

A generic model of corporate memory: application to the industrial systems

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Abstract:

This paper presents an industrial system model and a model of corporate memory supporting these models of systems. The corporate model sees the latter through two types of knowledge. Skill Knowledge, which constitutes the main capital knowledge of the company and refers to its basic skill. Theme Knowledge represents a specialized knowledge or a knowledge relating to a given field.

The objective of the corporate memory model, named ReCaRo, is to capitalize knowledge by allowing its systematic re-use. ReCaRo builds corporate memories which have a multi memory architecture. This architecture means that every memory will be made up of five communicating memories. We will answer to two questions: 1) how can we model an industrial system? and 2) how can we implement the re-use principle in such systems.

Key words: Corporate memories, meta-model, re-use, ReCaRo

1. INTRODUCTION

This work was motivated by the observation of the strong tendency of the today's company to be specialized. To be effective, the company standardizes its processes and its resources. It, often, handles the same entities for different actions. These entities can be physical objects, rules, processes, etc. Progressively and using these entities, the company constitutes, in the long run, a capital knowledge. However, this capital knowledge is often scattered on the experts of the company and in documents. It is very volatile. The objective is to collect it, organize it and preserve it for re-use purposes. This preservation is done, very often, through the concept of corporate memory (Brooking, 2000; Pomian, 1996; Vanheijst, 1996). This capital is then re-used in different situations in order to reduce the costs and the times of development. It is the concept of the company learning (knowledge creating company) (Nonaka, 2002) and the working knowledge (Davenport, 2000).

In this paper, we propose a corporate model and a generic corporate memory model supporting it. The corporate memory model is named ReCaRo which is the acronym of REsource, CAse and ROle which are the main concepts of the memory. We emphasize, particularly, the re-use problem of the knowledge contained in the corporate memory.

To build the corporate memory, we propose an approach in two stages. In the first stage, the objective is to propose a modelling of the company (in this research, we are interested in the industrial companies which we will call industrial systems) which supports the development of corporate memories allowing the easy and systematic re-use of capital knowledge. In a second stage, the objective is to propose a generic corporate memory deduced from the industrial system.

This paper is divided into four main parts. The first one presents the concept of knowledge and its reuse. The second one presents the model of the industrial system, the third presents the proposed generic model of the corporate memory and, finally, the last one presents the application of the ReCaRo model for the conception of a corporate memory in the design of industrial systems for liquid hydrocarbons transportation.

2. CORPORATE KNOWLEDGE AND REUSE

In this section, we give some theoretical elements regarding the knowledge management in the company as well as the concept of knowledge re-use. We will not try to define the corporate knowledge, but we will position ourselves directly within a framework of corporate knowledge management while trying to determine its main characteristics. Among these characteristics, we have the usual distinction between data, information, comprehension and knowledge (Boersma, 1996). The aspects of putting in context the knowledge were particularly developed in sociology (Vink, 1999) and in cognitive psychology (Poitou, 1996). Pomian (1996) introduced the distinction between "knowledge", "information" and "data". Hatchuel and Weil (1995) introduced the distinction between know-how and the knowledge. Davenport and Prusak (2000) evokes the link between knowledge and context. Finally Alquier (2003) and Ermine (1996) introduce the concept of knowledge system. The definition of the concept of knowledge in the organization remains very prone to discussion. For us, we remain in the optics of (Davenport, 2000) which is interested in the problem of the re-use of knowledge.

There is a multitude of classifications of corporate knowledge. In it, we find the typology of KADS (Breuker, 1995), which classifies knowledge according to the specialization. The typology of Brooking (2000) and Pomian (1996) classify knowledge according to the type. The typology of Grundstein (2000) classifies knowledge according to the mode of use. The typology of Colins (1992) classifies knowledge according to the degree of exactitude and distribution in the company.

An important point in this paper is the re-use of this knowledge. In the most general case, "To re-use" means, to use again existing elements. In the case of knowledge management, the term re-uses means, to use one or several existing components resources in order to create new components with a minimum search time and few adaptations. They have to be lower than those necessary to the

construction of new components offering the same functionalities (Demourieux, 1998). Most works on the re-use principle introduce the concept of reusable component (Bushman, 1998). These works introduce the reusable component as being an object of the organization described through a set of characteristics, often descriptive.

For simplification needs, these reusable components are often gathered in classes. Demourieux (1998) proposed a typology of reusable components for the design of information systems. Projects DECIDE (Alquier 1997) and PRIMA (Alquier, 2000) propose a classification of the reusable components for cost management in the design of new products.

3. THE INDUSTRIAL SYSTEM MODEL

In this section, we will answer the following question: how can one model an industrial system from a point of view of a corporate memory?

The model of the company that we propose sees the company through the entities it re-uses. Any industrial system, therefore, will be modelled as a system constituted of, or handling, two types of components:

The skill components: They represent every physical or logical object which constitutes the basic skills of the company.

The theme components: They represent all that is necessary to operate the system, such as the consumed resources, the inputs and the outputs of the system etc.

The two components' types are in interaction and are connected according to a logic suitable for the system. These components constitute the main objects on which a capital knowledge is developed. The corporate memory model that we propose aims to capitalize this knowledge with a re-use goal.

4. THE CORPORATE MEMORY MODEL

The corporate memory model that we propose as a support to the model of the industrial system handles two types of knowledge and has a multi-memory architecture. In this model, every memory is built around five main ones that we present below:

Reusable resources' memory (R. R. Memory): In the first stage, it is necessary to take an inventory of the capital corporate knowledge and the capital skill and theme knowledge. This is done through an inventory of the industrial system's components. Each component will be listed in the form of what we will call the reusable resource and will constitute the memory of the reusable resources. Each reusable resource answers a well defined model. To conceive the memory of the reusable resources comes down finally to take an inventory of the various types of components and modelling each one of these types.

Roles' memory: In a second stage, it is necessary to build the memory of the roles. A role describes an element of the reusable resource context. The objective of the roles is to ensure the connection of a resource's use to its context of use. Very often a role comes down to taking an inventory of the set of roles that describes and comments the capital knowledge, and proposing a model for each type.

Cases' memory: A case of use represents the description of the use or the re-use of a reusable resource in a given context. It is defined by a reusable resource, to which it was decided to add a set of roles. Each role is carrying a single semantic which relates to the described part of the context. In a third stage, it is necessary to take an inventory of all the experiences, around these reusable resources. Each experience is represented by a case of use. To constitute the memory of the cases, it is necessary to take an inventory of all the types of cases. Each type of case will be represented by a model.

Networks of cases' memory: A network of cases represents the description of the coordinated use of several cases for the realization of a common and single goal. It is an assembly of several cases using roles. In this situation, the roles keep exactly their function which is that of connectors carrying a

semantic. This memory is used to describe experiences which are too complex to be described by cases.

Contexts' memory: The context is a description of the situation in which the case was carried out. The concept of context is complementary to that of a role. It is used to describe situations which are either too rare or too complex to be described by roles.

According to this, every corporate memory will be made up of those five memories. These memories are connected according to the logic described by figure 1. The cases' memory consists of the connection of the reusable resources, the memory of roles and the memory of contexts. The memory of the cases network consists of the connection of the cases' memory, the roles' memory and the contexts' memory. The global design of the corporate memory is thus summarized as follows: make, for each of the five concepts, an inventory of its various forms and propose for each form an adequate model.

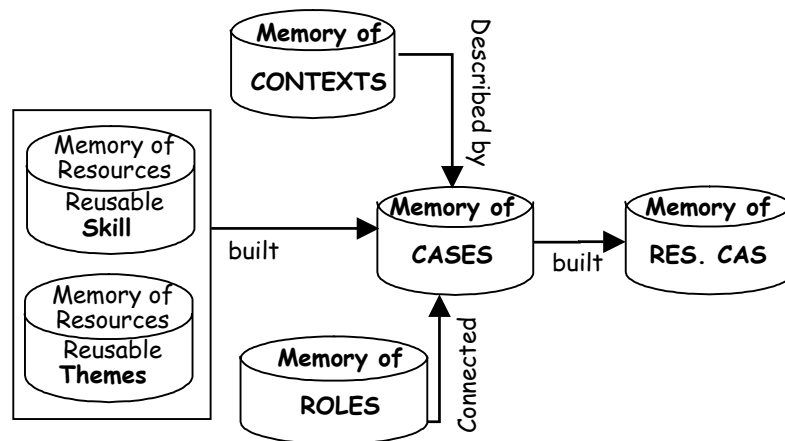


Figure 1 : General architecture of the corporate memory

5. TESTS AND RESULTS, APPLICATION OF THE MODEL TO THE SH_TRC PROJECT

The goal of this section is to validate the proposed model on a real case of corporate memories' modelling. We will present the SH_TRC project as well as the built corporate memory.

5.1. PRESENTATION OF THE SH_TRC PROJECT

This project aims to set up a corporate memory of all the capital experience and knowledge acquired during the design, the renovation, the maintenance or the extension of the transportation of liquid hydrocarbons. Each one of these actions is done through a study which gives rise to a specification, describing for example the requirements and the technical features of the future industrial system. This specification constitutes for us, in addition to the experts, one of the main sources of knowledge.

The goal of this project is to help the designers of future industrial systems to carry out their tasks in best times by assisting them in the design phase. This assistance will be done by proposing to the designers a set of components, resulting from the memory of components, and approaching the most their needs.

5.2. THE INDUSTRIAL MODEL OF THE SH_TRC PROJECT

As described in section 3, the industrial system of the SH_TRC project is seen through two types of components:

Skill components: we have listed two types of skill components. The component of type product which represents any physical element entering in the composition of an industrial facility (for example: pump, circuit breaker, pipe etc.) and the component of type process which represents all the

dynamics of the industrial system.

Theme components: Among the themes studied in the project SH_TRC, the topic retained is the conception of the specification draft. The development of the latter offers to the users an assistance in the specification of future installations. In this theme, we have found two types of components: the component of type portion of text and the component of type graphic element. The component of type portion of text gathers all that was written around a skill component and the component of type graphic element gathers all the diagrams and graphs associated to a component.

5.3. ARCHITECTURE OF THE PROPOSED MEMORY IN THE SH_TRC PROJECT

In accordance with the generic architecture proposed in section 4, the memory of the SH_TRC project will be made up of five memories that we will present below:

5.3.1. Reusable Resources' memory

This memory gathers the four types of reusable resources: product type, portion of test type, graphic element type and process type.

In this article, we are, particularly, interested in the first three reusable resources' types. The reusable resource of process type is described in (Admane, 2004).

Memory of the reusable resources of type product: It is the main resource among the ones of the skill type. Almost all the corporate memory requests are on it. The product is regarded as the element of the finest granularity. It can be used in the composition of an industrial facility, or in the composition of another product. The model of figure 2 describes the product isolated from any use. The structural properties describe the resource. The properties of environment describe the interaction of the resource with its environment. The properties of re-use describe the possible re-use forms of the resource.

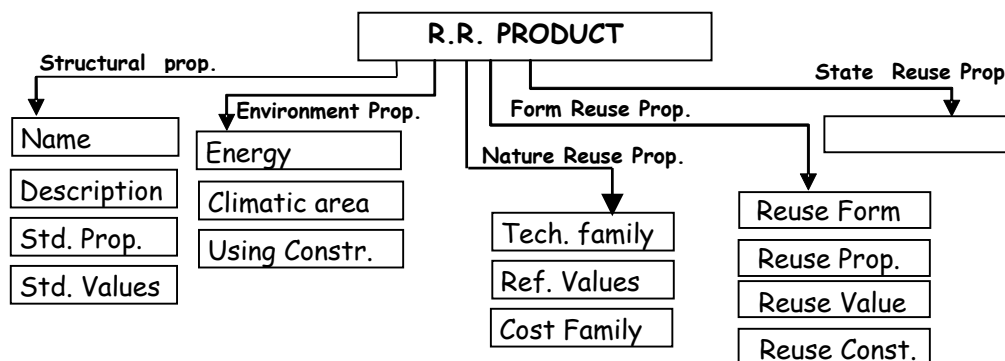


Figure 2 : Model of reusable resource type Product

Each instance of a component's model will become an element of the memory of the reusable resources of type product.

The example of figure 3 is an element of this memory. We represent this component as a record. This example describes a programmable pump. The characteristics of the re-use inform that this pump can be used as an amplifier of flow. It can also be used in manual or automatic mode.

Reusable Resource Product: pompe P217	
Name:	ZPHMP2002-1
Description:	Programmable Hydraulic pump
Standard Properties:	Double pumping, ...
Standard Values	Max Power: 100 bars, diameter of entry: 300 mm, ...
Energy:	Diesel
Climatic zone:	Arid, tropical
Constraints of reuse:	Product not corrosive
Technical Family:	Pumping, amplification flow ...
Cost Family:	High
Reference value:	
Form of reuse:	Amplifier of flow
Properties of reuse:	Flow parameters, modification section ...
Values of reuse:	
Constraints of reuse:	
Possible State:	Automatic, manuel ...

Figure 3 : Example of a reusable resource of type *PRODUCT*

The reusable resources' memory of type portion of text : It is a resource of the theme resources' memory. This resource represents any portion of text that seems interesting. It is described by figure 4. The re-use properties of type nature describe the form or the length of the text and those of the re-use type of usage gives the type of the text (descriptive, modifying, etc.)

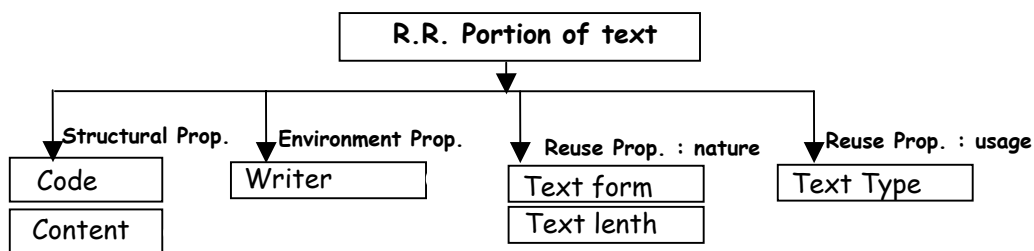


Figure 4 : Model of reusable resource of type *PORTION OF TEXT*

The example of figure 5 describes a reusable resource of type portion of text. It is an assembly notice of a reusable resource. It is a short technical text which describes a process. The text itself is in the Content property.

Reusable resource PORTION of TEXT : note of assembly	
Name :	Notice 111
Description :	Note of assembly of the programmable hydraulic pump
Content :	<Text >
Writer :	Name of the writer
Text Form :	Technical Text
Lenth of text :	Short
Type of text :	Processus

Figure 5 : Example of a reusable resource of type *PORTION OF TEXT*

The reusable resources memory of type graphic element : The reusable resource of type graphic element is, also, a resource of the theme resources memory. This resource represents any graphic element extracted from the specification which seems interesting. It is described in figure 6. The properties of re-use of the type nature describe the form or the dimensions of the graph and those of type of usage give the type of the graph (descriptive, modifying, assembly, etc.)

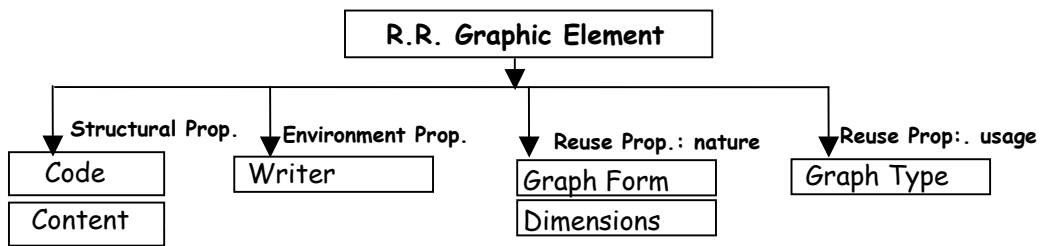


Figure 6 : Model of reusable resource of type GRAPHIC

A reusable resource of graphic type can be modelled exactly like a reusable resource of textual type.

5.3.2. Roles' memory

The roles serve to describe all or a part of a reusable resource within a particular use. All the semantics carried by the role relates to the evoked reusable resource. The model of roles is described by figure 7.

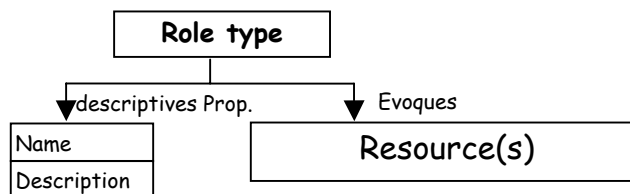


Figure 7. Role's model

In the SH-TRC project, we have proposed three models of roles.

Internal model of role: These roles implement only one reusable resource: the current resource. The global model of this role is described in figure 7. The internal role is described by a set of properties which are: The name which is used as an identifier and a short description of the role. As an example of internal roles, we can inventory all the roles which aim are to describe the called upon reusable resource. Among these roles, we find the Mechanical role which describes the reusable resource as being a mechanical component, the Manuel_mode role which means that the component is used in a manual mode, etc...

Model of connection's role: The roles of the type connection are roles which are used to describe all the interaction that the called upon reusable resource can have with another reusable resource. This latter is called dependent reusable resource. The general model of this role is identical to the internal role except that it implements two reusable resources. These roles can be for example: be_connected_to which informs that the current resource was connected to another, adapted_on which means that the component can be adapted on another component or commented_on which means that the component is commented on by another resource (of type portion of text or person that we can define).

Model of mediation's role: The roles of mediation type are used to describe the way with which the called upon reusable resource comes between two dependent reusable resources. This resource is used as a mediator between the two dependent reusable resources. The role of mediation, thus, calls upon three reusable resources. We give, as an example, the following roles: To assemble which means that the reusable resource is used to assemble two other reusable resources; to annotate which means that the reusable resource (of textual type) is used to put a comment on a portion of text associated to a resource etc.

The table of figure 8 presents some elements of the roles' memory .

Types	Roles
Internal Roles	Physical Obj, obj Informational, machine, module, hydraulic, mechanics, electric, location, make modification, section reduction, descriptif text, operating mode Position-fonction, Modify- characteristic, suppress -componant, (joint), etc.
Connection's Roles	Adapt on, connected to, connectable with, non compatible with, used in, described by, describe, schematized by, schematize, Add-component, Obligatory composition, Optionel Composition, Specialization, Generalization, Reuse, Derivation, Equivalence, Obligatory need, Optional need, Induction, precede, following, before, after, etc.
Mediation Roles	To assemble, to adapt, annotate, informs, etc.

Figure 8. Extraction from the roles' memory

5.3.3. Models of contexts memory

We thought of contexts' models which make it possible to describe situations in the form of texts. Practically, we built a single model of context. This model is illustrated in figure 9.

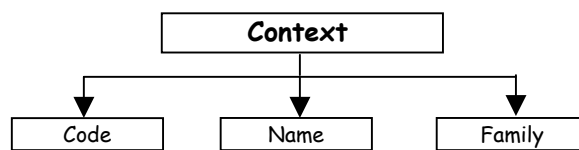


Figure 9 : Model of context

It represents the context as being a portion of text described by the context code, context name, and a family of context. We define for example the contexts:

Desert : knowledge is valid for desert regions

Renovation : knowledge is valid in a situation of renovation

Reduction of section: which means that the described knowledge is valid for problems of conducts section reduction.

5.3.4. Models of cases memory

The goal of these models is to represent the cases of use of reusable resources. Each model describes a type of a well defined case. A model of case is composed of the triplet: reusable resource, role and context. It is described by figure 10.

Structural properties: (name, description) describe the case itself;

The reusable resource: represents the resource implemented in this particular case. It results from the memory of the reusable resources to be added as a case in the memory of the cases;

The roles: are used to document the manner with which the reusable resource was used in this case. The role is called upon by its name;

The context: describes the context in which the case was built;

The action: explains the action defined by the role on the reusable resource.

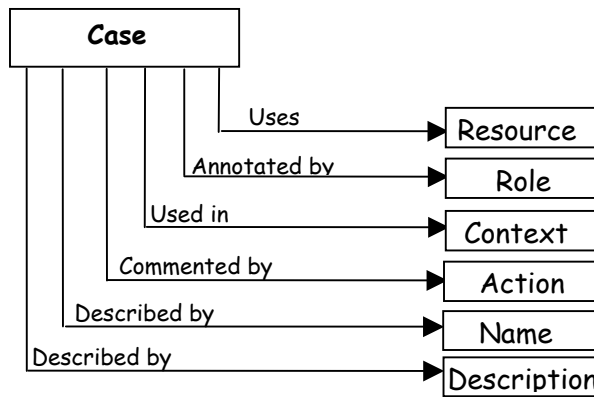


Figure 10 : Model of cases

The example of figure 11 describes a case of use of a programmable pump like a regulator of pressure.

Case: amplification of pressure	
<i>Description:</i>	<Description of the case>
<i>Reuse Res.:</i>	pump P217
<i>Role:</i>	Position-fonction, Modify- characteristic, Add-component (joint)
<i>Context:</i>	Increase power
<i>Actions:</i>	Position the pump in automatic mode, increase its section, remove the joint of origin and replace it by a hermetic one.

Figure 11 : Example of a reusable resource of type CASE

5.3.5. Scenarios of cases memory

There exists, in reality, situations which are meaningful only after the description of several cases of use of several reusable resources. For these situations, we introduce the concept of scenarios of cases. The latter are defined like the description of the interaction of two or several cases for the realization of a common objective. The general model of the scenario of cases is defined in figure 12.

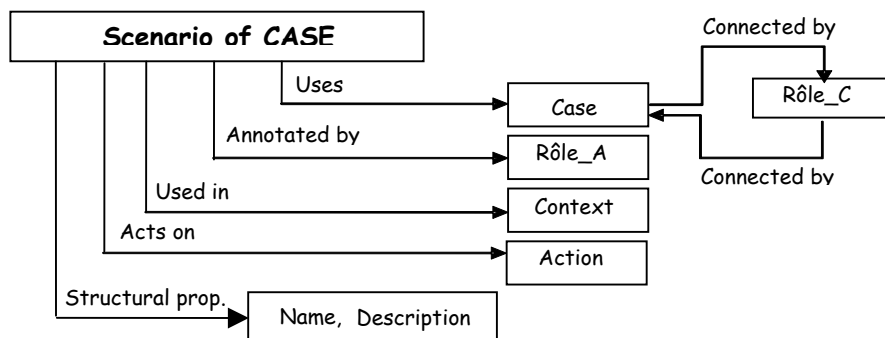


Figure 12: : model of a scenario of cases

The cases are connected by sequence or logic roles (and, or, oux etc).

For example, the connection of two conduits cannot be described by a case. It is the combination of four cases of use. The built scenario can be schematized by figure 12.

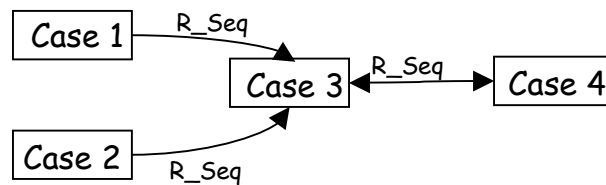


Figure 13 : Example of a scenario of cases

In this example, Cas1 means the assembly of a core of reduction (to reduce the diameter of a conduct), Cas2 means assembly of a core of increase (to increase the diameter of a control), and Cas3 means assembly of a ring of connection (connection of two conducts) and Cas4 means regulating assembly of pressure (regulation of the pressure)

6. CONCLUSION

In this article, we presented a meta-model and a methodological way for the design of corporate memories based on the re-use principle. Two ideas were developed.

The first relates to the architecture of the corporate memory. We chose an architecture multi memories which means that every memory developed according to the ReCaRo model will be made up of five communicating memories. We have the memory of the reusable resources, the memory of the roles, the memory of the cases and the networks of cases and the memory of the contexts.

The second idea relates to the implementation on industrial cases. The main problem that we had to solve was that of the definition of the concept of reusable resource in the field of the hydrocarbon transport. For that, we proposed a modelling of the industrial system through two classes of components: skill knowledge and theme knowledge.

The memory of corporate knowledge offers to the technicians all the help with the industrial systems design. The connection of the corporate memory to the documentary theme memory offers to them the assistance with specification when designing new installations.

We chose to implement the corporate memory as a data base. The set of models and reusable resources was implemented as a set of data bases. Admane & Al. (2002), Admane & Al. (2002a) and Admane & Al. (2003) give all the details for this modelling.

To capitalize, in the long run, this work, the idea is to develop mechanisms to collect produced knowledge. In our case, this knowledge is:

Generic models of reusable resources: they are collected throughout the dissemination of the suggested method. These models are standardized, and given to the designers of corporate memories as reusable generic models;

Generic models of reusable roles: they are collected in the same way as the reusable models of resources. The models of roles are standardized and classified;

Listing of the most usual roles: one could collect the roles themselves because they can be reusable in their state. Their capitalization becomes taking an inventory of those roles, organizing them and proposing them to the users.

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