Zen and the art of library maintenance

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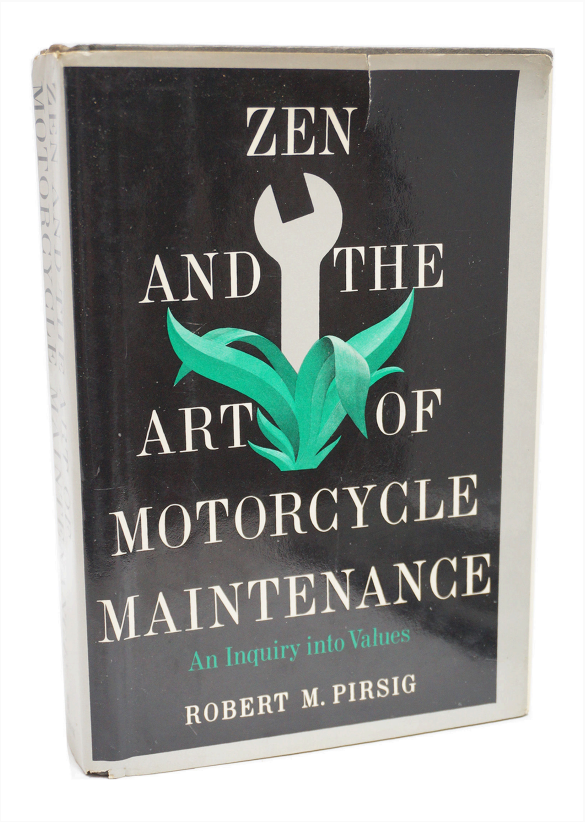

Zen and the Art of Motorcycle Maintenance by Robert Pirsig - Good book about quality

Writing libraries and testing

- General principles
- Rust design
- Testing
- Maintenance

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  - No serious developer will touch your “OSS” library if you forget a license

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  - If my type can work with "anything that can be turned into a Path," the constructor should not take only a hardcoded string type

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  - Types understood through their interfaces as distinct units

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- Small API
  - Less to learn, maintain, less opportunity to make breaking changes

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- Rust railroads you into idiomatic code pretty hard
  - Everyone fought the borrow-checker and various APIs at one time

Going back to the “well tested” point

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/// let mut vec = Vec::with_capacity(10);
/// assert_eq!(vec.len(), 0);
/// assert!(vec.capacity() >= 10);
/// for i in 0..10 {
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- `cargo test` will run doctests
- Document public items in any case
  - You can use `#![deny(missing_docs)]` in your crate root

Standard layout

```
$ tree
.
|-- Cargo.toml
|-- benches                 - benchmarks
|-- examples                - independent examples (binaries)
|-- src                     ↓
|   |-- bin                 ↓
|   |   `-- something.rs    - other binaries (if any)
|   |-- lib.rs              - library entrypoint
|   `-- main.rs             - if your crate also has an executable (eg. CLI)
`-- tests                   - "integration" tests
```

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- Make illegal states unrepresentable (Haskell proverb)
  - Meaning - only correct usage, within reason, should compile
- Avoid “stringly-typed” APIs (Pascal Hertleif quote)

```rust
use chrono::{DateTime, Utc, Weekday};

fn is_matching_day(datetime: DateTime<Utc>, day: &str) -> bool {
    let weekday = datetime.weekday();
    match day.to_lowercase().as_str() {
        "monday" => weekday == Weekday::Mon,
        "tuesday" => weekday == Weekday::Tue,
        "wednesday" => weekday == Weekday::Wed,
        "thursday" => weekday == Weekday::Thu,
        "friday" => weekday == Weekday::Fri,
        "saturday" => weekday == Weekday::Sat,
        "sunday" => weekday == Weekday::Sun,
        _ => unreachable!("there is only 7 days in a week, no?"),
    }
}
```

Oops

```
let is_tuesday = is_matching_day(
  some_date,
  "If you ask Rick Astley for a copy of the movie “UP”, he cannot give you it
as he can never give you up. But, by doing that, he is letting you down, and
thus, is creating something known as the Astley Paradox.",
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- The correct thing to do is use a more concrete type (e.g. an enum for all the days in this case)

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  - Enums are great for representing states in general
  - Unlike random strings, you can document enums

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fn main() {
    let car = CarBuilder::new("Toyota", "Corolla")
        .year(2020)
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    println!("{:#?}", car);
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- You can also do **session types** where your builder goes through several types with different methods

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fn main() {
    let car = CarBuilder::new("Toyota", "Corolla")
        .year(2020)
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        .automatic(true)
        .build();

    println!("{:#?}", car);
}
```

- Essentially: Constructor (`T::new()`) -> methods that modify the instance -> `build()`/`finish()`/`whatever()`
- Generally, the builder methods return either **T** or **&mut T** (and rarely **&T** if doing interior mutability magic)

Builder pattern

- Let's you validate and convert parameters implicitly, use defaults, and keep internal structure hidden
  - Forward compatibility - you can change the struct fields however you want
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- You can also do **session types** where your builder goes through several types with different methods

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(Meaning you can force an order of operations - useful with protocols, e.g. HTTP requests)
(starts to smell like substructural type systems :))

Type conversion ergonomics

```rust
use std::path::Path; // let's pretend Path::exists() doesn't exist :)
use std::fs;

fn file_exists(path: &Path) -> bool {
    fs::metadata(path).is_ok()
}

fn main() {
    // Example usage
    let path = Path::new("./example.txt");
    println!("Does the file exist? {}", file_exists(path));
}
```

- Not ideal, since we now require user to construct a Path directly. Less flexible

```rust
use std::path::Path; // let's pretend Path::exists() doesn't exist :)
use std::fs;

fn file_exists<P: AsRef<Path>>(path: P) -> bool {
    fs::metadata(path.as_ref()).is_ok()
}

fn main() {
    // Example usage with a &str
    let path_str = "./example.txt";
    println!("Does the file exist? {}", file_exists(path_str));

    // Example usage with a PathBuf
    let path_buf = Path::new("./example.txt").to_path_buf();
    println!("Does the file exist? {}", file_exists(path_buf));
}
```

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Naturally, you can implement these on your types wherever applicable

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- Debug and optionally Display

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- TIP: Prefer taking a slice to taking a Vec, and if possible, just take a generic Iterator
  - e.g `fn hi<T: Iterator<Item=u32>>(numbers: T)`

```rust
struct MyCollection<T> { // simple example
    elements: Vec<T>,    // consider e.g. address book or any tree ADT
}

// Implementing the FromIterator trait for MyCollection
impl<T> FromIterator<T> for MyCollection<T> {
    fn from_iter<I: IntoIterator<Item = T>>(iter: I) -> Self {
        let mut c = MyCollection { elements: Vec::new() };

        for i in iter { c.elements.push(i); }

        c
    }
}

let collected: MyCollection<i32> = vec![1, 2, 3, 4, 5].into_iter().collect();
println!("{:?}", collected.elements); // Prints: [1, 2, 3, 4, 5]
```

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- You can also write extension traits to provide additional functionality to existing items:
  - By convention name is `TraitOrTypeNameExt`
  - In std for example `std::ascii::AsciiExt` (deprecated)
- https://github.com/Ixrec/rust-orphan-rules

```rust
use std::fmt;
pub struct DisplayVec<T>(pub Vec<T>);

impl<T: fmt::Display> fmt::Display for DisplayVec<T> {
    fn fmt(&self, f: &mut fmt::Formatter<'_>) -> fmt::Result {
        let elements_as_strings: Vec<String> = self.0.iter().map(|e|
e.to_string()).collect();
        write!(f, "[{}]", elements_as_strings.join(", "))
    }
}

let numbers = DisplayVec(vec![1, 2, 3, 4, 5]);
println!("{}", numbers); // Prints: "[1, 2, 3, 4, 5]"
```

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    - Benchmarks - similar to integration tests, but for making perf statistics
      - Some parts of support are nightly-only

Test syntax in Rust

```rust
#[cfg(test)]
mod tests {
    #[test]
    fn test_addition() {
        let sum = 2 + 2;
        assert_eq!(sum, 4);
    }

    #[test]
    #[should_panic(expected = "assertion failed")]
    fn test_failure_scenario() {
        assert!(false, "This test will panic!");
    }
}
```

Run with `cargo test`

Result<T> tests

```rust
#[cfg(test)]
mod tests {
    #[test]
    fn test_division() -> Result<(), String> {
        let result = 10 / 2;
        if result == 5 {
            Ok(())
        } else {
            Err(String::from("Division result was not as expected."))
        }
    }
}
```

Benchmark

```rust
use criterion::{black_box, criterion_group, criterion_main, Criterion};

fn fibonacci(n: u64) -> u64 {
    match n {
        0 => 0,
        1 => 1,
        _ => fibonacci(n - 1) + fibonacci(n - 2),
    }
}

fn criterion_benchmark(c: &mut Criterion) {
    c.bench_function("fibonacci 20", |b| b.iter(|| fibonacci(black_box(20))));
}

criterion_group!(benches, criterion_benchmark); criterion_main!(benches);
```

Run with `cargo bench`

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