

Intention-based variant integration



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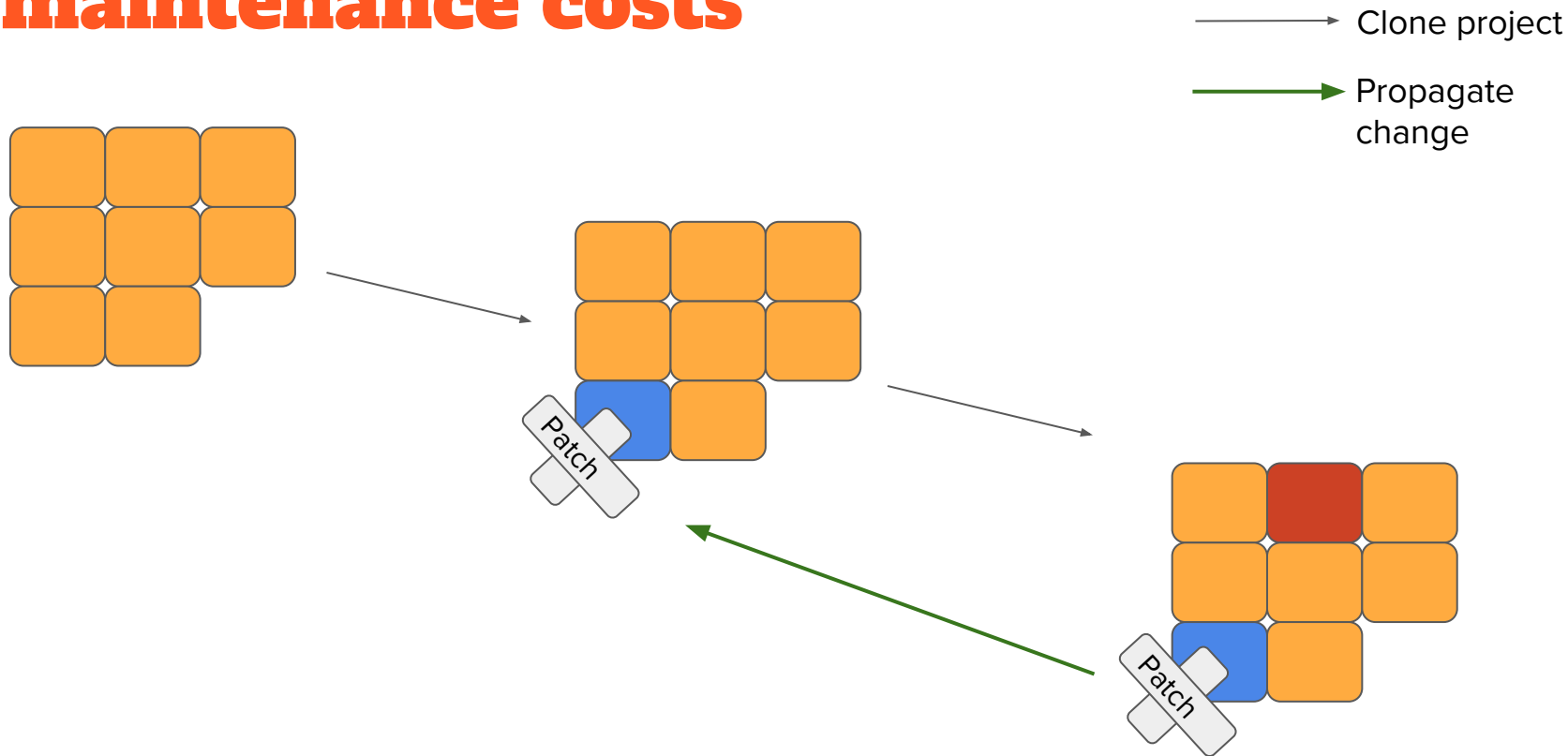
In collaboration with: Max Lillack, Stefan Stanciulescu,
Thorsten Berger, Andrzej Wasowski

Slides adapted from Stefan!

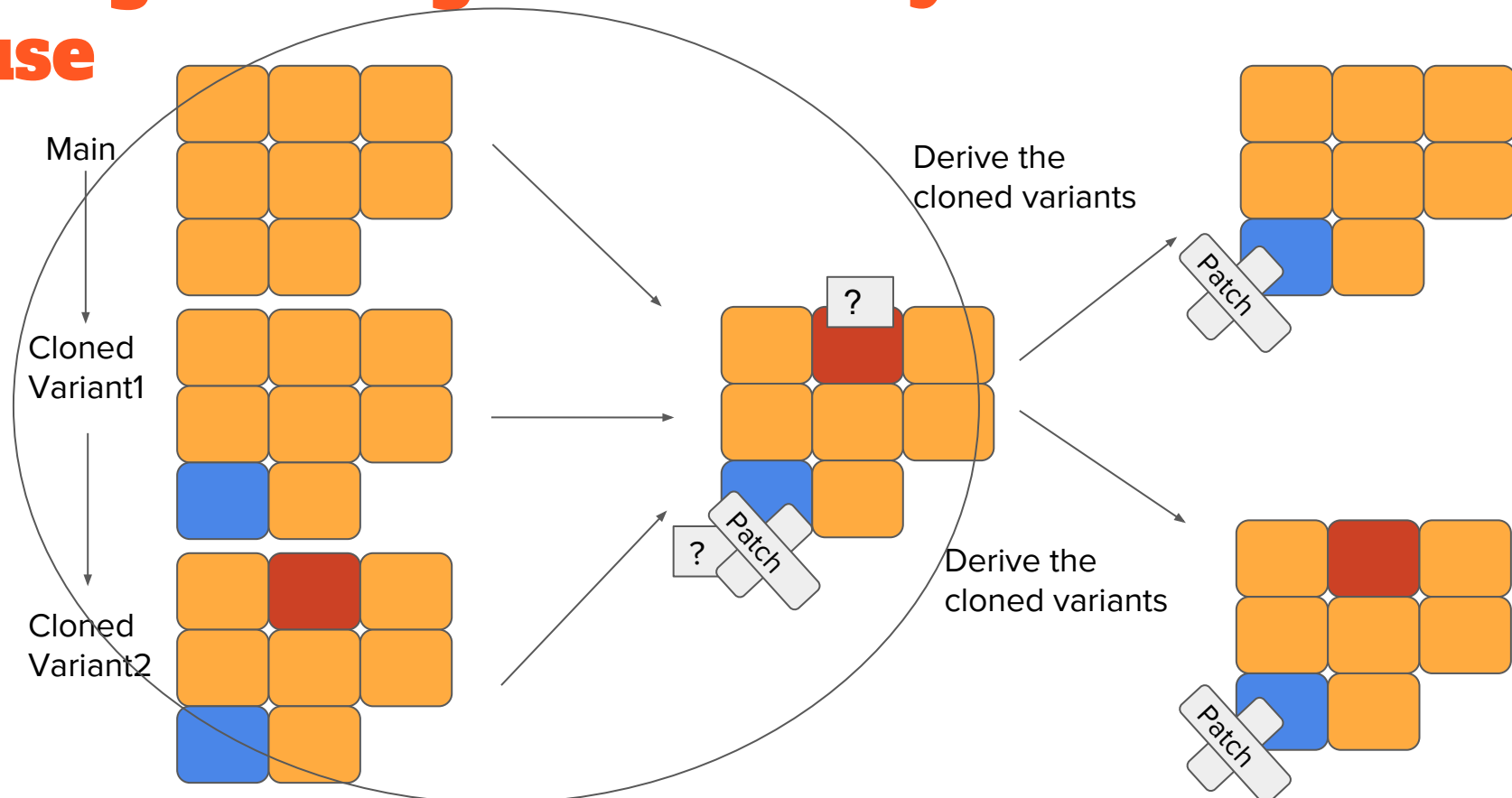
Agenda

- Background: Clones, clones, clones
- Solution: Intention-based clone integration
- Evaluation: Replaying integration scenarios

Clones: quick and easy with high maintenance costs



Re-engineering to enable systematic reuse



Variant integration vs. *regular* merging

- **Variant integration:** cohabilitating features to enable variants (semantics!)
- **Regular merging:** greedy - delegate conflicts (syntax!)
- Goals are different:
 - Ensuring that multiple features work together, contra
 - Single implementation of parallel changes

Diffing to the rescue?

```
#ifdef ULTIPANEL
...
uint8_t lastEncoderBits;

uint32_t encoderPosition;
- #if PIN_EXISTS(SD_DETECT)
-   uint8_t lcd_sd_status;

#endif
- #endif // ULTIPANEL

- menu_t cM = lcd_status_scrn;
  bool ignore_click = false;
```

Mainline

```
1 #ifdef ULTIPANEL
2   ...
3   uint8_t lastEncoderBits;
4   + int8_t encoderDiff;
5   uint32_t encoderPosition;
6
7
8   + #if (SDCARDDETECT > 0)
9   +   bool lcd_oldcardstatus;
10  #endif
11  + #endif//ULTIPANEL
12
13
14  bool ignore_click = false;
```

Fork

Diffing to the rescue?

```
1 #ifdef ULTIPANEL
2   uint8_t lastEncoderBits;
3   uint32_t encoderPosition;
4   #if PIN_EXISTS(SD_DETECT)
5     uint8_t lcd_sd_status;
6   #endif
7 #endif // ULTIPANEL
8
9 menu_t cM = lcd_status_scrn;
10 bool ignore_click = false;
```

Mainline

```
1 #ifdef ULTIPANEL
2   uint8_t lastEncoderBits;
3   int8_t encoderDiff;
4   uint32_t encoderPosition;
5   #if (SDCARDDETECT > 0)
6     bool lcd_oldcardstatus;
7   #endif
8 #endif //ULTIPANEL
9
10 menu_t cM = lcd_status_scrn;
```

Fork

Diff doesn't work :(

diff -D FORK

```
...
#ifdef FORK
  #if (SDCARDDETECT > 0)
    bool lcd_oldcardstatus;
  #else
    #if PIN_EXISTS(SD_DETECT)
      uint8_t lcd_sd_status;
    #endif
  #endif
#endif
...

```

Fixed missing #endif from merge

[Browse files](#)

Marlin_v1

 T3P3 committed on 22 Jul 2013

1 parent [66947f0](#)

commit [067c8e5c715302b01f6950be091ff782e81a85f4](#)



@@ -46,15 +46,16 @@ float current_temperature_bed = 0.0;

```
46 46  #ifdef TEMP_SENSOR_1_AS_REDUNDANT
47 47      int redundant_temperature_raw = 0;
48 48      float redundant_temperature = 0.0;
49 49  +#endif
49 50  #ifdef ALGEBRA_TEMP
```


Proper integrated AST is hard to construct by hand

```
1 #ifndef ULTIPANEL
2  uint8_t lastEncoderBits;
3  uint32_t encoderPosition;
4  #if PIN_EXISTS(SD_DETECT)
5  uint8_t lcd_sd_status;
6  #endif
7 #endif // ULTIPANEL
8
9 menu_t cM = lcd_status_scrn;
10 bool ignore_click = false;
```

```
1 #ifndef ULTIPANEL
2  uint8_t lastEncoderBits;
3  int8_t encoderDiff;
4  uint32_t encoderPosition;
5  #if (SDCARDDETECT > 0)
6  bool lcd_oldcardstatus;
7  #endif
8 #endif //ULTIPANEL
9
10 menu_t cM = lcd_status_scrn;
```

```
1 #ifndef ULTIPANEL
2  uint8_t lastEncoderBits;
3  #ifndef FORK
4  int8_t encoderDiff;
5  #endif
6  uint32_t encoderPosition;
7  #ifndef FORK
8  #if SDCARDDETECT > 0
9      bool lcd_oldcardstatus;
10     #endif
11 #else
12     #if PIN_EXISTS(SD_DETECT)
13         uint8_t lcd_sd_status;
14     #endif
15 #endif
16 #endif
17
18 menu_t cM = lcd_status_scrn;
19 #ifndef FORK
20     bool ignore_click = false;
21 #endif
```

Our goal:

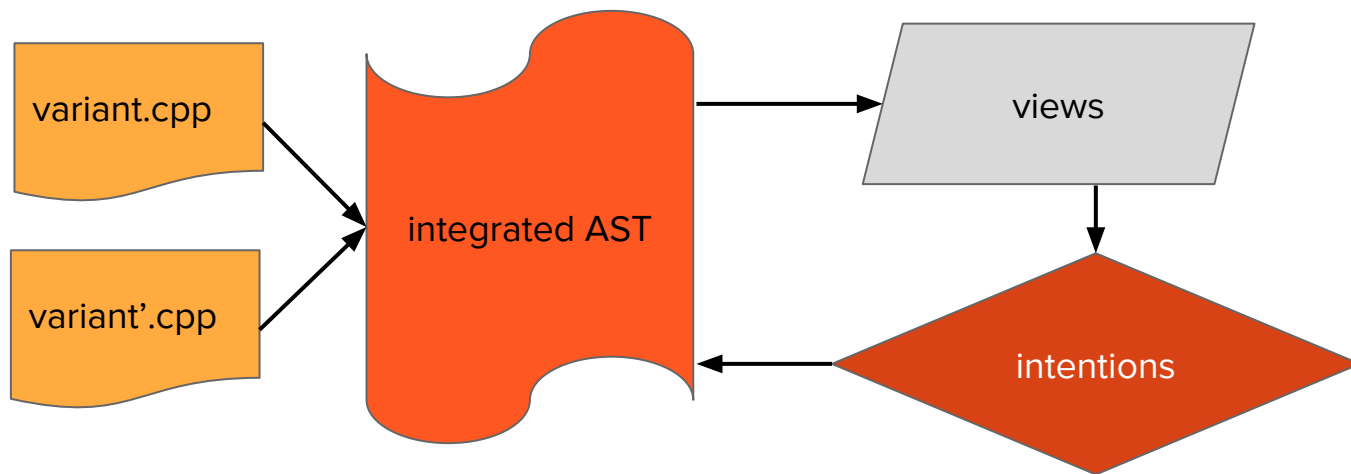
Support *re-engineering* of clone-based *variants* into software product lines using *intentions* and *views*

Achieved by:

- Abstraction from source code
- Intuitive intentions
- Views to explore results
- Interactive process

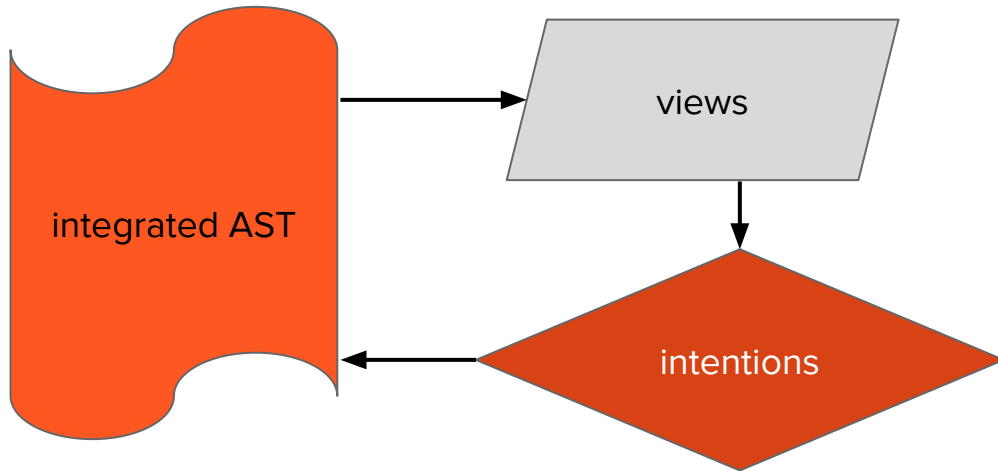
Integration process:

1. Automatically generate integrated AST from two variants
2. Explore integrated AST using views
3. Edit variational AST - add integration intentions



Integration process:

1. Automatically generate integrated AST from two variants
2. Explore integrated AST using views
3. Edit variational AST - add integration intentions



Benefits:

- The code can be compiled
- Test suites can be run
- Variants can be derived

Views and intentions in action

The screenshot displays an IDE with four windows showing code from 'paperexample01_integrated.cpp'. The top-left window shows the original code with a yellow highlight on a line and a lightbulb icon indicating an intention. The top-right window shows the code with a 'Future' projection and a yellow highlight. The bottom-left window shows the code with a 'Mainline' projection and a yellow highlight. The bottom-right window shows the code with a 'Clone' projection and a yellow highlight.

```
paperexample01_integrated.cpp
#if defined(ULTIPANEL)
uint8_t lastEncoderBits;
#if defined(FORK)
  int8_t encoderDiff;
#endif
uint32_t encoderPosition;
#if defined(FORK)
  #if SDCARDDTECT > 0
    bool lcd_oldcardstatus;
  #endif
#else
  #if PIN_EXISTS(SD_DETECT)
    uint8_t lcd_sd_status;
  #endif
#endif
menu_t cM = lcd_status_scrn;
#if !defined(FORK)
  bool ignore_click = false;
#endif

Future paperexample01_integrated.cpp
Projection: Future
#if defined(ULTIPANEL)
uint8_t lastEncoderBits;
uint32_t encoderPosition;
#if SDCARDDTECT > 0
  bool lcd_oldcardstatus;
#endif
#endif
menu_t cM = lcd_status_scrn;
#if !defined(FORK)
  bool ignore_click = false;
#endif

paperexample01_integrated.cpp
Projection: Mainline
#if defined(ULTIPANEL)
uint8_t lastEncoderBits;

uint32_t encoderPosition;
#if PIN_EXISTS(SD_DETECT)
  uint8_t lcd_sd_status;
#endif
#endif
menu_t cM = lcd_status_scrn;
bool ignore_click = false;

paperexample01_integrated.cpp
Projection: Clone
#if defined(ULTIPANEL)
uint8_t lastEncoderBits;
int8_t encoderDiff;
uint32_t encoderPosition;
#if SDCARDDTECT > 0
  bool lcd_oldcardstatus;
#endif
#endif
menu_t cM = lcd_status_scrn;
```

INCLINE in action!

paperexample01_integrated.cpp x

```
paperexample01_integrated.cpp
#if defined(ULTIPANEL)
  uint8_t lastEncoderBits;
  #if defined(FORK)
    int8_t encoderDiff;
  #endif
  uint32_t encoderPosition;
  #if defined(FORK)
    #if SDCARDDTECT > 0
      bool lcd_oldcardstatus;
    #endif
  #else
    #if PIN_EXISTS(SD_DETECT)
      uint8_t lcd_sd_status;
    #endif
  #endif
#endif

menu_t cM = lcd_status_scrn;
#if !defined(FORK)
  bool ignore_click = false;
#endif
```

paperexample01_integrated.cpp x

```
paperexample01_integrated.cpp
Projection: Mainline
#if defined(ULTIPANEL)
  uint8_t lastEncoderBits;

  uint32_t encoderPosition;
  #if PIN_EXISTS(SD_DETECT)
    uint8_t lcd_sd_status;
  #endif
#endif

menu_t cM = lcd_status_scrn;
bool ignore_click = false;
```

paperexample01_integrated.cpp x

```
Future paperexample01_integrated.cpp
Projection: Preview
#if defined(ULTIPANEL)
  uint8_t lastEncoderBits;
  uint32_t encoderPosition;
  #if SDCARDDTECT > 0
    bool lcd_oldcardstatus;
  #endif
#endif

menu_t cM = lcd_status_scrn;
#if !defined(FORK)
  bool ignore_click = false;
#endif
```

paperexample01_integrated.cpp x

```
paperexample01_integrated.cpp
Projection: Clone
#if defined(ULTIPANEL)
  uint8_t lastEncoderBits;
  int8_t encoderDiff;
  uint32_t encoderPosition;
  #if SDCARDDTECT > 0
    bool lcd_oldcardstatus;
  #endif
#endif

menu_t cM = lcd_status_scrn;
```

What are integration intentions?

- Intentions are intuitive declarations reflecting the developer's integration goal
 - e.g., keep functionality, remove functionality, keep as configurable feature
- Declared on blocks of code, shown in the different views
- Control the desired structure of the integrated file
- Intentions are automatically resolved on the integrated AST
- **Benefits:** raise abstraction level from `#if` structures to intuitive intentions

Intentions:

- Keep
- Remove
- KeepAsFeature
- Exclusive
- AssignFeature
- Postpone

Intentions: Keep

- Keep →
- Remove
- KeepAsFeature
- Exclusive
- AssignFeature
- Postpone

```
#ifndef FORK // block_not_fork  
    int servo_e1[] = SE  
    int servo_e2[] = SEA  
#else // block_fork  
    int16_t servo_e1 = SE  
    int16_t servo_e2[] = SEA  
#endif
```

Keep intention

```
int servo_e1[] = SE  
int servo_e2[] = SEA  
#ifdef FORK  
    int16_t servo_e1 = SE  
    int16_t servo_e2 = SEA  
#endif
```

Result

Intentions: Exclusive

- Keep
- Remove
- KeepAsFeature
- Exclusive →
- AssignFeature
- Postpone

```
#ifndef FORK //block2
    lcd.print(msg);
#else
#ifdef FIL_DISPLAY //block1
    if(condition){
        lcd.print(msg);
    }
    else{
        lcd.print(trnsf(data));
    }
#endif
#endif
```

Exclusive intention

```
#ifndef FIL_DISPLAY
    lcd.print(msg);
#else
    if(condition){
        lcd.print(msg);
    }
    else{
        lcd.print(trnsf(data));
    }
#endif
```

Result

Evaluation - so far

1. **Completeness** - intentions suffice
2. **Correctness** - intentions execution produces correct results
3. **Efficiency** - using intentions is faster than using unstructured approach

Method: Replay merge commits using ordinary tool and prototype tool.

1. Well, do they?
2. Check that output is well-formed.
3. Record number of edit operations.

Evaluation observations (so far)

1. **Completeness:** The intentions suffice for performing common integration tasks. Often, just using *Keep* and *Remove* resolve the task.
2. **Correctness:** When the intentions are correctly declared, they produce a correctly integrated configurable platform.
3. **Efficiency:** Developers need to perform substantially fewer operations using our approach.

Evaluation - next step

Challenges:

- Getting more examples (open source + industry projects)
- Controlled experiment, given better tool and intentions:
 - User study: students and professional developers to perform integration tasks
 - Compare **time/efficiency** and **correctness**

Summary

Diff doesn't work :(

diff -D FORK

```
...
#ifdef FORK
  #if (SDCARDDETECT > 0)
    bool lcd_oldcardstatus;
  #else
    #if PIN_EXISTS(SD_DETECT)
      uint8_t lcd_sd_status;
    #endif
  #endif
  ...
```

Fixed missing #endif from merge

Marlin_v1

TSP3 committed on 22 Jul 2013

1 parent 66947f0 commit 067c8e5c715302b0f16950e091f7782e1a05f4

```
46 46 #if (SDCARDDETECT > 0) float current_temperature_bed = 0.0;
47 47 #endif
48 48 #if TEMP_SENSOR_1_AS_REDUNDANT
49 49   int redundant_temperature_raw = 0;
50 50   float redundant_temperature = 0.0;
51 51 #endif
52 52 #ifdef ALGEBRA_TEMP
```

Intentions: Keep

- Keep
- Remove
- KeepAsFeature
- Exclusive
- AssignFeature
- Postpone

```
#ifdef FORK // block_not_fork
  int servo_e1[] = SE
  int servo_e2[] = SEA
#else // block_fork
  int16_t servo_e1 = SE
  int16_t servo_e2[] = SEA
#endif
```

Keep intention

```
int servo_e1[] = SE
int servo_e2[] = SEA
#ifdef FORK
  int16_t servo_e1 = SE
  int16_t servo_e2 = SEA
#endif
```

Result

In action!

```
@ papereample01_integrated.cpp
papereample01_integrated.cpp
#ifdef ULTIMAKER
  uint8_t lastEncoderBits;
  #if defined(FORK)
    uint8_t encoderRff;
  #endif
  uint32_t encoderPosition;
  #if defined(FORK)
    bool lcd_oldcardstatus;
    bool lcd_oldcardstatus;
  #endif
  #else
    #if PIN_EXISTS(SD_DETECT)
      uint8_t lcd_sd_status;
    #endif
  #endif
  menu_t cM = lcd_status_scrn;
  #if defined(FORK)
    bool ignore_click = false;
  #endif
#endif
```

```
@ papereample01_integrated.cpp
papereample01_integrated.cpp
Projection: Mainline
#ifdef ULTIMAKER
  uint8_t lastEncoderBits;
  #if defined(FORK)
    uint8_t encoderRff;
  #endif
  uint32_t encoderPosition;
  #if PIN_EXISTS(SD_DETECT)
    uint8_t lcd_sd_status;
  #endif
  #endif
  menu_t cM = lcd_status_scrn;
  bool ignore_click = false;
#endif
```

```
@ papereample01_integrated.cpp
papereample01_integrated.cpp
Projection: Remove
#ifdef ULTIMAKER
  uint8_t lastEncoderBits;
  #if defined(FORK)
    uint32_t encoderPosition;
    bool lcd_oldcardstatus;
  #endif
  #endif
  menu_t cM = lcd_status_scrn;
  #if defined(FORK)
    bool ignore_click = false;
  #endif
#endif
```

```
@ papereample01_integrated.cpp
papereample01_integrated.cpp
Projection: Clone
#ifdef ULTIMAKER
  #if defined(ULTIMAKER)
    uint8_t lastEncoderBits;
    uint32_t encoderRff;
    uint32_t encoderPosition;
    #if SDCARDDETECT > 0
      bool lcd_oldcardstatus;
    #endif
  #endif
  menu_t cM = lcd_status_scrn;
#endif
```

Evaluation - so far

1. **Completeness** - intentions suffice
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Method: Replay merge commits using ordinary tool and prototype tool.

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