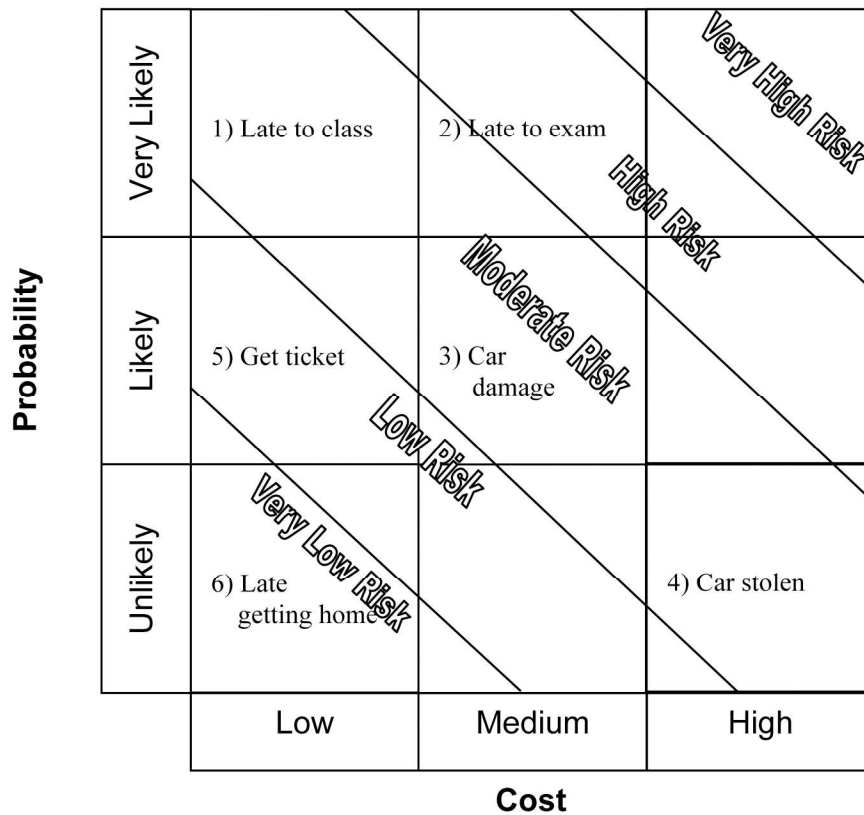


Figure 4.1: Risk Matrix

4.6. Risk Management Tools for the Design Professional

The generic tools such as the risk matrix are valuable for design professionals and should be part of your risk management tool kit. However, there are some other tools you should be aware of.

Perhaps the most valuable tool for risk management is the contract. A formal contract lets you handle risk professionally. It can be used to allocate risks by informing the parties of their responsibilities. It should identify things outside the control of the parties, particularly unpreventable or uninsurable risks. One of the greatest sources of risk is misunderstandings between parties. A well written contract can significantly reduce the probability of misunderstandings, thereby reducing risk. Finally, a contract can be used to establish mitigations, particularly complicated mitigations that require the cooperation and coordination of several parties.

One of the most powerful risk management tools available to anyone is to just say “No.” Walking away from a bad deal is the ultimate risk eliminator.

4.7. Compliance Planning

Regulatory Compliance carries significant risks to today’s design professional. There are a myriad of local, state, and federal laws that require compliance. These regulations cover many areas including: environmental compliance, employment law, fiscal accounting and reporting. In some cases failure to comply with regulations can bankrupt a company or put a company officer in jail.

Regulatory compliance programs are designed to

- Prevent violations
- Detect violations early
- Respond quickly to any violation
- Report compliance to regulators

Steps to establishing a corporate compliance program

1. Assess activities in areas subject to regulation
2. Obtain the commitment internally from all involved parties
3. Create policies and programs for compliance
4. Implement the program

- a) Education and training
- b) Controls, procedures, and recordkeeping
- c) Review and revise regularly
- d) Audit (internal, external)
- e) Reporting and disclosure system
- f) Revise and update (circles back to step 1)

The adage “an ounce of prevention is worth a pound of cure” applies to regulatory compliance. A good compliance plan can mitigate many risks.

4.8. Summary

Risks are unavoidable. They are part of our everyday life. Risks present opportunities to those who can manage them well. Rather than avoid all risks our objective should be to manage risks for our benefit.

Risk is not just the probability of failure. It is the combination of the probability of failure and the cost of that failure. In order to manage risks we must first identify the risks, evaluate each risk, and then allocate the risk to the appropriate party. We can then develop a mitigation plan to help us manage risks. The plan must be properly implemented or it is of no value.

Perhaps the most important risk management tool for the design professional is a contract. The contract helps to identify, allocate and mitigate risks.

References

The Risk Management Toolkit, Mitre Corporation,
<http://www.mitre.org/work/sepo/toolkits/risk/index.html>