Safely Evolving Legacy Code

Slides up at scottsauber.com

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Audience

- Anyone maintaining legacy code
- Poll
- How many people maintain legacy code?
- How many people enjoy it?

Agenda

- What is Legacy Code
- Options for making changes to Legacy Code
- Process for safely doing so
- How I’ve evolved legacy code with real world applications

Goals

- Give you ideas on how you can safely work with legacy code today
- This is **not** about how to completely rewrite your app, this is about **evolving**

Who am I?

- Director of Engineering at Lean TECHniques
- Microsoft MVP
- Co-organizer of Iowa .NET User Group
- Dometrain Author
- Blog at scottsauber.com

“Legacy Code is code without tests.”

Michael Feathers

“Legacy Code is valuable code we’re afraid to change.”

JB Rainsberger

Characteristics of Legacy Code

- Hard to understand
- Changing code often breaks the app in unexpected ways
- Long cycle times to add or change functionality
- Huge estimates for seemingly small changes
- Stories seemingly drag on across days, weeks, months
- 3rd party brought in for assessment

A JIRA issue gets created…
…for “that app”

3 options when changing legacy code

- Edit and Pray
- The Great Rewrite To Solve All Our Problems™
- Cover and Modify 

Question to ask yourself:
How much time do you have?

Answer 1:

I need to add this new functionality today!

I need to add new functionality today!

- Adding “just a few more lines” to the god classes/functions is not an option
- Find seams in existing code
- We **should not** refactor without existing tests in place
- Make minimal changes to untested code with one of two techniques
- Sprout
- Wrap

Sprout

Sprout

- Create new method/function/class to house new behavior
- TDD the new behavior
- Insert new, tested code into existing code (existing code untested)
- In the case of .NET you can call new C# code from old VB code

Sprout Example – Existing Code

```
11  public static async Task<Guid> RegisterNewUserAsync(NewUserRequest request)
12  {
13      var httpClient = new HttpClient { BaseAddress = new Uri("https://api.contoso.com") };
14      var userResult :HttpResponseMessage = await httpClient.PostAsJsonAsync( requestUri: "users", request);
15      userResult.EnsureSuccessStatusCode();
16      var userId = await userResult.Content.ReadFromJsonAsync<Guid>();
17
18      var sqlConnection = new SqlConnection("Data Source=ServerName;Initial Catalog=DBName;UserID=Username;Password=Password");
19      var sql = "insert into LegacyUsers (ColumnsGoHere) values @user";
20      await sqlConnection.ExecuteAsync(sql, param: new { user = request });
21
22      await new SmtpClient( host: "smtp.contoso.com").SendMailAsync( from: "donotreply@contoso.com" , recipients: request.Email, subject: "subject", body: "body");
23
24      Log.Debug( messageTemplate: "User {userId} was registered", userId);
25      return userId;
26  }
```

New Requirement!

Do not allow an invalid email address to be registered

Sprout Example – New Code Tested In Isolation

```
5   public class NewUserRequestValidator
6   {
        1 usage
7       public List<ValidationError> Validate(NewUserRequest request)
8       {
9           List<ValidationError> errors = [];
10
11          if (!new EmailAddressAttribute().IsValid(request.Email))
12              errors.Add(item: new ValidationError(nameof(request.Email), Error: "Email address is in an invalid format"));
13
14          return errors;
15      }
16  }
```

*just use Fluent Validation

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Sprout Example – Sprout into Existing Code

```
11  public static async Task<Guid> RegisterNewUserAsync(NewUserRequest request)
12  {
13      var validationErrors:List<ValidationError> = new NewUserRequestValidator().Validate(request);
14
15      if (validationErrors.Any())
16      {
17          // Throw a custom exception, return a Result... whatever makes sense in the context
18          throw new ValidationException(validationErrors);
19      }
20
21      var httpClient = new HttpClient { BaseAddress = new Uri("https://api.contoso.com") };
22      var userResult:HttpResponseMessage = await httpClient.PostAsJsonAsync(requestUri:"users", request);
23      userResult.EnsureSuccessStatusCode();
24      var userId = await userResult.Content.ReadFromJsonAsync<Guid>();
25
26      var sqlConnection = new SqlConnection("Data Source=ServerName;Initial Catalog=DBName;UserID=Username;Password=Password");
27      var sql = "insert into LegacyUsers (ColumnsGoHere) values @user";
28      await sqlConnection.ExecuteAsync(sql, param:new { user = request });
29
30      await new SmtpClient(host:"smtp.contoso.com").SendMailAsync(from:"donotreply@contoso.com", recipients:request.Email, subject:"subject", body:"body");
31
32      Log.Debug(messageTemplate:"User {userId} was registered", userId);
33      return userId;
34  }
```

Sprout Takeaways

- Write new code in isolation from the mess
- If you keep adding to the pile of debt, the only way out is bankruptcy
- Eventually over time things will get better (might take months or years)
- Can even test most of the untested sprouted code in isolation!

Wrap

Wrap

- Only works if new code needs to be added to beginning or end of existing code
- Process is:
- Extract all existing code into another method (safe to do with an IDE)
- Call newly extracted method from the original method (also safe)
- Insert new code before/after the extracted method

Wrap Example – Existing Code

```
11  public static async Task<Guid> RegisterNewUserAsync(NewUserRequest request)
12  {
13      var httpClient = new HttpClient { BaseAddress = new Uri("https://api.contoso.com") };
14      var userResult :HttpResponseMessage = await httpClient.PostAsJsonAsync( requestUri: "users", request);
15      userResult.EnsureSuccessStatusCode();
16      var userId = await userResult.Content.ReadFromJsonAsync<Guid>();
17
18      var sqlConnection = new SqlConnection("Data Source=ServerName;Initial Catalog=DBName;UserID=Username;Password=Password");
19      var sql = "insert into LegacyUsers (ColumnsGoHere) values @user";
20      await sqlConnection.ExecuteAsync(sql, param: new { user = request });
21
22      await new SmtpClient( host: "smtp.contoso.com").SendMailAsync( from "donotreply@contoso.com", recipients: request.Email, subject: "subject", body: "body");
23
24      Log.Debug( messageTemplate: "User {userId} was registered", userId);
25      return userId;
26  }
```

New Requirement!

Do not allow an invalid email address to be registered

Wrap Step 1 –Extract To Private Method

```
11  public static async Task<Guid> RegisterNewUserAsync(NewUserRequest request)
12  {
13      return await CreateNewUserAsync(request);
14  }
15
16  private static async Task<Guid> CreateNewUserAsync(NewUserRequest request)
17  {
18      Guid registerNewUserAsync;
19      var httpClient = new HttpClient { BaseAddress = new Uri("https://api.contoso.com") };
20      var userResult:HttpResponseMessage = await httpClient.PostAsJsonAsync(requestUri:"users", request);
21      userResult.EnsureSuccessStatusCode();
22      var userId = await userResult.Content.ReadFromJsonAsync<Guid>();
23
24      var sqlConnection = new SqlConnection("Data Source=ServerName;Initial Catalog=DBName;UserID=Username;Password=Password");
25      var sql = "insert into LegacyUsers (ColumnsGoHere) values @user";
26      await sqlConnection.ExecuteAsync(sql, param:new { user = request });
27
28      await new SmtpClient(host:"smtp.contoso.com").SendMailAsync(from:"donotreply@contoso.com", recipients:request.Email, subject:"subject", body:"body");
29
30      Log.Debug(messageTemplate:"User {userId} was registered", userId);
31      registerNewUserAsync = userId;
32      return userId;
33  }
```

Wrap Step 2 – Create + Test New Methods

```
5   public class NewUserRequestValidator
6   {
        1 usage
7       public List<ValidationError> Validate(NewUserRequest request)
8       {
9           List<ValidationError> errors = [];
10
11          if (!new EmailAddressAttribute().IsValid(request.Email))
12              errors.Add( item: new ValidationError(nameof(request.Email),  Error: "Email address is in an invalid format"));
13
14          return errors;
15      }
16  }
```

```
37      public static void Validate(NewUserRequest request)
38      {
39          var validationErrors :List<ValidationError> = new NewUserRequestValidator().Validate(request);
40
41          if (validationErrors.Any())
42          {
43              // Throw a custom exception, return a Result... whatever makes sense in the context
44              throw new ValidationException(validationErrors);
45          }
46      }
```

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Wrap Step 3 – Call from Original Method

```
public static async Task<Guid> RegisterNewUserAsync(NewUserRequest request)
{
    Validate(request);
    return await CreateNewUserAsync(request);
}
```

Wrap Takeaways

- Similar to Sprout (especially this example)
- Only works in some scenarios (new code added to start/end)

Sprout and Wrap Takeaways

- Use these techniques when you need to make a change immediately
- Sprout works always
- Wrap can work when code can be added to beginning or end

Questions about Sprout or Wrap?

Question to ask yourself:
How much time do you have?

Answer 2:
We have some extra time!

Avoid The Great Rewrite™

- The Great Rewrite™ is $$ and risky ***especially without proper understanding of the current system***
- Delays new feature development
- No iterative steps
- Without tests, you are Editing and Praying
- Don’t try to rewrite the entire app
- Instead - slice off pieces

Avoid The Great Rewrite™

- …but before you carve off, understand current state
- Can’t properly rearchitect without understanding current slice
- I am usually not a fan of moving app logic + db schema at the same time
- Move the app logic first, then move the db schema later when everything is on the new code
- Avoid replicating data, whole new sets of problems

How do I evolve Legacy Code?

1. Get the developer ecosystem stable
2. Understand what the app does
3. Add characterization/integration tests around existing code
4. Refactor safely!

1. Get the Developer Ecosystem Stable

- Is it in source control?
- Is there a reliable CI pipeline?
- Is there a reliable CD pipeline?
- Can I run it locally without being pointed at Production?
- Can we remove our Production access?
- Is there reliable test data?

2. Understand the app

- Add logging
- Add metrics
- Add instrumentation
- Observe the app in Production
- Read the code and take notes
- Refactor without tests, but ***throw the code away when you're done***

3. Add characterization tests

- After understanding the inputs and outputs, you can now add tests
- Blackbox implementation code as much as possible
- WebApplicationFactory is great for this in .NET
- Builds up knowledge of how the code works
- Need safety net when you refactor in the next step

3. Add characterization tests Paradox!

```
11    public static async Task<Guid> RegisterNewUserAsync(NewUserRequest request)
12    {
13        var httpClient = new HttpClient { BaseAddress = new Uri("https://api.contoso.com") };
14        var userResult:HttpResponseMessage = await httpClient.PostAsJsonAsync(requestUri: "users", request);
15        userResult.EnsureSuccessStatusCode();
16        var userId = await userResult.Content.ReadFromJsonAsync<Guid>();
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19        var sql = "insert into LegacyUsers (ColumnsGoHere) values @user";
20        await sqlConnection.ExecuteAsync(sql, param:new { user = request });
21
22        await new SmtpClient(host:"smtp.contoso.com").SendMailAsync(from:"donotreply@contoso.com", recipients:request.Email, subject:"subject", body:"body");
23
24        Log.Debug(messageTemplate:"User {userId} was registered", userId);
25        return userId;
26    }
```

3. Add characterization tests Paradox

- Paradox!
- I need to add tests so I can change the code safely
- I can’t test without changing the code
- Make ***absolute bare minimum changes*** to allow testability
- DI is your friend (constructor, method, and even property injection)

4. Refactor the Code

- Now that you have tests you can safely refactor
- Make change, run tests, repeat
- Get back to green as quickly as possible
- Avoid “long red”
- Repeat until code is in good state

Real Examples

Legacy Code Disclaimer

- Legacy code is not the fault of an individual
- Code is the product of an organization not an individual
  - Time constraints
  - Technical constraints
  - Technical training (or lack thereof)
  - Allowing silos to form
- Everybody does their best with the constraints they work within

Situation 1

- Inherit a weekly legacy ETL process
- ETL process sends data to hundreds of retail stores
- When the stores don’t have this data, they can’t set accurate prices
- 80% of this code is SQL (including xp_cmdshell), 10% is VB, 10% is C#
- Takes 40 hours to run and fails 90% of the time, needs babysat
- Required 20+ hours of off-hours support from devs, every single week
- Key Dev making this work left the company
- Millions of dollars lost to the business not having accurate data
- Tiger Team Created to fix this

1. Get The Developer Ecosystem Stable

- Created CI/CD Pipelines
- Got it to run locally (without pointing at Production)
- Root caused issues and fixed
- Avoided extending the timeout on long running stored procedures
- On-call rotation of 2 to shield team from immediate production issues

2. Understand the application

- Refactored w/out committing
- Created tools/utilized Grafana to measure the ETL worked
- Add instrumentation to understand how it performed in Production (NewRelic)
- Zero domain knowledge from 90% of team members
- Pair Programmed

3. Add characterization tests

- Created test environment
- Dockerized the databases required for local dev
- Added integration tests
- First test required 40K LOC of SQL across 3 databases
- Created tool to autogenerate that 40K LOC so we didn't have to maintain it

4. Refactor

- Analyzed NewRelic instrumentation
- Identified bottlenecks
- Optimizing code now safe to make with integration tests in place

Outcomes

- ETL process went from running 40hrs to 1hr
- 20 hours of off hours support dropped to 0
- Increased developer happiness
- Stores get their data faster
- Code is easier to make changes
- Users reported longstanding bugs rather than working around them, because they expected things to work

Situation 2

- Inherited WPF .NET 4.6 app that was not reliable
- Process run 1-5x a month to help a particular workflow
- Was ran on a developer's machine
- Desire to move it to the web and give it to users

1. Get The Developer Ecosystem Stable

- Created CI/CD Pipelines
- Got it to run locally (without pointing at Production)
- Root caused issues and fixed

2. Understand the application

- Refactored w/out committing
- Zero domain knowledge from 90% of team members
- Pair Programmed

3. Add characterization tests

- Created test environment
- Dockerized the dependencies required for local development
- Added integration tests

4. Refactor

- Converted it to latest .NET version (WPF runs on .NET 5+)
- Moved core logic code from WPF app to shared library
- Created web app
- Moved page by page over, referencing shared library

Outcomes

- WPF app used to run manually on a developer's computer for hours 😱
- Reduced dozens of known issues requiring manual intervention to zero
- Gave web app to users so no developer intervention needed going forward
- Increased developer happiness

Takeaways from Real World Scenarios

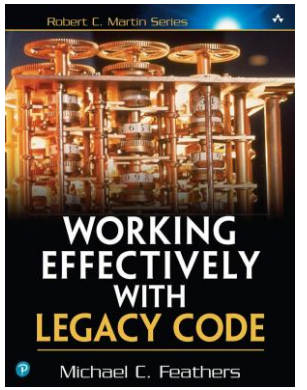
- Neither required a rewrite, even though it was tempting
- Solved immediate problems with the existing applications, not deferring those solutions til the rewrite was done
- Slow migration of existing slices

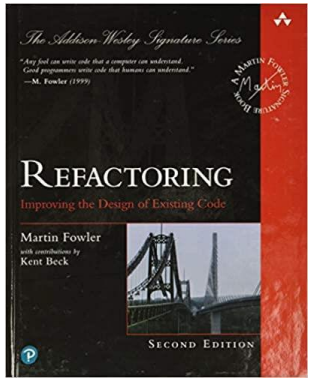
Takeaways

- Evolving should be your default, not rewriting
- Sprout or Wrap are techniques to deliver value quickly
- 4 step process when you do have time to “do it right”
- The payoff

Resources

- The Book
  - Working Effectively with Legacy Code by Michael Feathers
  - 435 pages
- https://understandlegacycode.com/
- Refactoring: Improving the Design of Existing Code by Martin Fowler
- This slide deck





Questions?

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Thanks!

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