Concurrent Design in Software Development Based on Axiomatic Design

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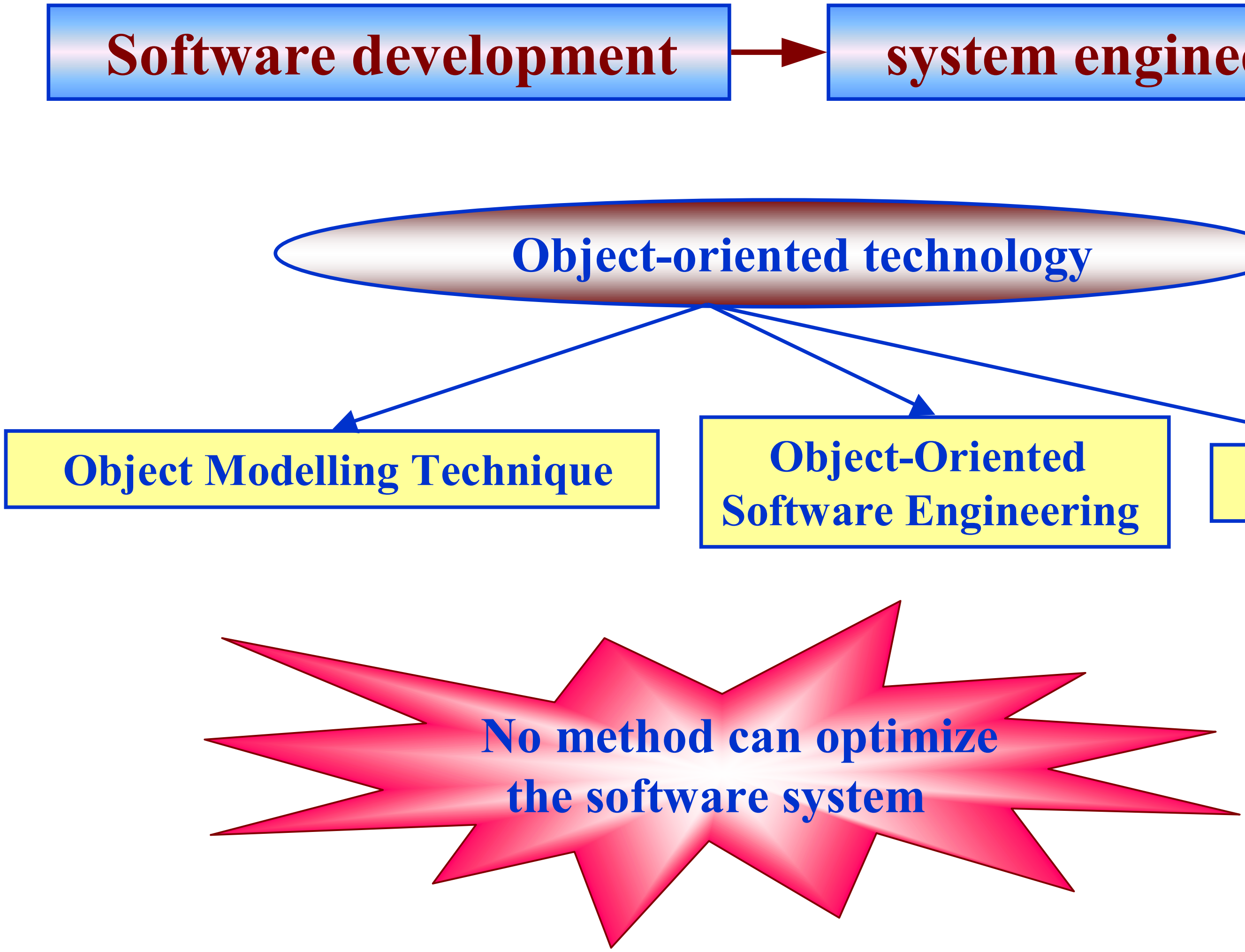
1. Introduction



Software development → system engineering

Object-oriented technology

Object Modelling Technique

Object-Oriented Software Engineering

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No method can optimize the software system

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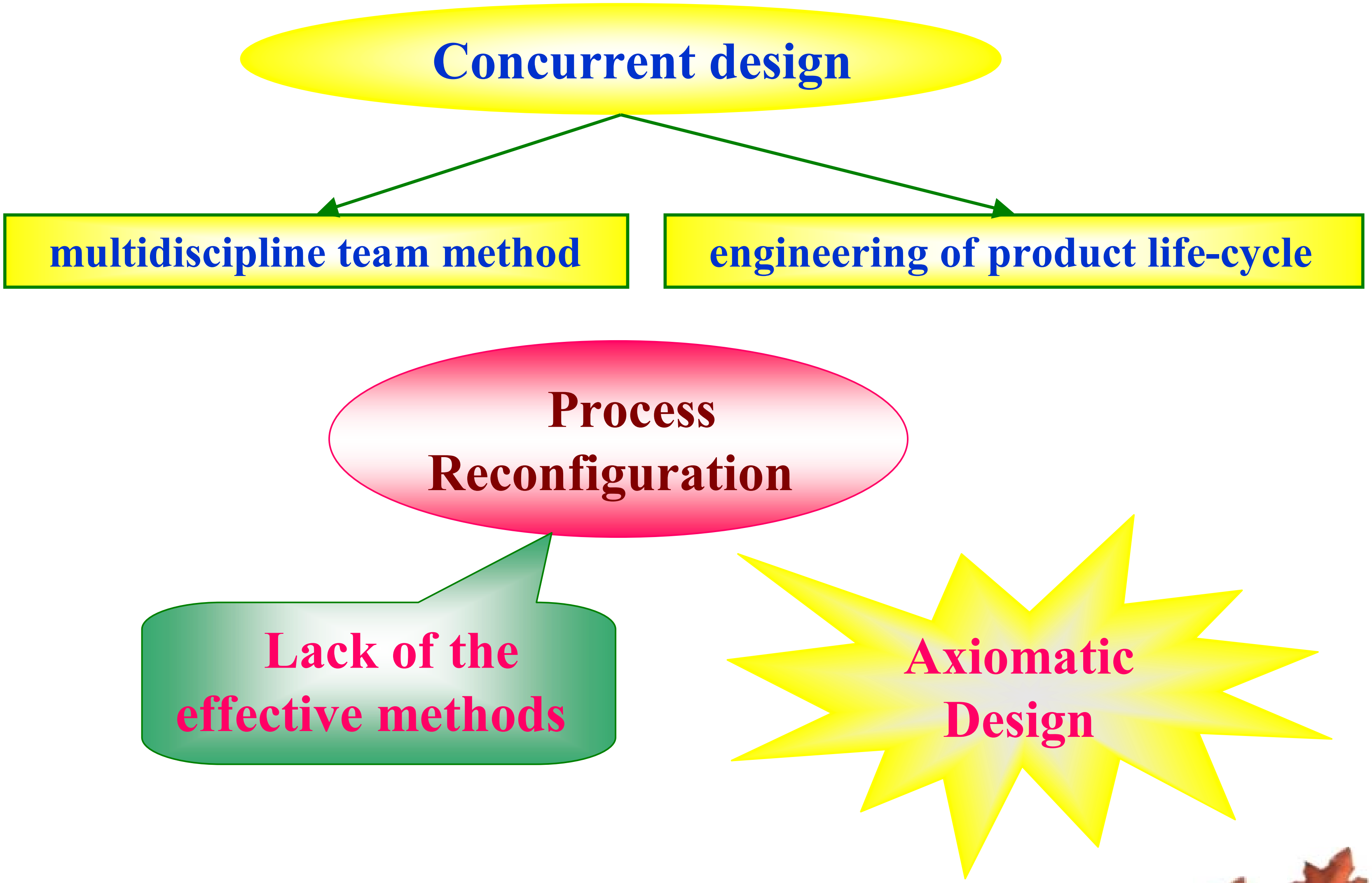


Concurrent design

multidiscipline team method

engineering of product life-cycle

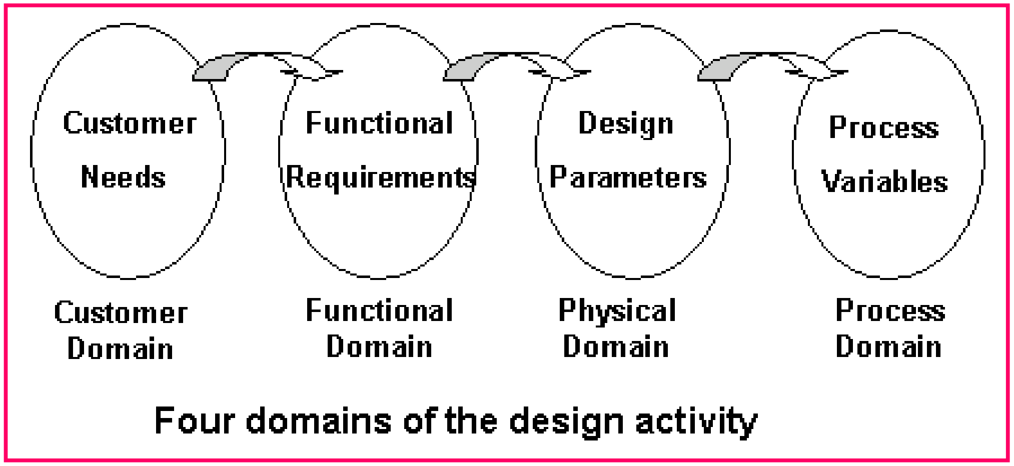
Process Reconfiguration

Lack of the effective methods

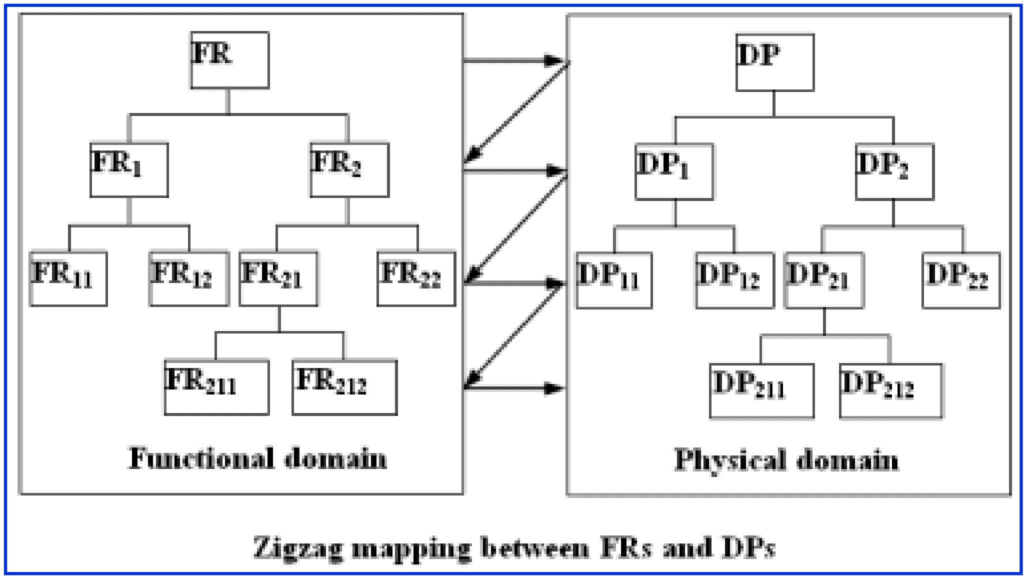
Axiomatic Design

2. Concurrent Design in Software Development Based on Axiomatic Design

2.1 Background of Axiomatic Design



Four domains of the design activity



Zigzag mapping between FRs and DPs

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Design equation for product design:

$$\{\boldsymbol{FRs}\} = [A]\ \ \{\boldsymbol{DPs}\}$$

Design matrix

$$[A] = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix}$$

- ❖ Diagonal matrix→ Uncoupled design √
- ❖Triangular matrix→ Decoupled design√
- ❖Other → Coupled design

Cont’d

- Uncoupled design -- design tasks are independent by nature and can be concurrently processed
- Decoupled design -- design tasks can be decoupled into triangle matrix, which should be processed by sequence
- Coupled design – design tasks are coupled so iterative design process is necessary

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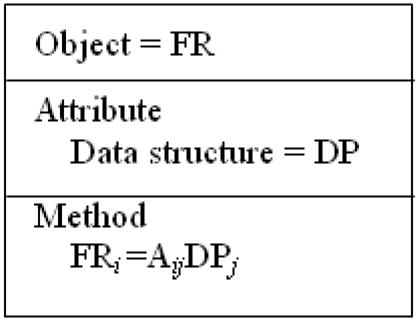
- AD method vs Object-oriented technology



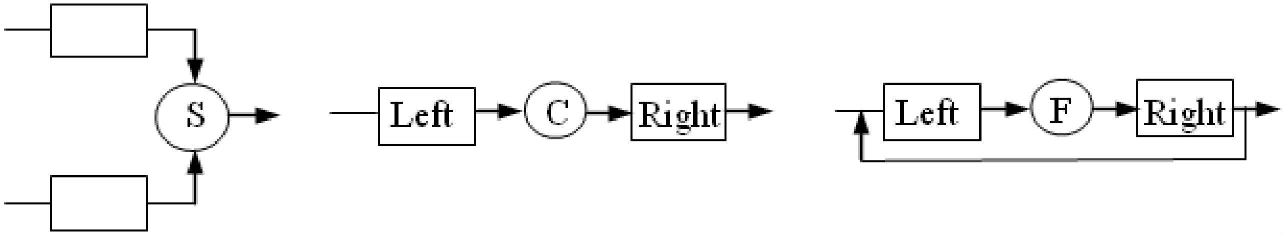
Graphic representation of an object

Module

$$\begin{Bmatrix} FR_1 \\ FR_2 \end{Bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{Bmatrix} DP_1 \\ DP_2 \end{Bmatrix}$$

$FR_1 = aDP_1 + bDP_2 = M_1 DP_1$ where, $M_1 = b(DP_2 / DP_1) + a$

$FR_2 = cDP_1 + dDP_2 = M_2 DP_2$ where, $M_2 = c(DP_1 / DP_2) + d$



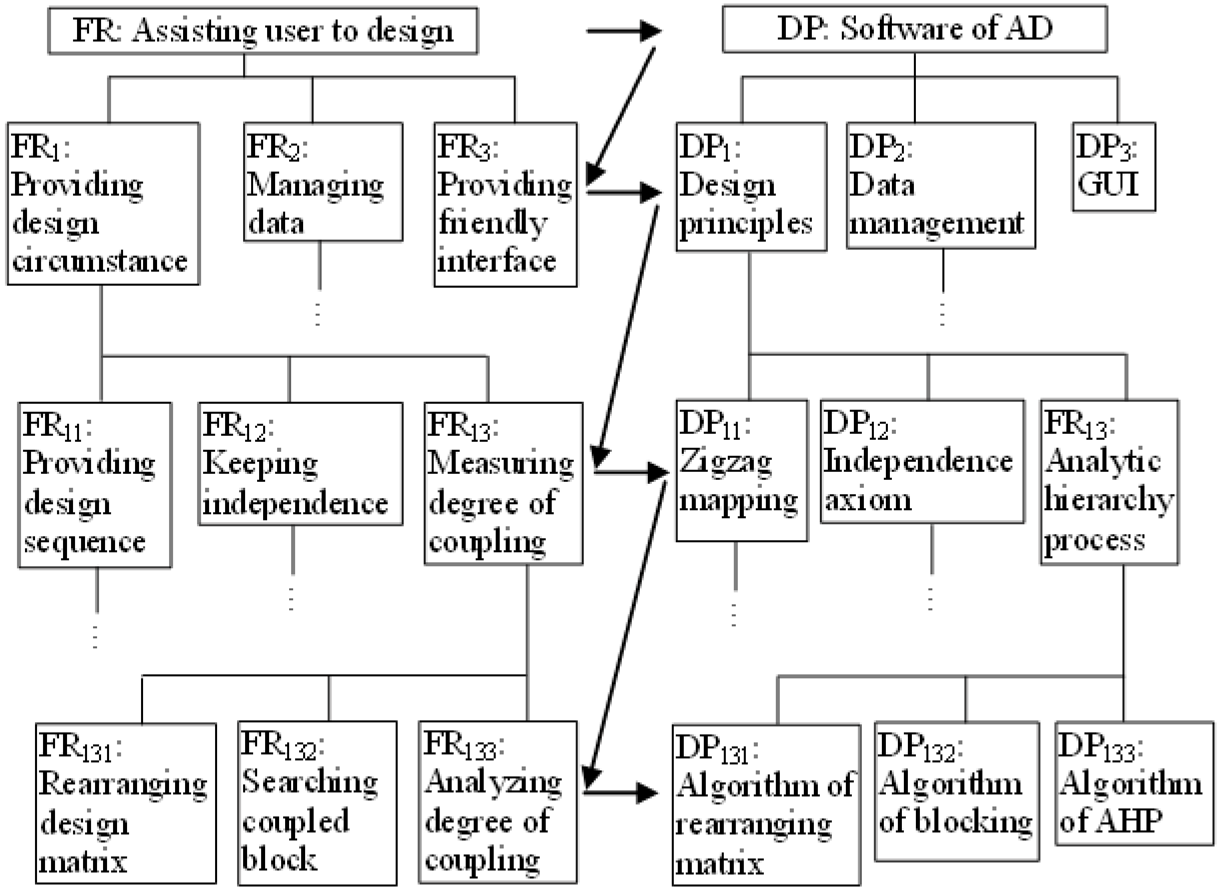
Graphic representations of the relationships between modules

2.2 Steps of Concurrent Design in Software Development Based on AD Method

- *Step 1: Analyzing the software with AD method*
- *Step 2: Defining modules of the software*
- *Step 3: Reconfiguring the sequence of modules*

3. Case Study – AD Based Software Development

3.1 Analyzing and Designing


FR: Assisting user to design
DP: Software of AD
FR$_1$: Providing design circumstance
FR$_2$: Managing data
FR$_3$: Providing friendly interface
DP$_1$: Design principles
DP$_2$: Data management
DP$_3$: GUI
FR$_{11}$: Providing design sequence
FR$_{12}$: Keeping independence
FR$_{13}$: Measuring degree of coupling
DP$_{11}$: Zigzag mapping
DP$_{12}$: Independence axiom
FR$_{13}$: Analytic hierarchy process
FR$_{131}$: Rearranging design matrix
FR$_{132}$: Searching coupled block
FR$_{133}$: Analyzing degree of coupling
DP$_{131}$: Algorithm of rearranging matrix
DP$_{132}$: Algorithm of blocking
DP$_{133}$: Algorithm of AHP

Functional-structure model

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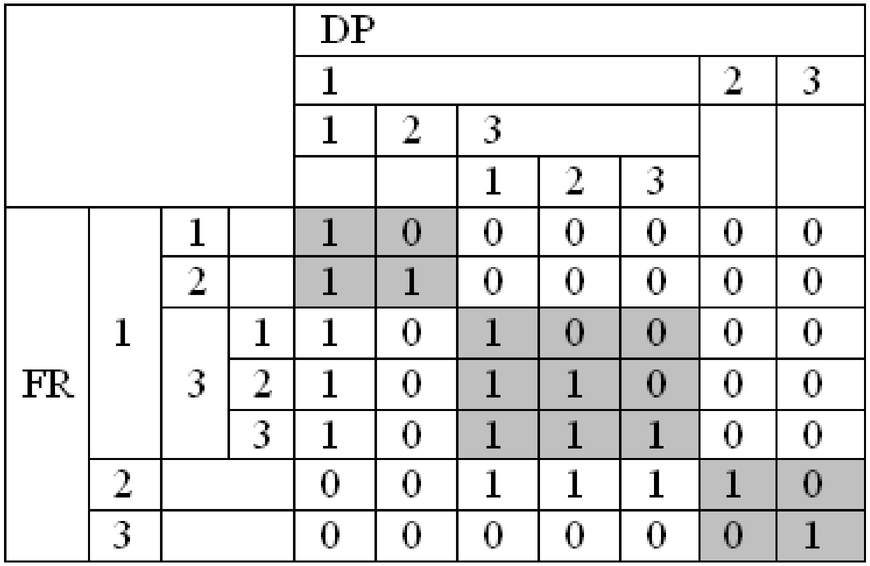
Full design matrix



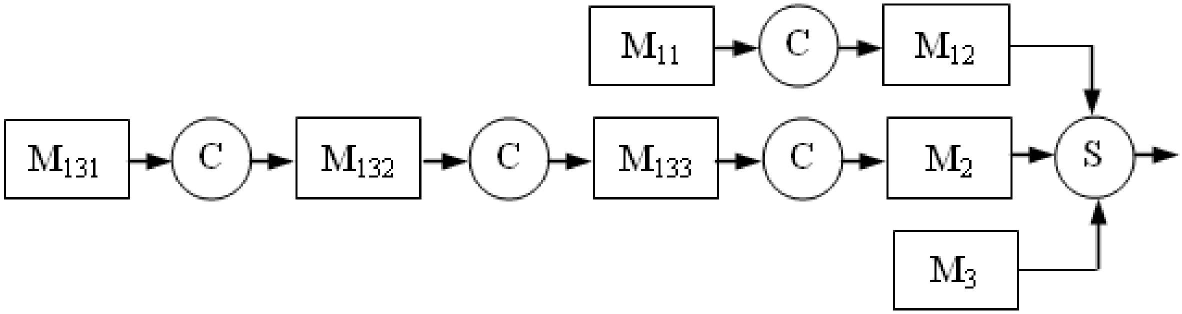
				DP						
				1					2	3
				1	2	3				
						1	2	3		
FR	1	1		1	0	0	0	0	0	0
		2		1	1	0	0	0	0	0
		3	1	1	0	1	0	0	0	0
			2	1	0	1	1	0	0	0
			3	1	0	1	1	1	0	0
	2			0	0	1	1	1	1	0
	3			0	0	0	0	0	0	1

3.2 Defining Modules of Software Development

- **Zigzag mapping**
- **Independence axiom**
- **Algorithm of rearranging matrix**
- **Algorithm of blocking**
- **Algorithm of AHP**
- **Data management**
- **GUI (Graphical User Interface)**

3.3 Reconfiguring the Sequence of Modules

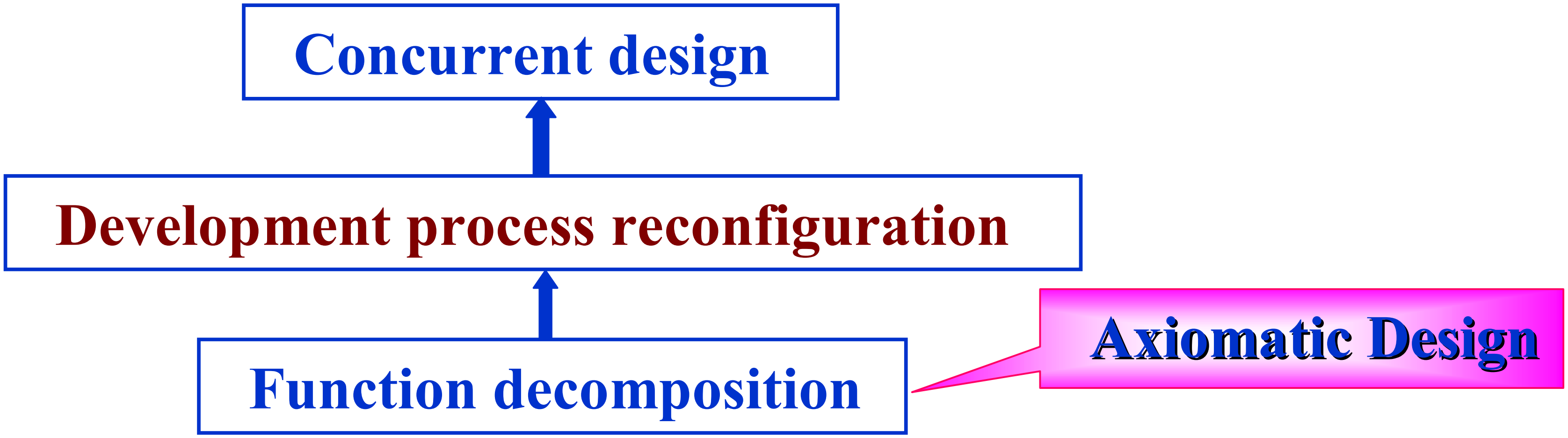
Design tasks are decoupled, so that these modules must be performed in sequence.



Module-junction structure diagram

- “S” indicates modules can be concurrently implemented.
- “C” indicates modules should be implemented sequentially with arrow direction

4. Conclusions



Concurrent design

Development process reconfiguration

Function decomposition

Axiomatic Design

- ◆Software design tasks can be categorised by uncoupled design and decoupled design with AD method
- ◆Uncoupled design tasks can be concurrently carried out with significantly shorter overall developing time
- ◆Decoupled design modules should be processed in sequence so that the development process can be managed effectively
- ◆Relationship between software modules is established by analyzing the design matrix with AD method

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THANKS FOR YOUR ATTENTION!

Q&A