Risk-First

Software Development De-Risked

Volume 1: The Menagerie

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Risk First: The Menagerie

By Rob Moffat

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Thanks to:

Books In The Series

- **Risk First: The Menagerie:** Book one of the **Risk-First** series argues the case for viewing *all* of the activities on a software project through the lens of *managing risk*. It introduces the menagerie of different risks you're likely to meet on a software project, naming and classifying them so that we can try to understand them better.
- **Risk First: Tools and Practices:** Book two of the **Risk First** series explores the relationship between software project risks and the tools and practices we use to mitigate them. Due for publication in 2020.

Online

Material for the books is freely available to read, drawn from `risk-first.org`.

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Contents

Preface

Welcome to Risk-First!

Let's cover some of the big questions up-front: The why, what, who, how and where of *The Menagerie*.

Why

> "Scrum, Waterfall, Lean, Prince2: what do they all have in common?"

I've started this because, on my career journey, I've noticed that the way I do things doesn't seem to match up with the way the books *say* it should be done. And, I found this odd and wanted to explore it further. Hopefully, you, the reader, will find something of use in this.

I started with this observation: *Development Teams* put a lot of faith in methodology. Sometimes, this faith is often so strong it borders on religion. (Which in itself is a concern.) For some, this is Prince2. For others, it might be Lean or Agile.

Developers put a lot of faith in *particular tools* too. Some developers are pro-or-anti-Java, others are pro-or-anti-XML. All of them have their views coloured by their *experiences* (or lack of) with these tools. Was this because their past projects *succeeded* or *failed* because of them?

As time went by, I came to see that the choice of methodology, process or tool was contingent on the problem being solved, and the person solving the problem. We don't face a shortage of tools in IT, or a shortage of methodologies, or a shortage of practices. Essentially, that all the tools and methodologies that the industry had supplied were there to help *minimize the risk of my project failing*.

This book considers that perspective: that building software is all about *managing risk*, and that these methodologies are acknowledgements of this fact, and they differ because they have *different ideas* about which are the most important *risks to manage*.

What This Is

Hopefully, after reading this, you'll come away with:

- An appreciation of how risk underpins everything we do as developers, whether we want it to or not.
- A framework for evaluating methodologies, tools and practices and choosing the right one for the task-at-hand.
- A recontextualization of the software process as being an exercise in mitigating different kinds of risk.
- The tools to help you decide when a methodology or tool is *letting you down*, and the vocabulary to argue for when it's a good idea to deviate from it.

This is not intended to be a rigorously scientific work: I don't believe it's possible to objectively analyze a field like software development in any meaningful, statistically significant way. (For one, things just change too fast.)

> "I have this Pattern"

Does that diminish it? If you have visited the TVTropes website, you'll know that it's a set of web-pages describing *common patterns* of narrative, production, character design etc. to do with fiction. For example:

> tbd.

Is it scientific? No. Is it correct? Almost certainly. TVTropes is a set of *empirical patterns* for how stories on TV and other media work. It's really useful, and a lot of fun. (Warning: it's also incredibly addictive).

In the same way, tbd, the tbd published a book called "Design Patterns: tbd". Which shows you patterns of *structure* within Object-Oriented programming:

> tbd.

Patterns For Practitioners

This book aimed to be a set of *useful* patterns which practitioners could use in their software to achieve certain goals. "I have this pattern" was a phrase used to describe how they had seen a certain set of constraints before, and how they had solved it in software.

This book was a set of experts handing down their battle-tested practices for other developers to use, and, whether you like patterns or not, knowing them is an important part of being a software developer, as you will see them used everywhere you go and probably use them yourself.

In the same way, this book aims to be a set of *Patterns for Software Risk*. Hopefully after reading this book, you will see where risk hides in software projects, and have a name for it when you see it.

Towards a "Periodic Table"

In the latter chapters of "The Menagerie" we try to assemble these risk patterns into a cohesive whole. Projects fail because of risks, and risks arise from predictable sources.

What This is Not

This is not intended to be a rigorously scientific work: I don't believe it's possible to objectively analyze a field like software development in any meaningful, statistically significant way. (For one, things just change too fast.)

Neither is this site isn't going to be an exhaustive guide of every possible software development practice and methodology. That would just be too long and tedious.

Neither is this really a practitioner's guide to using any particular methodology: If you've come here to learn the best way to do Retrospectives, then you're in the wrong place. There are plenty of places you can find that information already. Where possible, this site will link to or reference concepts on Wikipedia or the wider internet for further reading on each subject.

Who

This work is intended to be read by people who work on software projects, and especially those who are involved in managing software projects.

If you work collaboratively with other people in a software process, you should find Risk-First a useful lexicon of terms to help describe the risks you face.

But here's a warning: This is going to be a depressing book to read. It is book one of a two-book series, but in **Book One** you only get to meet the bad guy.

While **Book Two** is all about *how to succeed*, This book is all about how projects *fail*. In it, we're going to try and put together a framework for understanding the risk of failure, in order that we can reconstruct our understanding of our activities on a project based on avoiding it.

So, if you are interested in *avoiding your project failing*, this is probably going to be useful knowledge.

For Developers

Risk-First is a tool you can deploy to immediately improve your ability to plan your work.

Frequently, as developers we find software methodologies "done to us" from above. Risk-First is a toolkit to help *take apart* methodologies like Scrum, Lean and Prince2, and understand them. Methodologies are *bicycles*, rather than *religions*. Rather than simply *believing*, we can take them apart and see how they work.

For Project Managers and Team Leads

All too often, Project Managers don't have a full grasp of the technical details of their projects. And this is perfectly normal, as the specialization belongs below them. However, projects fail because risks materialize, and risks materialize because the devil is in those details.

This seems like a lost cause, but there is hope: the ways in which risks materialize on technical projects is the same every time. With Risk-First we are attempting to name each of these types of risk, which allows for a dialog with developers about which risks they face, and the order they should be tackled.

Risk-First allows a project manager to pry open the black box of development and talk with developers about their work, and how it will affect the project. It is another tool in the (limited) arsenal of techniques a project manager can bring to bear on the task of delivering a successful project.

How

One of the original proponents of the Agile Manifesto, Kent Beck, begins his book Extreme Programming by stating:

"It's all about risk" > Kent Beck

This is a promising start. From there, he introduces his methodology, Extreme Programming, and explains how you can adopt it in your team, the features to observe and the characteristics of success and failure. However, while *Risk* has clearly driven the conception of Extreme Programming, there is no clear model of software risk underpinning the work, and the relationship between the practices he espouses and the risks he is avoiding are hidden.

In this book, we are going to introduce a model of software project risk. This means that in **Book Two** (Risk-First: Tools and Practices), we can properly analyse Extreme Programming (and Scrum, Waterfall, Lean and all the others) and *understand* what drives them. Since they are designed to deliver successful software projects, they must be about mitigate risks, and we will uncover *exactly which risks are mitigated* and *how they do it*.

Where

All of the material for this book is available Open Source on github.com[1], and at the risk-first.org[2] website. Please visit, your feedback is appreciated.

There is no compulsion to buy a print or digital version of the book, but we'd really appreciate the support. So, if you've read this and enjoyed it, how about buying a copy for someone else to read?

A Note on References

Where possible, references are to the Wikipedia[3] website. Wikipedia is not perfect. There is a case for linking to the original articles and papers, but by using Wikipedia references are free and easy for everyone to access, and hopefully will exist for a long time into the future.

On to The Executive Summary

[1] https://github.com

[2] https://risk-first.org

[3] https://wikipedia.org

Executive Summary

1. There are Lots of Ways of Running Software Projects

There are lots of different ways to look at a project. For example, metrics such as “number of open tickets”, “story points”, “code coverage” or “release cadence” give us a numerical feel for how things are going and what needs to happen next. We also judge the health of projects by the practices used on them - Continuous Integration, Unit Testing or Pair Programming, for example.

Software methodologies, then, are collections of tools and practices: “Agile”, “Waterfall”, “Lean” or “Phased Delivery” (for example) all suggest different approaches to running a project, and are opinionated about the way they think projects should be done and the tools that should be used.

None of these is necessarily more “right” than another- they are suitable on different projects at different times.

A key question then is: **how do we select the right tools for the job?**

2. We can Look at Projects in Terms of Risks

One way to examine a project in-flight is by looking at the risks it faces.

Commonly, tools such as RAID logs and RAG status reporting are used. These techniques should be familiar to project managers and developers everywhere.

However, the Risk-First view is that we can go much further: that each item of work being done on the project is mitigating a particular risk.

Risk isn't something that just appears in a report, it actually drives *everything we do*.

For example:

- A story about improving the user login screen can be seen as reducing *the risk of users not signing up*.
- A task about improving the health indicators could be seen as mitigating *the risk of the application failing and no-one reacting to it*.
- Even a task as basic as implementing a new function in the application is mitigating *the risk that users are dissatisfied and go elsewhere*.

One assertion of Risk-First therefore, is that every action you take on a project is to mitigate some risk.

3. We Can Break Down Risks on a Project Methodically

Although risk is usually complicated and messy, other industries have found value in breaking down the types of risks that affect them and addressing them individually.

For example:

- In manufacturing, *tolerances* allow for calculating the likelihood of defects in production.
- In finance, reserves are commonly set aside for the risks of stock-market crashes, and teams are structured around monitoring these different risks.
- The insurance industry is founded on identifying particular risks and providing financial safety-nets for when they occur, such as death, injury, accident and so on.

Software risks are difficult to quantify, and mostly, the effort involved in doing so *exactly* would outweigh the benefit. Nevertheless, there is value in spending time building *classifications of risk for software*. That's what Risk-First does: describes the set of *risk patterns* we see every day on software projects.

With this in place, we can:

- Talk about the types of risks we face on our projects, using an appropriate language.
- Expose Hidden Risks that we hadn't considered before.
- Weigh the risks against each other, and decide which order to tackle them.

4. We Can Analyse Tools and Techniques in Terms of how they Mitigate Risk

If we accept the assertion above that *all* the actions we take on a project are about mitigating risks, then it stands to reason that the tools and techniques available to us on a project are there for mitigating different types of risks.

For example:

- If we do a Code Review, we are partly trying to mitigate the risks of bugs slipping through into production, and also mitigate the Key-Man Risk of knowledge not being widely-enough shared.
- If we write Unit Tests, we're also mitigating the risk of bugs going to production, but we're also mitigating against future changes breaking our existing functionality.
- If we enter into a contract with a supplier, we are mitigating the risk of the supplier vanishing and leaving us exposed. With the contract in place, we have legal recourse against this risk.

Different tools are appropriate for mitigating different types of risks.

5. Different Methodologies for Different Risk Profiles

In the same way that our tools and techniques are appropriate to dealing with different risks, the same is true of the methodologies we

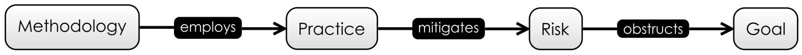


Figure 1: Methdologies, Risks, Practices

use on our projects. We can use a Risk-First approach to examine the different methodologies, and see which risks they address.

For example:

- **Agile** methodologies prioritise mitigating the risk that requirements capture is complicated, error-prone and that requirements change easily.
- **Waterfall** takes the view that coding effort is an expensive risk, and that we should build plans up-front to avoid it.
- **Lean** takes the view that risk lies in incomplete work and wasted work, and aims to minimize that.

Although many developers have a methodology-of-choice, the argument here is that there are tradeoffs with all of these choices. Methodologies are like *bicycles*, rather than *religions*. Rather than simply *believing*, we can take them apart and see how they work.

We can place methodologies within a framework, and show how choice of methodology is contingent on the risks faced.

6. Driving Development With a Risk-First Perspective

We have described a model of risk within software projects, looking something like this:

How do we take this further?

The first idea we explore is that of the Risk Landscape: Although the software team can't remove risk from their project, they can take actions that move them to a place in the Risk Landscape where the risks on the project are more favourable than where they started.

From there, we examine basic risk archetypes you will encounter on the software project, to build up a Taxonomy of Software Risk, and look at which specific tools you can use to mitigate each kind of risk.

Then, we look at different software practices, and how they mitigate various risks. Beyond this we examine the question: *how can a Risk-First approach inform the use of this technique?*

For example:

- If we are introducing a **Sign-Off** in our process, we have to balance the risks it *mitigates* (coordination of effort, quality control, information sharing) with the risks it *introduces* (delays and process bottlenecks).
- If we have **Redundant Systems**, this mitigates the risk of a *single point of failure*, but introduces risks around *synchronizing data* and *communication* between the systems.
- If we introduce **Process**, this may make it easier to *coordinate as a team* and *measure performance* but may lead to bureaucracy, focusing on the wrong goals or over-rigid interfaces to those processes.

Risk-First aims to provide a framework in which we can *analyse these choices* and weigh up *accepting* versus *mitigating* risks.

Still interested? Then dive into reading the introduction.

Part I

Introduction

Part II

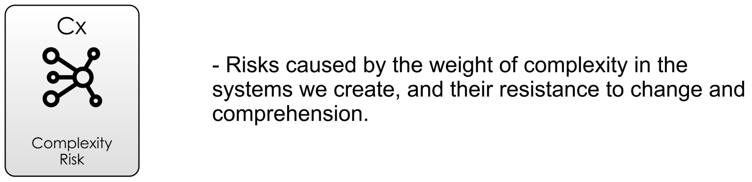
Risk

CHAPTER 1

Complexity Risk

Complexity Risk are the risks to your project due to its underlying "complexity". Over the next few chapters, we'll break down exactly what we mean by complexity, looking at Dependency Risk and Boundary Risk as two particular sub-types of Complexity Risk. However, in this chapter, we're going to be specifically focusing on *code you write*: the size of your code-base, the number of modules, the interconnectedness of the modules and how well-factored the code is.

You could think of this chapter, then, as **Codebase Risk**: We'll look at three separate measures of codebase complexity and talk about Technical Debt, and look at places in which **Codebase Risk** is at it's greatest.



- Risks caused by the weight of complexity in the systems we create, and their resistance to change and comprehension.

Figure 1.1: Complexity Risks

1.1 Kolmogorov Complexity

The standard Computer-Science definition of complexity, is Kolmogorov Complexity[1]. This is:

> "...is the length of the shortest computer program (in a predetermined programming language) that produces the object as output." - Kolmogorov Complexity, Wikipedia

This is a fairly handy definition for us, as it means that to in writing software to solve a problem, there is a lower bound on the size of the software we write. In practice, this is pretty much impossible to quantify. But that doesn't really matter: the techniques for *moving in that direction* are all that we are interested in, and this basically amounts to compression.

Let's say we wanted to write a javascript program to output this string:

```
abcdabcdabcdabcdabcdabcdabcdabcdabcdabcd
```

We might choose this representation:

```
function out() {                                    (7 symbols)
    return "abcdabcdabcdabcdabcdabcdabcdabcdabcdabcd"   (45)
}                                                   (1 )
```

... which contains **53** symbols, if you count `function`, `out` and `return` as one symbol each.

But, if we write it like this:

```
const ABCD="ABCD";                                          (11 symbols)

function out() {                                            (7 symbols)
    return ABCD+ABCD+ABCD+ABCD+ABCD+ABCD+ABCD+ABCD+ABCD+ABCD (21 symbols)
}                                                           (1 symbol)
```

[1] https://en.wikipedia.org/wiki/Kolmogorov_complexity

With this version, we now have **40** symbols. And with this version:

```
const ABCD="ABCD";                                      (11 symbo

function out() {                                        (7 symbol
    return ABCD.repeat(10)                              (7 symbol
}                                                       (1 symbol
```

. . . we have **26** symbols.

Abstraction

What's happening here is that we're *exploiting a pattern*: we noticed that `ABCD` occurs several times, so we defined it a single time and then used it over and over, like a stamp. Separating the *definition* of something from the *use* of something as we've done here is called "abstraction". We're going to come across it over and over again in this part of the book, and not just in terms of computer programs.

By applying techniques such as Abstraction, we can improve in the direction of the Kolmogorov limit. And, by allowing ourselves to say that *symbols* (like `out` and `ABCD`) are worth one complexity point, we've allowed that we can be descriptive in our `function` name and `const`. Naming things is an important part of abstraction, because to use something, you have to be able to refer to it.

Trade-Off

But we could go further down into Code Golf[2] territory. This javascript program plays FizzBuzz[3] up to 100, but is less readable than you might hope:

```
for(i=0;i<100;)document.write(((++i%3?'':'Fizz')+
(i%5?'':'Buzz')||i)+"<br>")                             (66 symbo
```

So there is at some point a trade-off to be made between Complexity Risk and Communication Risk. This is a topic we'll address more in

[2] https://en.wikipedia.org/wiki/Code_golf

[3] https://en.wikipedia.org/wiki/Fizz_buzz

that chapter. But for now, it should be said that Communication Risk is about *misunderstanding*: The more complex a piece of software is, the more difficulty users will have understanding it, and the more difficulty developers will have changing it.

1.2 Connectivity

A second, useful measure of complexity comes from graph theory, and that is the connectivity of a graph:

> "...the minimum number of elements (nodes or edges) that need to be removed to disconnect the remaining nodes from each other" - Connectivity, *Wikipedia*[4]

To see this in action, have a look at the below graph:

It has 10 vertices, labelled **a** to **j**, and it has 15 edges (or links) connecting the vertices together. If any single edge were removed from this diagram, the 10 vertices would still be linked together. Because of this, we can say that the graph is *2-connected*. That is, to disconnect any single vertex, you'd have to remove *at least* two edges.

As a slight aside, let's consider the **Kolmogorov Complexity** of this graph, by inventing a mini-language to describe graphs. It could look something like this:

```
<item> : [<item>,]* <item>    # Indicates that the item before the colon
                              # has a connection to all the items after th


a: b,c,d
b: c,f,e
c: f,d
d: j
e: h,j
f: h
g: j
h: i
i: j                                                  (39 symbols)
```

[4] https://en.wikipedia.org/wiki/Connectivity_(graph_theory)

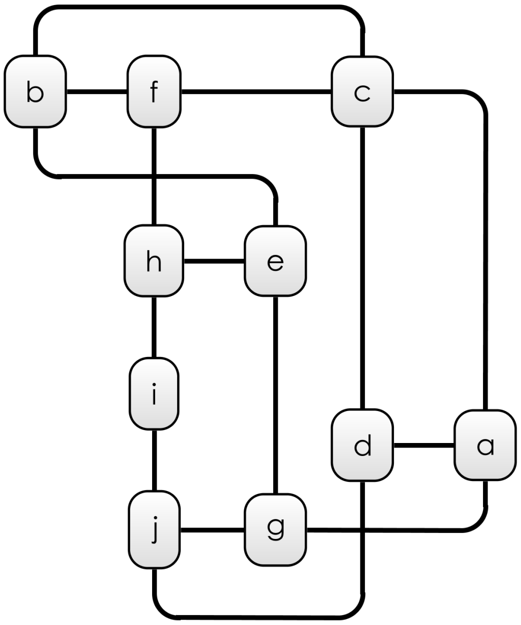


Figure 1.2: Graph 1

Let's remove some of those extra links:

In this graph, I've removed 6 of the edges. Now, we're in a situation where if any single edge is removed, the graph becomes *unconnected*. That is, it's broken into distinct chunks. So, it's *1-connected*.

The second graph is clearly simpler than the first. And, we can show this by looking at the **Kolgomorov Complexity** in our little language:

```
a: d,g
b: f
c: d,f
d: j
f: h
e: h
h: i                                                                  (25 symbo
```

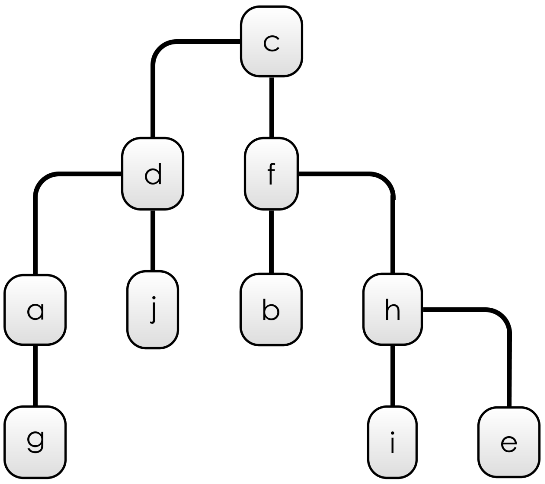


Figure 1.3: Graph 2

Connectivity is also **Complexity**. Heavily connected programs/-graphs are much harder to work with than less-connected ones. Even *laying out* the first graph sensibly is a harder task than the second (the second is a doddle). But the reason programs with greater connectivity are harder to work with is that changing one module potentially impacts many others.

1.3 Hierarchies and Modularization

In the second, simplified graph, I've arranged it as a hierarchy, which I can do now that it's only 1-connected. For 10 vertices, we need 9 edges to connect everything up. It's always:

```
edges = vertices - 1
```

Note that I could pick any hierarchy here: I don't have to start at **c** (although it has the nice property that it has two roughly even sub-trees attached to it).

How does this help us? Imagine if **a** - **j** were modules of a software system, and the edges of the graph showed communications between the different sub-systems. In the first graph, we're in a worse position: who's in charge? What deals with what? Can I isolate a component and change it safely? What happens if one component disappears? But, in the second graph, it's easier to reason about, because of the reduced number of connections and the new heirarchy of organisation.

On the downside, perhaps our messages have farther to go now: in the original **i** could send a message straight to **j**, but now we have to go all the way via **c**. But this is the basis of Modularization[5] and Hierarchy[6].

As a tool to battle complexity, we don't just see this in software, but everywhere in our lives. Society, business, nature and even our bodies:

- **Organelles** - such as Mitochondria[7].
- **Cells** - such as blood cells, nerve cells, skin cells in the Human Body[8].
- **Organs** - like hearts livers, brains etc.
- **Organisms** - like you and me.

The great complexity-reducing mechanism of modularization is that *you only have to consider your local environment*. Elements of the program that are "far away" in the hierarchy can be relied on not to affect you. This is somewhat akin to the **Principal Of Locality**:

> "Spatial locality refers to the use of data elements within relatively close storage locations." - Locality Of Reference, *Wikipedia*[9]

1.4 Cyclomatic Complexity

A variation on this graph connectivity metric is our third measure of complexity, Cyclomatic Complexity[10]. This is:

[5]https://en.wikipedia.org/wiki/Modular_programming

[6]https://en.wikipedia.org/wiki/Hierarchy

[7]https://en.wikipedia.org/wiki/Mitochondrion

[8]https://en.wikipedia.org/wiki/List_of_distinct_cell_types_in_the_adult_human_body

[9]https://en.wikipedia.org/wiki/Locality_of_reference

[10]https://en.wikipedia.org/wiki/Cyclomatic_complexity

```
Cyclomatic Complexity = edges  vertices + 2P,
```

Where **P** is the number of **Connected Components** (i.e. distinct parts of the graph that aren't connected to one another by any edges).

So, our first graph had a **Cyclomatic Complexity** of 7. `(15 - 10 + 2)`, while our second was 1. `(9 - 10 + 2)`.

Cyclomatic complexity is all about the number of different routes through the program. The more branches a program has, the greater it's cyclomatic complexity. Hence, this is a useful metric in Testing and Code Coverage: the more branches you have, the more tests you'll need to exercise them all.

1.5 More Abstraction

Although we ended up with our second graph having a **Cyclomatic Complexity** of 1 (the minimum), we can go further through abstraction, because this representation isn't minimal from a **Kolmogorov Complexity** point-of-view. For example, we might observe that there are further similarities in the graph that we can "draw out":

Here, we've spotted that the structure of subgraphs **P1** and **P2** are the same: we can have the same functions there to assemble those. Noticing and exploiting patterns of repetition is one of the fundamental tools we have in the fight against Complexity Risk.

So, we've looked at some measures of software structure complexity, in order that we can say "this is more complex than this". However, we've not really said why complexity entails Risk. So let's address that now by looking at two analogies, Mass and Technical Debt.

1.6 Complexity As Mass

The first way to look at complexity is as **Mass** or **Inertia** : a software project with more complexity has greater **Inertia** or **Mass** than one with less complexity.

Newton's Second Law states:

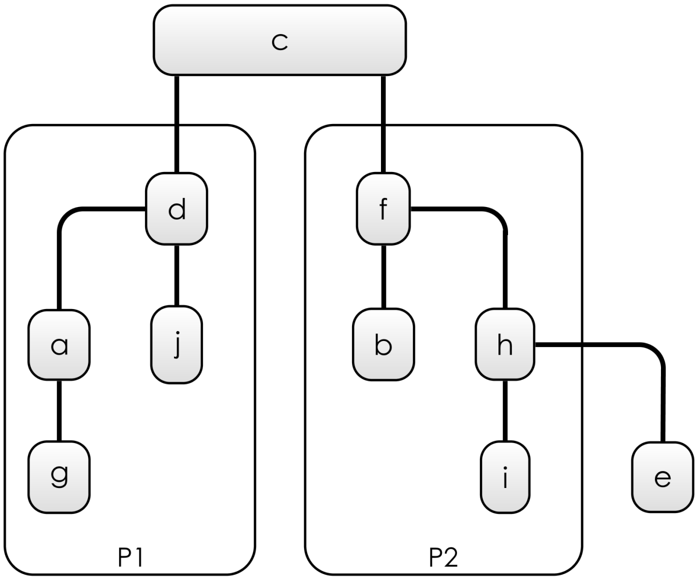


Figure 1.4: Complexity 3

> "F = *m***a**, (Force = Mass x Acceleration)" - Netwon's Laws Of Motion, *Wikipedia*[11]

That is, in order to move your project *somewhere new*, and make it do new things, you need to give it a push, and the more **Mass** it has, the more **Force** you'll need to move (accelerate) it.

Inertia and **Mass** are equivalent concepts in physics:

> "mass is the quantitative or numerical measure of a body's inertia, that is of its resistance to being accelerated". - Inertia, *Wikipedia*[12]

You could stop here and say that the more lines of code a project contains, the higher it's mass. And, that makes sense, because in

[11] `https://en.wikipedia.org/wiki/Newton%27s_laws_of_motion`

[12] `https://en.wikipedia.org/wiki/Inertia#Mass_and_inertia`

order to get it to do something new, you're likely to need to change more lines.

But there is actually some underlying sense in which *this is real*, as discussed in this Veritasium[13] video. To paraphrase:

> "Most of your mass you owe due to E=mcš, you owe to the fact that your mass is packed with energy, because of the **interactions** between these quarks and gluon fluctuations in the gluon field... what we think of as ordinarily empty space... that turns out to be the thing that gives us most of our mass." - Your Mass is NOT From the Higgs Boson, *Veritasium*[14]

I'm not an expert in physics, *at all*, and so there is every chance that I am pushing this analogy too hard. But, substituting quarks and gluons for pieces of software we can (in a very handwaving-y way) say that more complex software has more **interactions** going on, and therefore has more mass than simple software.

The reason I am labouring this analogy is to try and make the point that Complexity Risk is really fundamental:

- Feature Risk: like **money**.
- Schedule Risk: like **time**.
- Complexity Risk: like **mass**.

At a basic level, Complexity Risk heavily impacts on Schedule Risk: more complexity means you need more force to get things done, which takes longer.

1.7 Technical Debt

The most common way we talk about unnecessary complexity in software is as Technical Debt:

[13] https://www.youtube.com/user/1veritasium

[14] https://www.youtube.com/watch?annotation_id=annotation_3771848421&feature=iv&src_vid=Xo232kyTsO0&v=Ztc6QPNUqls

> "Shipping first time code is like going into debt. A little debt speeds development so long as it is paid back promptly with a rewrite... The danger occurs when the debt is not repaid. Every minute spent on not-quite-right code counts as interest on that debt. Entire engineering organizations can be brought to a stand-still under the debt load of an unconsolidated implementation, object-oriented or otherwise." – Ward Cunningham, 1992[15]

Building a perfect first-time solution is a waste, because perfection takes a long time. You're taking on more attendant Schedule Risk than necessary and Meeting Reality more slowly than you could.

A quick-and-dirty, over-complex implementation mitigates the same Feature Risk and allows you to Meet Reality faster (see Prototyping).

But, having mitigated the Feature Risk, you are now carrying more Complexity Risk than you necessarily need, and it's time to think about how to Refactor the software to reduce this risk again.

1.8 Kitchen Analogy

It's often hard to make the case for minimizing Technical Debt: it often feels that there are more important priorities, especially when technical debt can be "swept under the carpet" and forgotten about until later. (See Discounting The Future.)

One helpful analogy I have found is to imagine your code-base is a kitchen. After preparing a meal (i.e. delivering the first implementation), *you need to tidy up the kitchen*. This is just something everyone does as a matter of *basic sanitation*.

Now of course, you could carry on with the messy kitchen. When tomorrow comes and you need to make another meal, you find yourself needing to wash up saucepans as you go, or working around the mess by using different surfaces to chop on.

It's not long before someone comes down with food poisoning.

We wouldn't tolerate this behaviour in a restaurant kitchen, so why put up with it in a software project?

[15] https://en.wikipedia.org/wiki/Technical_debt

1.9 Feature Creep

In Brooks' essay "No Silver Bullet - Essence and Accident in Software Engineering", a distinction is made between:

> - **Essence**: *the difficulties inherent in the nature of the software.*
> - **Accident**: *those difficulties that attend its production but are not inherent.*
>   - Fred Brooks, *No Silver Bullet*[16]

The problem with this definition is that we are accepting features of our software as *essential*.

The **Risk-First** approach is that if you want to mitigate some Feature Risk then you have to pick up Complexity Risk as a result. But, that's a *choice you get to make*.

Therefore, Feature Creep[17] (or Gold Plating[18]) is a failure to observe this basic equation: instead of considering this trade off, you're building every feature possible. This has an impact on Complexity Risk, which in turn impacts Communication Risk and also Schedule Risk.

Sometimes, feature-creep happens because either managers feel they need to keep their staff busy, or the staff decide on their own that they need to keep themselves busy. But now, we can see that basically this boils down to bad risk management.

> "Perfection is Achieved Not When There Is Nothing More to Add, But When There Is Nothing Left to Take Away" - Antoine de Saint-Exupery

1.10 Dead-End Risk

Dead-End Risk is where you build functionality that you *think* is useful, only to find out later that actually, it was a dead-end, and is superceded by something else.

[16]https://en.wikipedia.org/wiki/No_Silver_Bullet

[17]https://en.wikipedia.org/wiki/Feature_creep

[18]https://en.wikipedia.org/wiki/Gold_plating_(software_engineering)

- The risk that a particular approach to a change will fail. Caused by the fact that at some level, our internal models are not a complete reflection of reality.

Figure 1.5: Dead-End Risk

For example, let's say that the Accounting sub-system needed password protection (so you built this). Then the team realised that you needed a way to *change the password* (so you built that). Then, that you needed to have more than one user of the Accounting system so they would all need passwords (ok, fine).

Finally, the team realises that actually logging-in would be something that all the sub-systems would need, and that it had already been implemented more thoroughly by the Approvals sub-system.

At this point, you realise you're in a **Dead End**:

- **Option 1**: You carry on making minor incremental improvements to the accounting password system (carrying the extra Complexity Risk of the duplicated functionality).
- **Option 2**: You rip out the accounting password system, and merge in the Approvals system, surfacing new, hidden Complexity Risk in the process, due to the difficulty in migrating users from the old to new way of working.
- **Option 3**: You start again, trying to take into account both sets of requirements at the same time, again, possibly surfacing new hidden Complexity Risk due to the combined approach.

Sometimes, the path from your starting point to your goal on the Risk Landscape will take you to dead ends: places where the only way towards your destination is to lose something, and do it again another way.

This is because you surface new Hidden Risk along the way. And the source of a lot of this hidden risk will be unexpected Complexity Risk in the solutions you choose. This happens a lot.

Source Control

Version Control Systems[19] like Git[20] are a useful mitigation of Dead-End Risk, because it means you can *go back* to the point where you made the bad decision and go a different way. Additionally, they provide you with backups against the often inadvertent Dead-End Risk of someone wiping the hard-disk.

The Re-Write

Option 3, Rewriting code or a whole project can seem like a way to mitigate Complexity Risk, but it usually doesn't work out too well. As Joel Spolsky says:

> There's a subtle reason that programmers always want to throw away the code and start over. The reason is that they think the old code is a mess. And here is the interesting observation: they are probably wrong. The reason that they think the old code is a mess is because of a cardinal, fundamental law of programming: *It's harder to read code than to write it.* - Things You Should Never Do, Part 1, *Joel Spolsky*[21]

The problem that Joel is outlining here is that the developer mistakes hard-to-understand code for unnecessary Complexity Risk. Also, perhaps there is Agency Risk because the developer is doing something that is more useful to him than the project. We're going to return to this problem in again Communication Risk.

1.11 Where Complexity Hides

Complexity isn't spread evenly within a software project. Some problems, some areas, have more than their fair share of issues. We're going to cover a few of these now, but be warned, this is not a complete list by any means:

[19]https://en.wikipedia.org/wiki/Version_control

[20]https://en.wikipedia.org/wiki/Git

[21]https://www.joelonsoftware.com/2000/04/06/things-you-should-never-do-part-i/

- Memory Management
- Protocols / Types
- Algorithmic (Space and Time) Complexity
- Concurrency / Mutability
- Networks / Security

Memory Management

Memory Management is another place where Complexity Risk hides:

> "Memory leaks are a common error in programming, especially when using languages that have no built in automatic garbage collection, such as C and C++." - Memory Leak, *Wikipedia*[22]

Garbage Collectors[23] (as found in Javascript or Java) offer you the deal that they will mitigate the Complexity Risk of you having to manage your own memory, but in return perhaps give you fewer guarantees about the *performance* of your software. Again, there are times when you can't accommodate this Operational Risk, but these are rare and usually only affect a small portion of an entire software-system.

Protocols And Types

Whenever two components of a software system need to interact, they have to establish a protocol for doing so. There are lots of different ways this can work, but the simplest example I can think of is where some component **a** calls some function **b**. e.g:

```
function b(a, b, c) {
    return "whatever" // do something here.
}

function a() {
    var bOut = b("one", "two", "three");
```

[22] https://en.wikipedia.org/wiki/Memory_leak

[23] https://en.wikipedia.org/wiki/Garbage_collection_(computer_science)

```
    return "something "+bOut;
}
```

If component **b** then changes in some backwards-incompatible way, say:

```
function b(a, b, c, d /* new parameter */) {
    return "whatever" // do something here.
}
```

Then, we can say that the protocol has changed. This problem is so common, so endemic to computing that we've had compilers that check function arguments since the 1960's[24]. The point being is that it's totally possible for the compiler to warn you about when a protocol within the program has changed.

The same is basically true of Data Types[25]: whenever we change the **Data Type**, we need to correct the usages of that type. Note above, I've given the `javascript` example, but I'm going to switch to `typescript` now:

```
interface BInput {
    a: string,
    b: string,
    c: string,
    d: string
}

function b(in: BInput): string {
    return "whatever" // do something here.
}
```

Now, of course, there is a tradeoff: we *mitigate* Complexity Risk, because we define the protocols / types *once only* in the program, and ensure that usages all match the specification. But the tradeoff is (as

[24] https://en.wikipedia.org/wiki/Compiler

[25] https://en.wikipedia.org/wiki/Data_type

we can see in the `typescript` code) more *finger-typing*, which some people argue counts as Schedule Risk.

Nevertheless, compilers and type-checking are so prevalent in software that clearly, you have to accept that in most cases, the trade-off has been worth it: Even languages like Clojure[26] have been retro-fitted with type checkers[27].

We're going to head into much more detail on this in the chapter on Protocol Risk.

Space and Time Complexity

So far, we've looked at a couple of definitions of complexity in terms of the codebase itself. However, in Computer Science there is a whole branch of complexity theory devoted to how the software *runs*, namely Big O Complexity[28].

Once running, an algorithm or data structure will consume space or runtime dependent on it's characteristics. As with Garbage Collectors), these characteristics can introduce Performance Risk which can easily catch out the unwary. By and large, using off-the-shelf data structures and algorithms helps, but you still need to know their performance characteristics.

The Big O Cheatsheet[29] is a wonderful resource to investigate this further.

Concurrency / Mutability

Although modern languages include plenty of concurrency primitives, (such as the java.util.concurrent[30] libraries), concurrency is *still* hard to get right.

Race conditions[31] and Deadlocks[32] *thrive* in over-complicated concurrency designs: complexity issues are magnified by concurrency con-

[26]https://clojure.org

[27]https://github.com/clojure/core.typed/wiki/User-Guide

[28]https://en.wikipedia.org/wiki/Big_O_notation

[29]http://bigocheatsheet.com

[30]https://docs.oracle.com/javase/9/docs/api/java/util/concurrent/package-summary.html

[31]https://en.wikipedia.org/wiki/Race_condition

[32]https://en.wikipedia.org/wiki/Deadlock

cerns, and are also hard to test and debug.

Recently, languages such as Clojure have introduced persistent collections[33] to alleviate concurrency issues. The basic premise is that any time you want to *change* the contents of a collection, you get given back a *new collection*. So, any collection instance is immutable once created. The tradeoff is again attendant Performance Risk to mitigate Complexity Risk.

An important lesson here is that choice of language can reduce complexity: and we'll come back to this in Software Dependency Risk.

Networking / Security

The last area I want to touch on here is networking. There are plenty of Complexity Risk perils in *anything* to do with networked code, chief amongst them being error handling and (again) protocol evolution.

In the case of security considerations, exploits *thrive* on the complexity of your code, and the weaknesses that occur because of it. In particular, Schneier's Law says, never implement your own crypto scheme:

> "Anyone, from the most clueless amateur to the best cryptographer, can create an algorithm that he himself can't break. It's not even hard. What is hard is creating an algorithm that no one else can break, even after years of analysis." - Bruce Schneier, 1998[34]

Luckily, most good languages include crypto libraries that you can include to mitigate these Complexity Risks from your own code-base.

This is a strong argument for the use of libraries. But, when should you use a library and when should you implement yourself? This is again covered in the chapter on Software Dependency Risk.

tbd - next chapter.

costs associated with complexity risk

CHANGE is also more risky why?

[33] https://en.wikipedia.org/wiki/Persistent_data_structure

[34] https://en.wikipedia.org/wiki/Bruce_Schneier#Cryptography

Part III

Preview

book1/Part3.md practices/Estimates.md

Glossary

Abstraction

Feedback Loop

Goal In Mind

Internal Model

The most common use for Internal Model is to refer to the model of reality that you or I carry around in our heads. You can regard the concept of Internal Model as being what you *know* and what you *think* about a certain situation.

Obviously, because we've all had different experiences, and our brains are wired up differently, everyone will have a different Internal Model of reality.

Alternatively, we can use the term Internal Model to consider other viewpoints: - Within an organisation, we might consider the Internal Model of a *team of people* to be the shared knowledge, values and working practices of that team. - Within a software system, we might consider the Internal Model of a single processor, and what knowledge it has of the world. - A codebase is a team's Internal Model written down and encoded as software.

An internal model *represents* reality: reality is made of atoms, whereas the internal model is information.

Meet Reality

Risk

Attendant Risk

Hidden Risk

Mitigated Risk

Take Action