

Software Product Line Development

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Motivation



Frans Post. Brasil Holandês



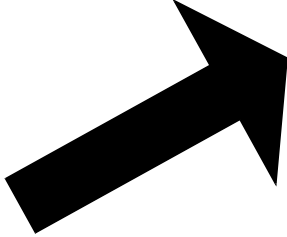
J.S. Bach.
"Goldberg
Variations"

Industrial Revolution

1826
interchangeable
parts



1901
assembly lines
1913 Henry Ford



1980s
automated
assembly lines
1961 General Motors

Chevrolet - Microsoft Internet Explorer

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TUDO SOBRE
- Escolha seu carro -

OPÇÕES DE PAGAMENTO

COMPRA O SEU

SEU PEDIDO

USUÁRIO **SENHA**

Quero me cadastrar Esqueci a senha


Monte o seu CHEVROLET

- 1 Monte o Seu
- 2 **Resumo**
- 3 Itens de Personalização
- 4 Previsão de Entrega

As cores mostradas aqui são uma representação aproximada das cores reais e podem sofrer variações de acordo com a configuração e o modelo do seu monitor.

* O preço do seu Chevrolet está em conformidade com o Estado ou a Concessionária que você informou.

Lembre-se de que o preço do veículo pode ser alterado a qualquer momento.



[imprimir este resumo](#) [enviar por e-mail](#)

Modelo: Celta 2 portas hatch 1.0 VHC	R\$ 17.245,00
Ano-Modelo: 2003	
Cor: Prata	R\$ 354,00
Cor Interna: Preto	R\$ 0,00
Opcionais: PROMOÇÃO* - Aplicada sobre o valor final dos veículos adquiridos somente através deste site. Aproveite. Promoção por Tempo Limitado. (*Esta promoção não é válida para a Lista de Espera)	-R\$ 450,00
Ar Condicionado - Ar condicionado integrado frio e quente	R\$ 2.611,00
TOTAL	R\$ 19.760,00*

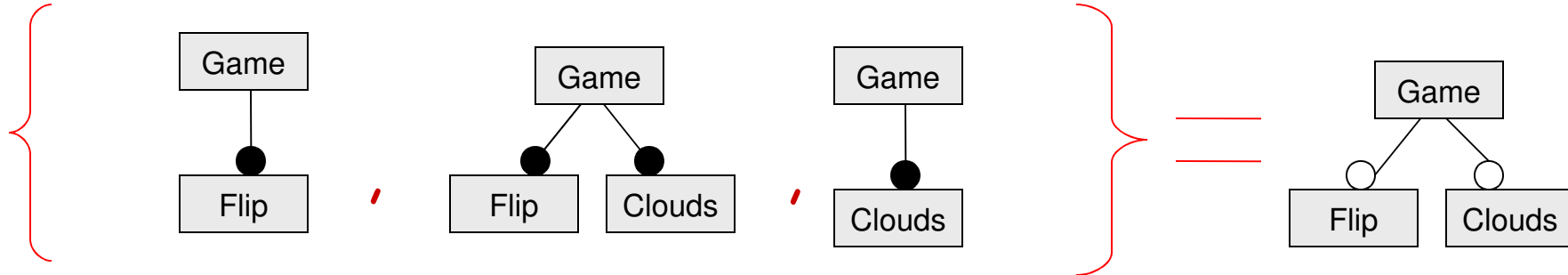
[Salvar este Resumo](#)

[Ver Itens de Personalização >>>](#)

Equipamentos de Série

Segurança:
Barra de proteção contra impactos laterais no interior das portas
Cinto de segurança traseiro central sub-abdominal
Cintos de segurança dianteiro laterais retráteis de 3 pontos com regulagem de altura
Cintos de segurança traseiro laterais de 3 pontos

Mobile Games



Workaround...

- Design patterns
- Frameworks
 - "we've got the car body, you the rest"
- Components
 - "we deliver the car, you assemble"

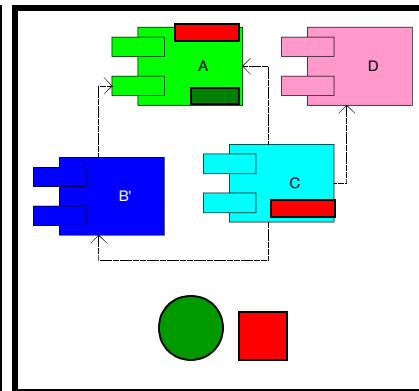
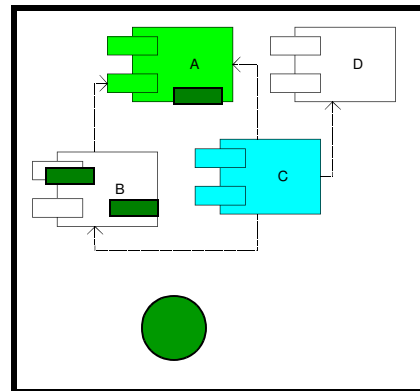
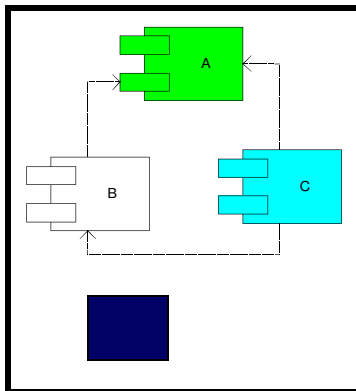
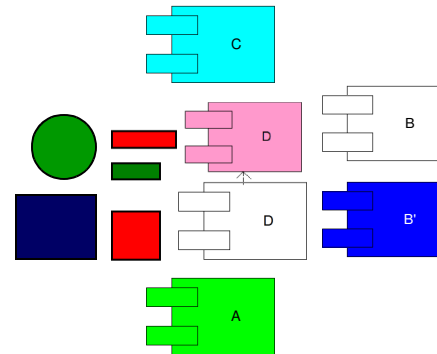
Software Product Line (SPL)

set of related applications
build from reusable artifacts

[Clements e Northrop 2001]

SPL

Strategic reuse of core assets and variations



As simple as 1,2,3

- *1 - feature models*
(what products)
- *2 - artifacts*
(what building elements)
- *3 - configuration knowledge*
(features → artifacts)

Conditional Compilation

Feature 1

```
class TestResult {  
public:  
#ifdef HAS_TEST_COUNT  
    void incrementTestCount() {...}  
#endif
```

```
#ifdef HAS_FAILURE  
    void addFailure() {...}  
#endif  
};
```

```
class TestCase {  
public:  
    void run(TestResult& tr) {  
#ifdef HAS_TEST_COUNT  
        tr.incrementTestCount();  
#endif
```

```
        // perform test
```

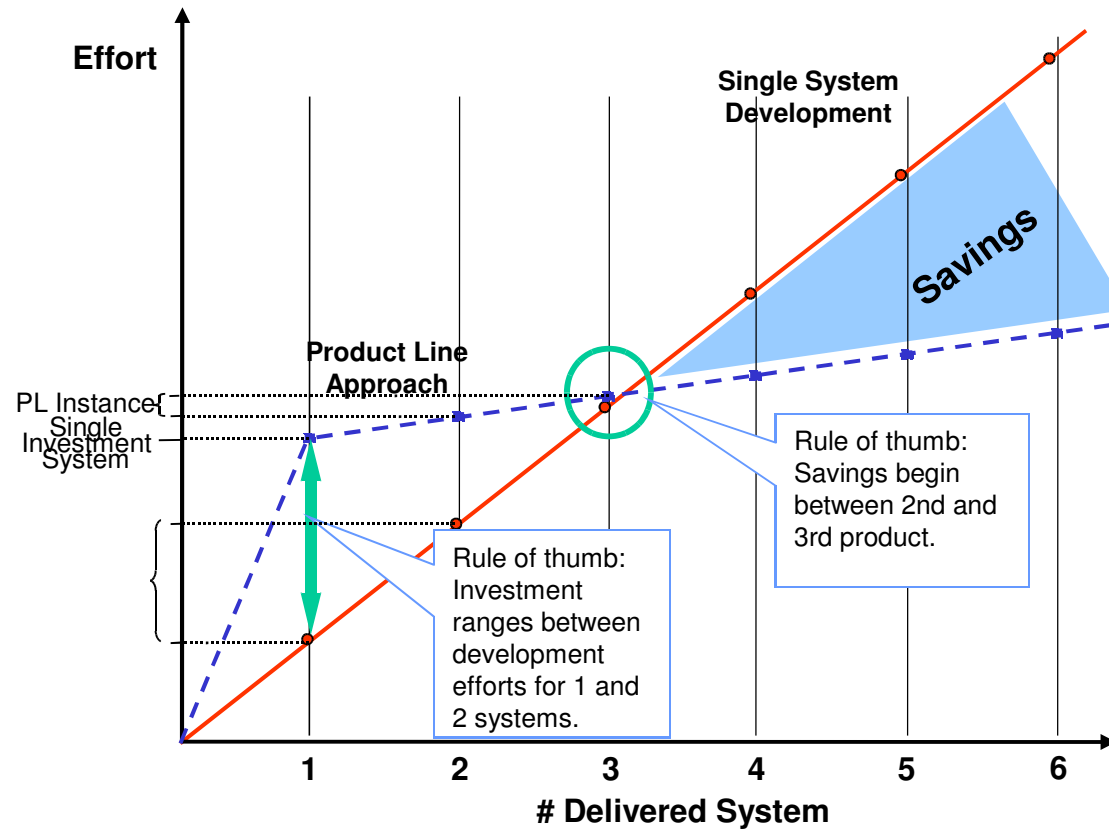
```
#ifdef HAS_FAILURE  
        if(failureDetected) tr.addFailure();  
#endif  
    }  
};
```

Feature 2

One
possible
product
specification

```
void main() {  
#define HAS_TEST_COUNT  
    TestCase tc;  
    TestResult tr;  
    tc.run(tr);  
}
```

Product Line Economics - Development Effort

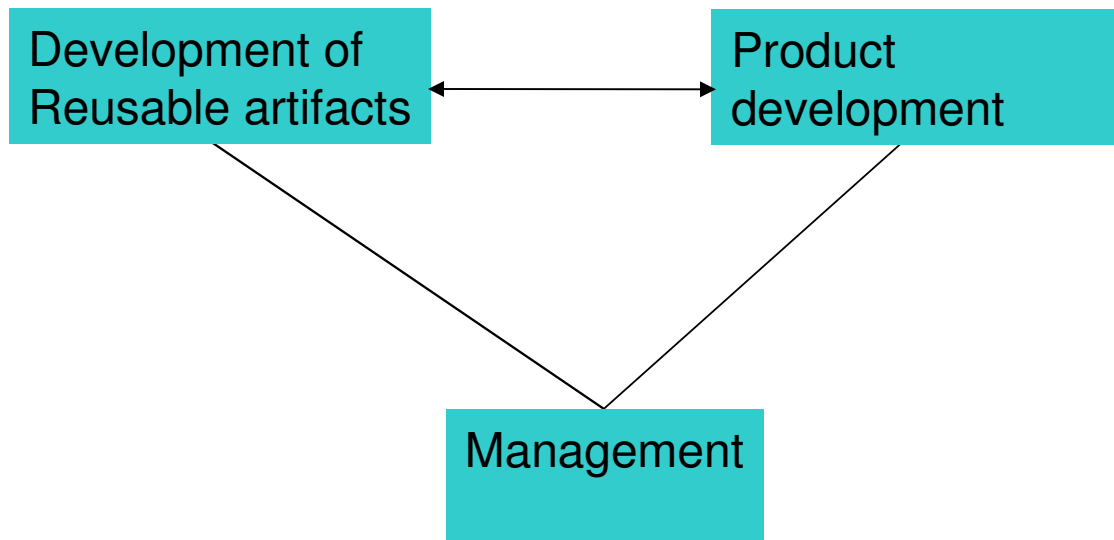


[Weiss/Lai]

SPL Examples

- Mobile Games (Meantime)
- ERP (SAP)
- Air bag & engine controller (Bosch)
- Medical imaging (Siemens)
- Revenue tax (TurboTax/US)
- Many others...

SPL Structure



SPL Challenges

- Variability
- Adoption strategies
- Tool Support

Different devices, 15 to 60 different applications...



64kb, flip



4Mb, flip

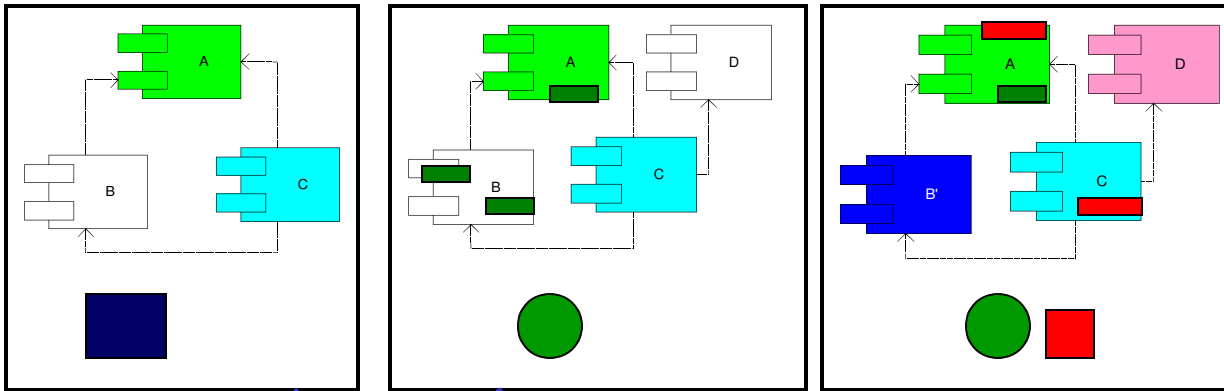


100Kb, no flip

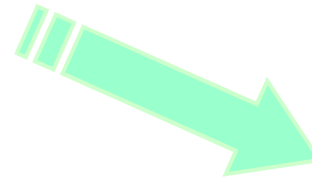
With plenty of common functionality, but also with variability



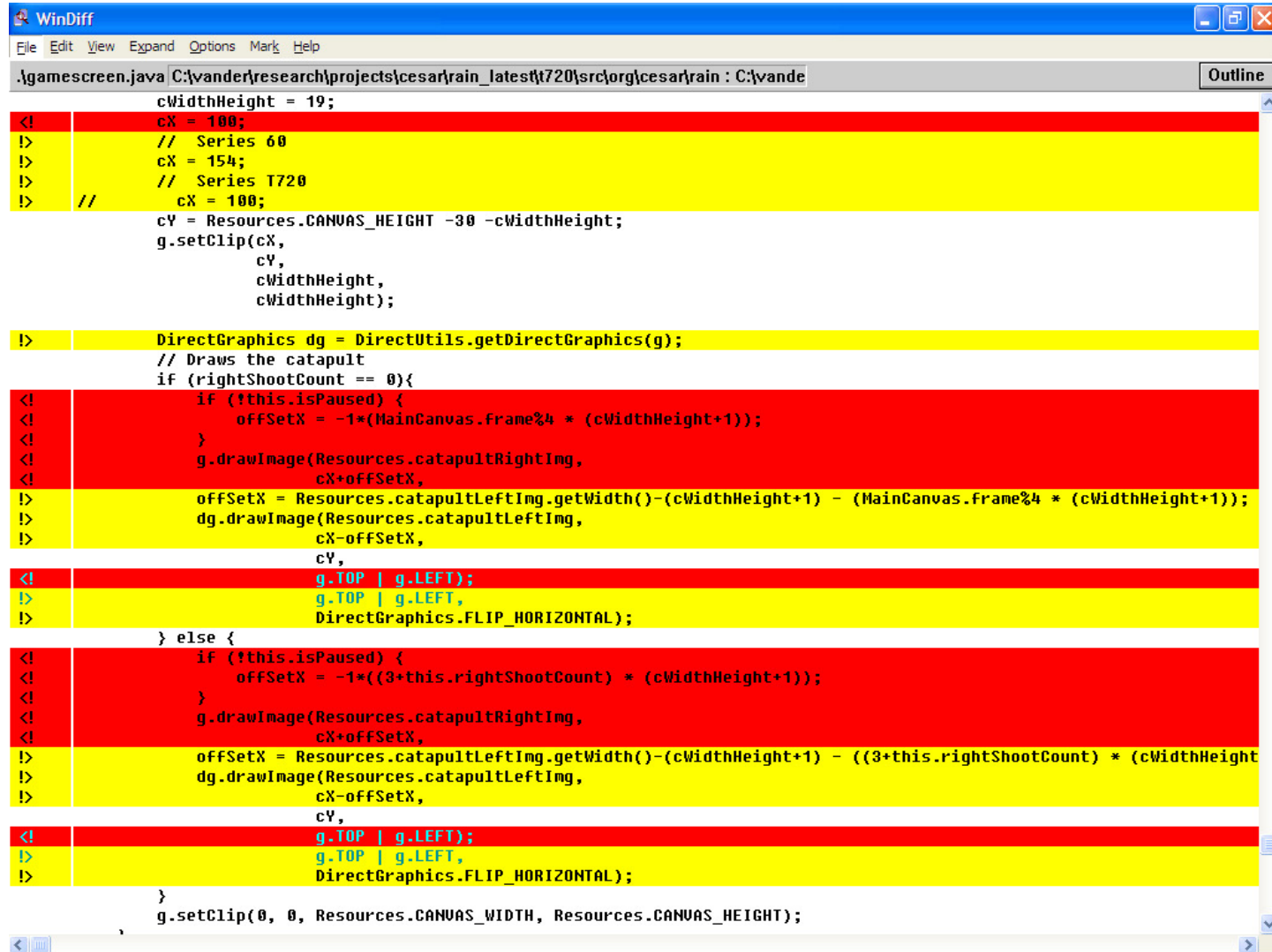
Little reuse and high cost



```
WinDiff
File Edit View Expand Options Mark Help
Jenemy.java C:\vander\research\projects\cesar\rain_latest\src\org\cesar\rain\C:\vander
Outline
67 //
68 public void draw(Graphics g) {
69     if (this.isVisible()) {
70         int offsetx = 0;
71         if (this.collisonCount <= 0) {
72             // Draws the dragon
73             g.setClip(this.getX(),
74                 this.getY(),
75                 this.getWidth(),
76                 this.getHeight());
77             if (this.getSpeed() > 0) {
78                 if (this.openMouth > 0 || (this.isSpecial && this.isFiring)) {
79                     offsetx = -7 * (this.getWidth());
80                 } else {
81                     offsetx = -1 * (this.getWidth());
82                 }
83             }
84             g.drawImage(this.getImage(),
85                 this.getX() + offsetx,
86                 this.getY(),
87                 g.TOP | g.LEFT);
88             } else {
89                 if (this.openMouth > 0 || (this.isSpecial && this.isFiring)) {
90                     offsetx = 0;
91                 } else {
92                     offsetx = this.getWidth() - this.getWidth() - (this.getWidth());
93                 }
94                 DirectGraphics dg = DirectUtils.getDirectGraphics(g);
95                 dg.drawImage(this.getImage(),
96                     this.getX() + offsetx,
97                     this.getY(),
98                     g.TOP | g.LEFT,
99                     DirectGraphics.FLIP_HORIZONTAL);
100             }
101             // Draw the breath of fire
102             if (this.isSpecial && this.isFiring) {
103                 offsetx = (this.getWidth() - (this.getWidth()) / 2);
104                 g.setClip(this.getX() + this.getWidth(),
105                     this.getY() + this.getHeight(),
106                     this.getWidth(),
107                     this.getHeight());
108             }
109         }
110     }
111 }
```



Scattering and Tangling



```
WinDiff
File Edit View Expand Options Mark Help
.gamescreen.java C:\vander\research\projects\cesar\rain_latest\T720\src\org\cesar\rain : C:\vande Outline

cWidthHeight = 19;
<! cX = 100;
!> // Series 60
!> cX = 154;
!> // Series T720
!> // cX = 100;
cY = Resources.CANVAS_HEIGHT - 30 - cWidthHeight;
g.setClip(cX,
cY,
cWidthHeight,
cWidthHeight);

!> DirectGraphics dg = DirectUtils.getDirectGraphics(g);
// Draws the catapult
if (rightShootCount == 0){
<! if (!this.isPaused) {
<! offsetX = -1*(MainCanvas.Frame%4 * (cWidthHeight+1));
<! }
<! g.drawImage(Resources.catapultRightImg,
<! cX+offsetX,
!> offsetX = Resources.catapultLeftImg.getWidth()-(cWidthHeight+1) - (MainCanvas.Frame%4 * (cWidthHeight+1));
!> dg.drawImage(Resources.catapultLeftImg,
!> cX-offsetX,
cY,
<! g.TOP | g.LEFT);
!> g.TOP | g.LEFT,
!> DirectGraphics.FLIP_HORIZONTAL);
} else {
<! if (!this.isPaused) {
<! offsetX = -1*((3+this.rightShootCount) * (cWidthHeight+1));
<! }
<! g.drawImage(Resources.catapultRightImg,
<! cX+offsetX,
!> offsetX = Resources.catapultLeftImg.getWidth()-(cWidthHeight+1) - ((3+this.rightShootCount) * (cWidthHeight+1));
!> dg.drawImage(Resources.catapultLeftImg,
!> cX-offsetX,
cY,
<! g.TOP | g.LEFT);
!> g.TOP | g.LEFT,
!> DirectGraphics.FLIP_HORIZONTAL);
}
g.setClip(0, 0, Resources.CANVAS_WIDTH, Resources.CANVAS_HEIGHT);
```

Variability

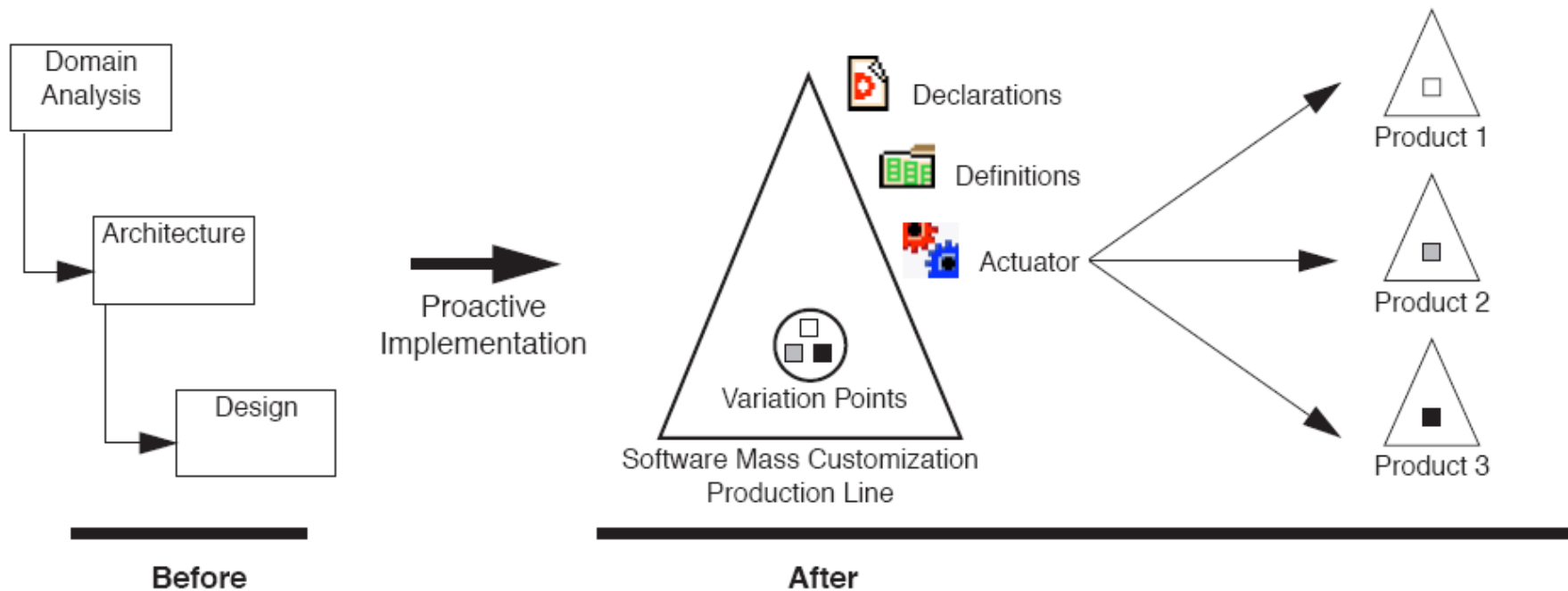
- Different lifecycle artifacts and binding times
- Hard to manage
 - Related to features
 - Often scattered & tangled
- Implies new notions
 - Type safety
 - Refactoring

Variability at different abstraction levels

- Domain
- Requirements
- Architecture
- Implementation
- Tests

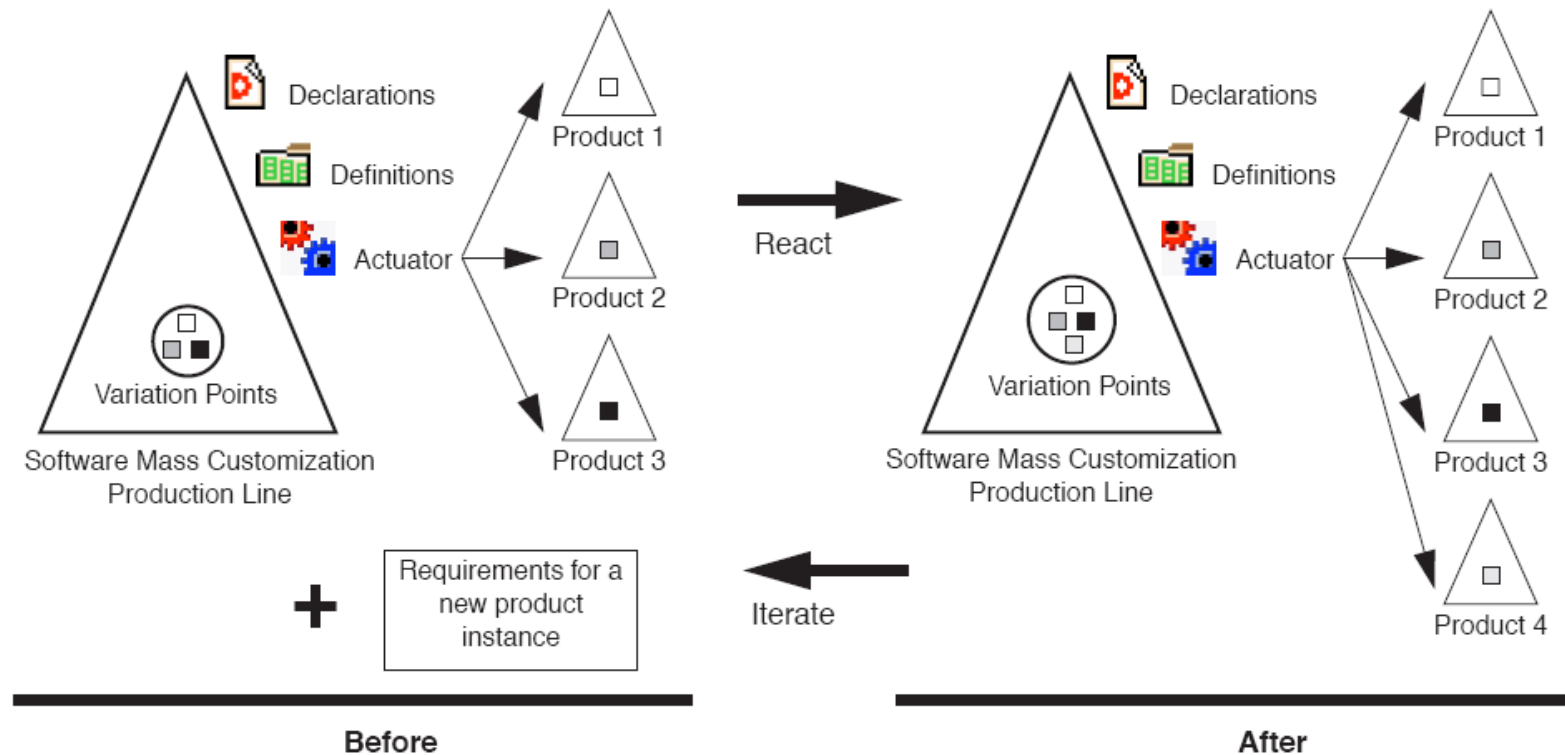
Adoption Strategies

Proactive Adoption Strategy



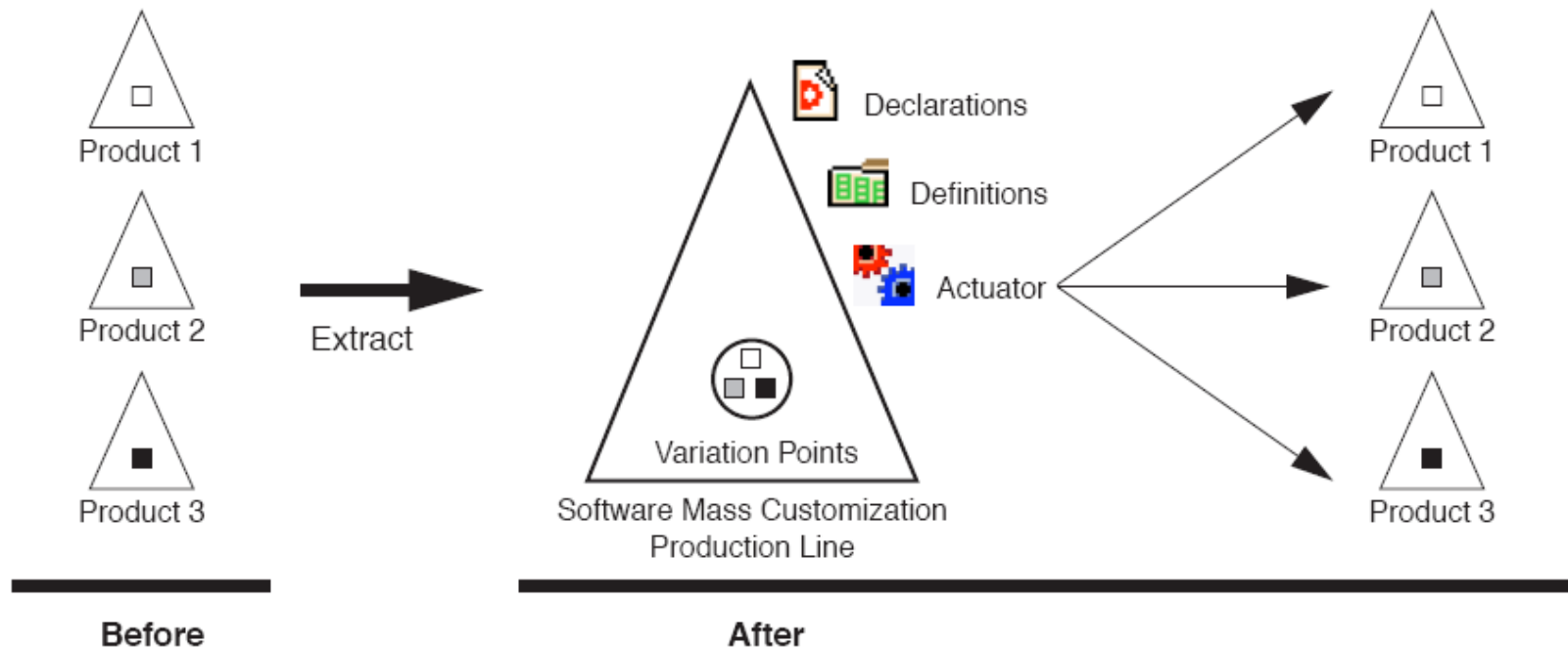
Source: Krueger, PFE'01

Reactive Adoption Strategy



Source: Krueger, PFE'01

Extractive Adoption Strategy



Source: Krueger, PFE'01