

ETHOS: A Pedagogical Design Pattern

Design patterns and pattern languages are celebrated as a new kind of literature in the software engineering community: they help to capture, communicate, and reuse design experience in a clear and concise way. It is this *economy of expression* that have inspired instructors to use the pattern form to condense the body of knowledge in educating and training people in object technology [1, 2, 4]. Like software engineering, pedagogy, too, is regarded as a *design* discipline: courses, lectures, exercises, and labs have all to be designed. As most instructors of object technology haven't had a specific pedagogical education or training, they look for an efficient vehicle to transfer teaching experience. Pedagogical design patterns will help here. A first internet-based project has started and about 50 patterns have already been collected.¹ However, none of them have yet been reviewed in a PLoP-styled *Writer's Workshop*.

1 Pedagogical Patterns: Successes in Teaching Object Technology

A number of pedagogical patterns workshops have been run: ECOOP '96 in Linz, Austria, TOOLS USA '96 in Santa Barbara, California, OOPSLA '96 in San Jose, California. In addition, potential patterns were collected during a fourth workshop, held at the OT '97 conference in Oxford, England. There was also a large amount of interest generated after a short Educators' Symposium presentation and Birds-of-a-Feather session held at the OOPSLA '97 conference. What is still missing is the creative feedback of a *Writer's Workshop* as practiced at PLoP conferences. The author of this paper is willing to incite a similar kind of workshop series for instructors of object technology in academia and industry called (Euro)PLoT: Pattern Languages of Teaching [7]. A great many of the attendees of PLoP conferences are instructors or trainers of object technology. So EuroPLoP '98 would be a good start to submit a pedagogical design pattern to the spirit of the new writing culture.

2 Pattern Form

From the feedback acquired from participants at the pedagogical patterns workshops mentioned above and from those who have provided feedback in other ways, the current format has been drafted and is still open for review. It contains the following sections:

¹ <http://www.cs.unca.edu/~manns/oopsla.html>

I	NAME pattern name
II	INTENT what the instructor wants to teach, or avoid, or ...
III	IDEA how this pattern can achieve the INTENT
IV	MOTIVATION describes why the instructor achieves the INTENT with this pattern Note: Think of the above three sections in the following way: "I want to (the INTENT), using (the IDEA), because (the MOTIVATION)."
V	APPLICABILITY circumstances in which this pattern is most useful, in the opinion of the pattern author and others who have used the pattern
VI	CONTRAINDICATIONS when not to use the pattern
VII	STRUCTURE description of the pattern`s elements
VIII	CONSEQUENCES what has been seen to occur when this pattern has been used
IX	ISSUES TO CONSIDER the pragmatics of using the pattern
X	CULTURAL DEPENDENCIES issues which may make this pattern less useful for a particular culture
XI	RESOURCES NEEDED the resources which are needed to implement the pattern
XII	EXAMPLE INSTANCES OF THIS PATTERN specific instances in which the pattern has been successfully used
XIII	RELATED PATTERNS other patterns which are related to this pattern

3 Example of a Pedagogical Pattern

I NAME
 ETHOS

II INTENT

Structures a presentation, a lecture, or a manuscript as a whole. Helps to comprehend a manifold subject matter in its entirety.

III IDEA

ETHOS is both an acronym for a structure of five different elements and a concise mnemonic aid. It represents a universal pattern for teaching the different facets of a wide ranging engineering subject. ETHOS reminds you that a solution to an engineer's problem commonly comprises Economic, Technical, Human, Organizational, and Social aspects.

IV MOTIVATION

You want to draft an introductory course about object-oriented software engineering, for example. The subject matter is to be taught in its whole spectrum avoiding pedantic and boring lectures. You choose aspects you want to elaborate upon for a longer period of time. In a way, you are looking for some pedagogical "spotlights" to focus the student's attention to the principal aspects of the teaching matter. Your motive can be outlined as follows:

You want:

- ! to give variety to your lectures;
- ! to take account of all important aspects;
- ! to follow a red thread where to line up your lectures supporting cohesive learning;
- ! to widen the student's perspective to interdisciplinary aspects.

V APPLICABILITY

The subject matter should be one of engineering, e.g. a method for analyzing, designing, and implementing large-scale systems. It is important that economic and technical aspects are present.

Check if one or more of the following points apply to your problem:

- ? the subject matter involves a "paradigm" [3], i.e. (1) a "higher principle" or way of thinking, typical of a certain discipline, but which cannot be clearly formulated and which manifests itself by examples, and (2) a "disciplinary matrix" of opinions and values holding together a "scientific community");
- ? the subject matter comprises many and diverse aspects that you intent to teach in more than five sessions;
- ? you want to hold an introductory course, i.e. you don't intent to go into much details.

The pattern also applies to structuring a textbook or manuscript about a wide ranging theme.

VI CONTRAINDICATIONS

None identified yet.

VII STRUCTURE

As an acronym, ETHOS is strictly sequential (thus a test whether all relevant aspects are taken into account); as a reading instruction, chapters structured in the ETHOS fashion can be read sporadically in any order. The pattern's basic structure follows its initials:

- E : economic,
- T : technical,
- H : human,
- O : organizational, and
- S : social aspects.

If several topics apply to the same aspect, subdivide the structure's individual elements by indexing, e.g. T₁, T₂ ,..., T_n (see section XII for a concrete example).

VIII CONSEQUENCES

- 👍 ETHOS allows kaleidoscopic lectures, i.e. being arranged in a colorful succession, each one a self-contained unit within a wide spectrum;
- 👍 ETHOS favors breadth before depth, general knowledge before specialized knowledge;
- 👍 it supports cohesive learning;
- 👍 it permits continuous learning: even if some lectures have been missed, the student can follow the others, thus, ETHOS helps to encapsulate a lecture as a learning unit; with the manuscript being similarly structured, the congruence between lecture and manuscript will be hold, i.e. arbitrary cuts and context switches can be avoided;
- 👍 ETHOS provides a general framework where new topics (current developments, etc.) can easily be integrated without changing the lecture's basic structure.

IX ISSUES TO CONSIDER

ETHOS presupposes a deep analysis of both the subject matter and its didactic; the importance of and relationship between individual ETHOS aspects have to be made explicit. Try to visualize the ETHOS pattern with the help of typography and layout.

Integrate the ETHOS aspects into the general structure of your course, don't let them stand for their own. For a concrete example, topics and contents of a course on object-oriented systems design are given in section XII.

X Cultural Dependencies

None.

XI RESOURCES NEEDED

None.

XII EXAMPLE INSTANCES OF THIS PATTERN

At the University of Siegen the ETHOS pattern has been successfully applied to a half-year lecture on "Object-Oriented Systems Design" annually given since 1994. The manuscript of the lecture follows the same pattern.

Topics of lectures ²	
1.	Overview: ECBS "Engineering of Computer-Based Systems"
2.	Paradigms of Design in Computer Science
3.	Complexity of Designing
4.	Mastering Design Complexity
5.	E Industrialized Software
6.	T₁ OOx: Abstracting – Partitioning – Communicating
7.	T₂ OOAD: Foundations of Analysis and Design Methods
8.	T₃ OOP: Defining and Categorizing Object-Oriented Programming Languages
9.	H₁ Cognitive Aspects: Designing as Human Problem Solving
10.	H₂ On the Tripartition of an Object: Structure – Behavior – Constraints
11.	O Management Aspects: Technology Transfer and Project Organization
12.	S A Science of Design
13.	Looking Back: FAQ and Course Evaluation

2 <http://www.ti.et-inf.uni-siegen.de/courses/oos/oos.html>

Contents of Manuscript [6]

- 1 Paradigm Shifts in Computer Science
Paradigm Shifts in the Large: Kuhn's Thesis.
Paradigm Shifts in the Small: A Time without a Method •
The Art of Programming vs. Software Engineering • The Human Factor • SA/SD vs. OOx.
Object-Oriented World Models: Executable Models • Scenario of Object-Oriented Designing.
- 2 The Problem: Mastering Design Complexity
"No Silver Bullet": The Descriptive Nature of Complexity • Complexity and its Dimensions •
Design Complexity.
"Hopes for the Silver": The Magical Number Seven • The Architecture of Complexity •
Divide and Conquer.
ETHOS Aspects of the Object Paradigm
- 3 **E for Economic**
On the Way to Industrialized Software: The Principle of Locality • Software Reuse •
Standard Class Libraries.
Competitive Pressure: Productive Software Development • Software Quality.
- 4 **T for Technical**
Object-Oriented Concepts: Abstracting • Partitioning • Communicating.
Object-Oriented Applications: Analysis and Design • Programming Languages.
- 5 **H for Human**
On the Psychology of Object-Oriented Concepts: Designing as Human Problem Solving •
Cognitive Structures • Scheme and Correction • The Contribution of the Object Paradigm.
On the Philosophy of Object-Oriented Concepts: The World of Ontology •
An Ontological Object Model.
- 6 **O for Organizational**
Technology Transfer: Questions about the Technology •
Questions about the Interface between Client and Designer •
Questions about the Design Process •
Questions about Project Control • Questions about Staff Management.
Aspects of Management: Homomorphism between Process and Product • Lean Management •
Object Management.
- 7 **S for Social**
"The Science of Design": Creating the Artificial • Curriculum of a Science of Design •
The Contribution of the Object Paradigm.
Architectural Designing: Ideals of a Generalized Discipline of Design •
Good Designing from an Architectural Perspective • The Contribution of The Object Paradigm.
An Ontology of Design: Deep Structure: States – Events – Laws •
Good Designing from an Ontological Perspective • The Contribution of the Object Paradigm.
- A Excursions: Imagery • Classification • Inheritance vs. Encapsulation • "The Treaty of Orlando" •
The Terminology of the Object Management Group.
- B The Object-Oriented Method by Example: Analysis • Design • Programming.
- C Tables: Literature • Persons • Glossary • Abbreviations • Index.

The ETHOS pattern has been recommended in a textbook on presentation techniques [8]. It was also used to condense the broad spectrum of benefits of design patterns in an introductory article for a scientific journal [5].

XIII RELATED PATTERNS

In principle, any instance of the Alexanderian pattern form, i.e. Problem – Context – Forces – Solution, is a likely candidate for structuring a course or manuscript. Experiences of applying the pattern form in this way are yet to be published.

References

- [1] Anthony, Dana L. G.: Patterns for Classroom Education. Pattern Languages of Program Design 2. Reading: Addison-Wesley 1996.
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- [3] Kuhn, Thomas S.: The Structure of Scientific Revolutions. University of Chicago 1970.
- [4] Lilly, Susan: Patterns for Pedagogy. Object Magazine, January 1996, pp. 93-96.
- [5] Quibeldey-Cirkel, Klaus: Hot Topic: Design Patterns. Informatik-Spektrum 19 (1996), pp. 326-327. (in German)
- [6] ... The Object Paradigm in Computer Science. Stuttgart: Teubner 1994. (in German)
- [7] ... Transferring Teaching Experience with Patterns: A Contribution to a Pedagogy of Computer Science. Proc. of "Informatik und Ausbildung", Stuttgart 1998. (to be published by Springer LNCS, in German)
- [8] Thiele, Albert: Presenting Successfully: Presentation Techniques for Managers. Düsseldorf: VDI 1991. (in German)