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Anything, everything and things playing roles: Three realizing principles as a contribution to a platform for understanding

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Abstract

It is argued that in order seriously to consider any consolidation of views on IS-concepts, it is necessary first to establish *a common platform for understanding*. On the most fundamental level such a platform relies on certain *views of how to consider and describe things in the world*. Three such perspectives are outlined here - each one with emphasis on a certain universal principle. The first perspective explores *the role-principle* - the necessary distinction between a thing as such and the possible roles the thing may play in respect to other things. The other two perspectives concern the principles of *characterization* and *composition*. The three principles focus on different aspects of the same things, and they form a kind of *realizing whole* where each principle is partly explained by means of the other two. It happens that all three principles are known from various conceptual modelling tools or approaches. This may lead less careful readers to say: "This is well-known stuff". Well, if that was so, it would not be nessesary to consolidate views, which there still is a need for. Aiming at more insight at the general level may also help reducing the conceptual confusion and the unfortunate terminology that still hamper a proper understanding in our area.

Keywords

Conceptual foundation, role, characterization, composition, property, predicate, understanding

WARNINGS !!

Those who believe anything is easy, will see great difficulties.
Lao-Tse

All attempts to understand the world in one fixed and final system, enevitably, will fail.
Søren Kierkegaard

Every day we become a little wiser. We just don't notice - because it is so little.
Lis Byrdal

E. D. Falkenberg et al. (eds.), *Information System Concepts*

1. Introduction and basic assumptions

The relevance of the theme of this conference can be questioned: Has it at present any purpose to gather in our professional society trying to *consolidate* views. Can we make sense of each other, if we don't have a *common* reference background to rely on in describing the different views? Not only in a wild growing commercial context, but unfortunately also in scientific communication our professional area suffers from an abundance of terms and phrases that clearly indicate conceptual confusion and lack of basic insight. Without a proper professional language based on *accepted and well understood general concepts*, improvements cannot be judged, and the comparisons between views that are necessary for consolidation may lead to endless and senseless disputes. We may use words and phrases that appear well-known, but in practice we will associate different, often very specific concepts with them, and thereby we will fail to understand each other.

In society in general people can rely on knowledge-exchange in natural languages based a deep inter-subjectivity among members of society, that has grown out of hundreds of years of co-existence under a common culture. But in the young society of professionals around IFIP TC8 the situation is more difficult. When we wish to discuss our specialized concepts, we have no *common platform for understanding*. This is explicitly stated in the manifesto for TC8's own task group FRISCO, that is aiming at a set of IS-concepts, [FRI 90], just as it is in the call for papers for this very conference. It is also clearly demonstrated in practice by the steady stream of ever-changing buzz-words, that seems to govern a lot of business and research activities in our area much more than insight.

Accordigly, *this paper does not aim at consolidating any specific view of IS-concepts*. Instead it elaborates on some aspects of the general approach described in the appendix-section of the first FRISCO-report [FRI 90]. The aim is to draw more attention to this general level of concepts by presenting *three perspectives* of things, each one associated with *a universal realizing principle* for how to view things in respect to other things. They are principles we all intuitively know, but which we virtually never make explicit in explanations. They have in fact occationally been applied in our area, where they appear as particular features in certain conceptual modelling tools. However, they have not generally been recognized - and far less explained - as universal principles. But if the principles are "liberated" from the often too narrow IS-inspired views and explained in general, they probably more than anything else can contribute to a common platform for understanding to build upon when we aim at specific concepts and approaches in our area.

The "Weltanshaung" behind the perspectives can be summarized in the following way:

> It is assumed that there is some universe comprising **everything**. In this universe we as *persons* behave and form *societies*. As a result of individual and social behaviour persons will acquire knowledge by forming *conceptions* in their *mind*. As soon conceptions are formed, they may influence the person's behaviour. Although each of us thinks about the universe as "our world", we also intellectually realize that each of the other persons will see it as "their world". All these individual worlds - including the conceptions in the minds of all persons - all this taken together is here called **the world**.
>
> It is also assumed that persons will realize the world as consisting of **things** having their own individuality, but which are also related in many ways and maybe also overlapping.

Thus, **anything** in the world - including the world itself - is a thing. Basically persons may realize things differently, but it is assumed that there are some universal principles - "realizing patterns" - that are common among persons: For example, all things (except the world itself) may generally be conceived as being *parts of other things*, and certain things may be conceived *to characterize other things*. Furthermore, certain things may be perceived as *physically concrete* by means of the physiological senses of the body, while other things like conceptions, thoughts, ideas, etc. are conceived as being entirely *in the mind* of individual persons. Finally, it is assumed that persons also have a common notion of *existence* of particular things, i.e. that one may conceive a thing either as being or as not being in the world within a certain period of time. However the existence (sic!) of such a common notion of »existence« doesn't mean that there are any *absolute* criteria for deciding whether a certain thing exists or whether two things are "the same thing".

The question whether or not things exists objectively in the world is not relevant here. In practice persons with a common cultural background can always develop *patterns of co-behaviour* that, eventually, may provide a sufficient degree of inter-subjectivity about certain things. These things then - in a way - become objective *for the society*. The established inter-subjectivity is reflected in *concepts*, i.e. *socially shared conceptions* and represented in commonly known and used words and phrases in the applied language.

Readers troubled by special connotations with the word 'thing' as used here, for example that neither human beings nor conceptions can be things, should just substitute 'thing' with 'pling' or with any other preferred word to serve as *a universal term for anything*.

Now - thinking basically of the world as declared above - we shall look at things *in three different ways*, and we shall do it *iteratively*. The reason is that the principles associated with the three perspectives are mutually related, and each one will in turn contribute to the explanation of the other two.

The iterative approach may appear as being in conflict with a common principle insisted upon by some formalists, who claim that things should be defined *in a strict hierarchical order* involving no loops. Well, this may hold and even be useful in some cases, if it is possible to rely on some un-defined, *but well understood* fundamental concepts and axiomatic principles. But this paper exactly aims at explaining these fundamental concepts and basic principles upon which formal hierarchical structures may be build.

2. The role perspective (First iteration)

The **first realizing principle** is an important distinction: On the one hand *a thing as such* - for example the present paper - and on the other hand the possible *roles* played by the thing in respect to other things - for example that the paper has been submitted to the ISCO-3 conference. Metaphorically a thing playing a role is similar to an actor playing a part in some play on a theatre. The acting person is one thing and the part played (ie. the character to be brought to life during a stage performance) is another thing. This way to illustrate the concept is also reflected in the etymology of the word 'Role'. Like the word 'scroll' it is derived from French 'rôle' ≈ roll, which in fact originally referred to a scroll of paper where an actor's lines in a play were written down.

The two concepts »thing« and »a role played by a thing« are related *in an asymmetrical way*. In principle a thing may exists independently of the possible roles it plays, but *a role has no existence, unless there is a thing playing the role*. The person who wrote the paper would exist whether or not the paper had been written, but the role of being author requires a person to play the role. Now, the paper has in fact been written and thereby been brought to exist, but it could

have existed as such without being submitted to ISCO-3. On the other hand, the role of being submitted to ISCO-3 cannot manifest itself, unless there is a paper to play the role.

But this is not enough: When a role is played by a thing, it is always *in respect to some other thing*, and this thing must also exist for the role to come "into effect". This paper could not have been submitted the way it is, unless ISCO-3 had been brought into existence - ie. officially established by IFIP as a conference. Similarly, a person cannot play the role of being author, unless he/she produces a written work to become the author of. We shall call the two involved things *the (role-)subject* and *the (role-)object*, respectively. (See fig. 1). The terminology is chosen intentionally to reflect the similar grammatical concepts. The point is, that the principle of things playing roles is so profound in the way we conceive the world and is deeply bound in our common language. In a typical main clause the asymmetrical aspect of roles is reflected in the grammatical difference between subject and object, while the role itself - or rather *the role-type* - is directly expressed in the involved verb phrase. Thus, in the statement 'This paper is submitted to ISCO-3', the phrase 'this paper' represents the role-subject and 'ISCO-3' the role-object, while 'is submitted to' represents the role-type. The sentence as a whole represents a thing itself - *a composition* - which we shall call *a role-association* (in proper context here just *an association*). Similarly we say that *two things are associated* if one of the things is playing a role in respect to the other one.

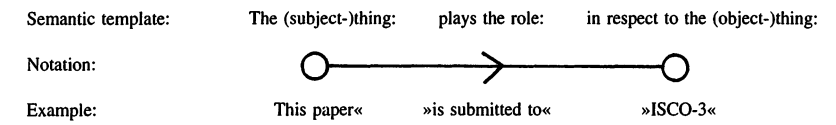

Figure 1 Graphical notation and example of a role-association

Further inspired by linguistic terms the *sub-composition* formed by the role and the object together is called *the predicate* (of the subject). In the following iterations we shall return to the concepts: role-type, composition, role-association, and predicate, and also discuss how roles and relationships are related. But before that two further aspects of the role-concept should be mentioned:

The *first aspect* is a minor one, but still one to be aware of. For most roles the associated subject and object are different things, but sometimes this is not the case. Then the role is said to be *reflexive*. A person shaving himself is an example of such a reflexive role.

The *second aspect* has much more importance in practice: All the roles discussed so far in the examples are very specific in respect to the kinds of involved subjects and objects. But there are also a number of very important *universal roles*, and they are behind a lot of what we usually tend to regard as very specific for our area. Some of these universal roles - the property role, the predicate-role, the part-of role, the instance-of role and the sub-type role - are discussed in connection with the other two perspectives of this paper. However, two further universal roles should also be mentioned here, and there are three reasons for that: *First* to further emphasize the role-concept as fundamental for explaining other important, but more specific concepts. *Secondly* because occationally in this paper we need to refer to these universal roles, which belong in other parts of the envisioned platform for understanding. *Third* because they provide good examples of the unfortunate lack of basic understanding in our area.

The first of these necessary universal role-types is involved *when persons in a society exchange knowledge* and more specifically when *data* is used to convey or preserve *information*. We are talking about the role *to represent* - the principle that a concrete (physical) thing *by convention* is used to stand for another thing, a mental one. This kind of role is deeply involved in the meaning of *the sign-concept* which is generally studied in the scientific area *semiotics*, that is behind linguistics and communication, and which is also very important in our area.

The representation-role is reflected in the notation applied here: The bracket-pair » « is used to indicate a certain *thing as such* while the pair of ' ' is used to indicate a certain *name*, (ie. a character-string) *thought of as a thing itself*. For example, the thing »ISCO-3« is to be thought of as a particular social and scientific event characterized as a working conference, while the 6-character thing 'ISCO-3' is a name that represents this conference.

The observant reader may thus have asked if the phrase 'this paper' in the ISCO-3 example should be understood as *some sheets of printed paper* or as *a work by an author*, ie. a mental thing. It is in fact the latter that is the subject of the role »is submitted to«. The sheets of paper, on the other hand, play the role of representing the author's mental product, and thereby in practice enabling the other involved persons (program committee, reviewers, editors etc) to consider it.

The lack of basic understanding in our area is most profound with those who do not recognize the role »represent« by distinguishing properly between *data* and *information*. The resulting symptoms are *conceptual confusion and unfortunate and misleading terminology*. Many professionals fail to recognize that data is different from information - that *data is a representation of information*, or more specifically that *data* is a structure of physically concrete phenomena which according to a convention is playing the role of representing information. *Information*, on the other hand, *is a mental thing*. Expressed generally it is *formalized knowledge* of states in some domain.

Here are just a few common examples of confusion caused by lack of insight with the representation-role:

- The phrase: *'redundant information'* is senseless, because redundancy is not a characterizing property of information. However, 'redundant data' or 'information represented redundantly' may be relevant phrases, when the same information is represented in different ways within the same domain.

- *A description of entity and relationship-types* referring to some (business-)domain, certainly, *is not a data-model*, but *an information-model*. The reason is that entities and relationships are exactly the key-concepts behind the formalization of knowledge of states into information. The term 'data-model' may be relevant for a description of structures of different data-types, for example the use of pointers, records and files in some file system or database.

- The term *'data-communication'* is misleading, because data cannot be communicated. Data can be transmitted (or otherwise moved) as a means for communicating information. (The word 'communication' is derived from Latin 'communicare' ≈ »to make common« - which refers to the information represented in the data).

- A similar confusion is behind the popular mis-term *'information processing'*, which even is used in the full name of IFIP. Since information is a mental thing (formalized knowledge), the processing of it can only take place in the mind of a person, and it is rather limited what we can say with certainty about processes there. However, what we can talk about and even prescribe, is *data processing*, for example as going on in computers and in connection with all kinds of clerical work in organisations.

The second universal role-type is involved *whenever an actor carries out an activity*. However, 'actor' here should not just be taken in the sense of an actor on stage, but in the wider and more abstract sense of [FRI 90], ie. as something carrying out an activity, for example a person, a group of persons, a machine or computer, or any synergetic combination of such things. An actor plays the role of being *the agent of* one or more types of activities. In the conference example, the »program commitee« is an actor playing the agent-role in respect to activity-types like: »accepting/rejecting paper« and »composing conference program«. The agent-role is crucial

for understanding *organisational systems* and thereby also for understanding some of the senses of the term 'information system'. It is also vital for understanding communication, where at least two actors are involved in a *co-action*, one as the sender and one as the receiver af a certain message.

Many in our profession seems not to be aware of the importance of the agent role. The fallacy is most obvious in the still widespread use of so-called *data-flow diagrams* for modelling what goes on in an organisations and other kinds of active systems. By the naive claim that data just "flow" (continously?) between activities/processes, the users of this tool are forced to ignore that any activity on the organisatorial level is carried out - not anonymously by itself, but by an actor, and that the involved data just play the role of *representing* the information of the message that is communicated - not between activities, but between the actors (often persons) who/which are the agents of the activities in the organisation.

3. The characterization perspective (First iteration)

The **second realizing principle** is a distinction between - again on the one side *a thing as such* and on the other side this time *the various things characterizing that thing*. Probably there is no problem intuitively to understand what is meant by 'characterizing' in this connection, but in order to be as explicit as possible we shall evaluate it by means of two "excercises": Below we first relate characterizing to *some intuitively well-known concepts*. Afterwards, in the next iteration of the characterization perspective we shall apply the role principle on the conceptual meta-level to describe »property«. Both excercises will contribute to making it explicit what characterization means.

In the first excercise we shall study the concept *property* in respect to concepts like *category, type, class, population and instance*, and we shall also incorporate the classical distinction between *universal things* and *particular things*:

A category is a group of things where all elements are realized as having *something in common*. Some categories can be formally defined as the population of a certain *type*, ie. specified by *a certain set of properties* as explained in [FRI 90]. However, as Lakoff has pointed out, there are many relevant categories in society for which it is impossible to be explicit about the characteristic properties or otherwise state precisely what the common features are [Lak 87].

According to a fairly common interpretation we shall define a universal thing as *an abstraction of a category*, ie. we disregard all individual features of the particular category members and consider only the aspects that are common for them. But in practice that means that we can only be explicit about universal things, *if the corresponding categories are defined by a type*. Since the very purpose here is to be explicit and as much as possible avoid tacit assumptions, we will restrict us to such categories. Under this assumption a universal thing is simply the same as a type, and thereby only characterized by the corresponding properties.

The restriction here to categories that can be explicitly defined by a type is just an acknowledgement of Kirkegaard's warning quoted at the beginning. Dealing as we do with concepts that in no way are absolute - just created by humans - it would be naive to ignore that in practice there are many categories of things that cannot be precisely defined, but which, anyway, still are relevant. On the other hand *being explicit* about the properties that characterize things and constitute types of things *is a necessary prerequisite* for being able *to formalize* and *to declare something in a normative way*. This is in essence what the conflict between "the wet and the dry" is about, as Goguen talked about in his keynote speech at the ISCO-2 conference [Gou 92], and it is at the core of the dilemma we all face, if we at the same time want both to be precise and cover everything.

Informally we can define a property as a thing that is conceived as a common *quality* of all elements of a category. The word 'property' originates from Latin 'proprius' ≈ »belonging to«, and this is in accordance with common language usage where a thing is said *to possess* certain qualities or properties. For example, each instance of the universal thing »conference« (ie. *each particular* member of the category »conference*s*«) *has* a title, *has* an organizer, *has* a program committee, *has* a conference chair, etc. and each of these characterizing properties *are members of the set that constitute the type »conference«*.

It is worthwhile to notice that in common language, the same term is often used as well for for a type as for an instance of the type, for example 'a conference' or 'an author'. On the other hand there is a conventional grammatical way to distinguish between on the one side a type and on the other the corresponding category/class/population. The means for this distinction is to apply a plural form also, for example 'author' for the type and 'authors' for the class corresponding to the type.

Just as a thing usually is characterized by several properties, the same property can be member of several types. We shall consider this in connection with the description of type-hierarchies during the third iteration.

While a universal thing like »conference« is characterized only by properties of its type, *a particular thing is also characterized by the predicates* of all the role-associations that have the particular thing as the subject. »ISCO-3« is a particular thing of the type »working conference«. Accordingly, it is characterized by properties of its type like »organizer«, »title«, »conference chair« and similar "conference-relevant" things that constitute the type. But ISCO-3 also plays particular roles like: it is located in Marburg, it takes place 28-30 March 1995, it has a particular number of accepted papers on the program, etc., and each predicate of such role-associations is a particular thing that also characterizes »ISCO-3«.

Looking finally at characterization in general, it is useful to introduce *an **aspect** of a thing* as a generic concept covering as well a characterizing property as a characterizing predicate. Thus, for universal things the only aspects are properties of the corresponding type, but for particular things both kinds of aspects are relevant: A certain particular thing is always characterized by the predicates of a set of role-associations in which the particular thing is the subject (the set may vary over time, but it is never empty). Furthermore, since it is an instance of a universal thing, it is also characterized by the specific set of properties P of the corresponding type. This type is important for what the associations mean, because, as we shall see in a later iteration, each of the role-types of the actual set of associations *corresponds uniquely to one of the properties of P*.

4. The composition perspective (First iteration)

The **third realizing principle** is in several ways more complicated than the former two, and probably more than the other principles it justifies Lao-Tse's warning at the beginning. Again we have a distinction between things, but the involved things are generally related in a complex manner. In essence the principle expresses that *one thing can be conceived as a composition of a number of other things*. These things may just be members of a set, but in most cases in practice they are related and may also somehow *contribute* to what is conceived as the composition. A particular conference, for example, is a complex composition comprising many related things like: a title, a number of themes, a program, a program committee (PC), a number of submitted papers and a corresponding set of authors, a number of referees, a subset of the

submitted papers chosen by the PC to be accepted papers, etc. These things play the role as parts of a composition, where each part in its own way contributes to what actually constitutes the conference. The parts are reflected by corresponding properties belonging to the type of the universal thing »conference«, where each such property defines the type of the component. However, we shall focus on the components as *parts in respect to the composition* and on their possible contributions to the aspects of the composition.

Being a part of something is another example of a universal role-type that is played by a certain thing in respect to another thing - here to a thing that is composed of the part together with other parts. However, what in general makes composition complicated is that the components not only play the part-of role, but that they also may play roles *in respect to each other* that *influence the part-of roles.* Added to this comes that the parts of a composition may themselves be compositions - even through several levels, and the influencing part-part roles will often go across the composition levels. For example, the conference themes selected by the PC will influence the actual set of submitted papers, and so will the different assessments from the reviewers of the conference-relevance of the submitted papers. The comments from the reviewers may also influence the possible ways in which the authors of accepted papers edit and later on present their contributions.

For the part-of role we shall use the notation as shown in fig.2.

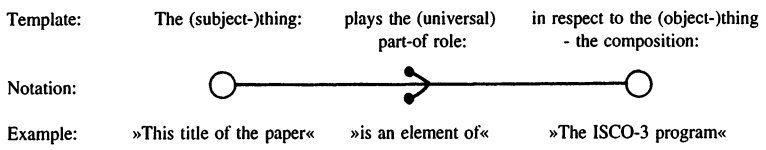

Figure 2 Notation and example of a part-of role.

In general the following three rules hold for compositions:

1. All things except the world itself are parts of the world.
   This follows from the definition of the world in the introduction.

2. Any part of the world may be a part of one or more other things in the world.
   In the conference example, a certain person can be member of the PC and also of the staff of reviewers.

3. A thing which is a part of a composition may itself be a composition.
   A PC is a composition of a person in the role of PC-chairman together wirh a number of other persons, and a PC is itself a part of a conference.

The complexity of the composition principle in general is caused by two (in principle) independent distinctions.

The first distinction concerns the part-of roles and it goes whether *all parts play the same type of part-of role* - a so-called *homogeneous composition* - or whether *the part-of roles are different depending on the parts* - a *selective composition.* In this way a conference is a selective composition, because the main components play quite different types of part-of roles. The staff of reviewers, on the other hand, is a homogeneous composition.

The second distinction concerns *the nature of the composition*, where there are three categories and correspondingly three sub-kinds of the part-of role:
- is a member of a *set-composition*
- is an element of an *area-composition*
- is a contributor to a *systemic composition.*

We shall discuss the first two categories here and the last one in section 7.

In the simplest case a composition is just *a set* with at least two members. (Although formally it could be defined as legal, it is contra-intuitive to regard empty sets or singleton sets as compositions). Characteristic for a set-composition is that *possible part-part roles* played by the members in respect to each other *are completely irrelevant* for conceiving them as a set. For example, two of the reviewers may be married to each other or some of them may be collegues or business partners, but this is not relevant for their roles as members of the reviewer-set.

In describing details of set-compositions it is useful to be aware of the linguistic distinction reflected in the two phrases: 'there are a number of things' compared to 'there is a set of things'. The first one refers to the things as individuals, while the latter refers to them as a composition.

The members of a set-composition can be *specified intensionally* as a subset of the population of a certain type (within some domain). In such cases the composition will most often be *homogeneous*. On the other hand, it can also be *specified extensionally* possibly as instances of different types. If this is the case, it will often be *a selective composition*, where the members play a type-specific part-of role. In practice, however, the most common situation is that *the parts are mutually related* and often such, that some of the part-of roles will be influenced by some of the part-part roles. This composition-category is best described by the concept *area* introduced by the present author in [FRI 90] and further applied and elaborated in [Lin 92]. However, by utilizing the role concept we can here be more specific about what constitutes an area:

First we shall define in a recursive way:
Two things A and B are *connected* if any of the following conditions hold:
- A plays at least one role in respect to B
- A is connected to a thing C which is different from B, but which is connected to B.

Then we can define:
An area is a composition of a number of connected things together with the connecting roles and any number of things characterizing any element of the area.

A conference program is an example of an area-composition. It is resulting from activities by the program committee and is represented in a program-text. However, here we shall look at a program as a composition independent of its possible representations: As such a program is not just a set of components, because a program is composed of things that are related in program-relevant ways. A program comprises a number of *planned sessions* which usually are related with the conference themes that also are parts of the program. The sessions are also mutually related to form *a temporal structure* where as well the session-components as their sub-components - typically presentations of accepted papers by their authors - can be mapped to time-points and intervals on a time-scale. The involved associations between on the one side the papers and on the other side the authors, titles and possible session-themes do also contribute to the program as being an area.

A program, being itself a component of a conference, is, in fact, an area where some of the involved element-associations are significant *also for the parts of another conference component*, ie. the registered conference attendents. The associations in the program between papers, titles, authors and themes may influence the attending persons in their choice of which of the *planned* sessions they should take part in. Thereby the program components will influence the components of the *actual* sessions taking place during the conference. This is an example of part-part roles that influence *across levels* of a component structure.

Although the examples above are typical for the complexity of area-compositons, the real complexity of the concept comes from the area-definition above, because it is a recursive one: It says that an area may include components characterizing other components. But that leads to an infinite regression, because when a characterizing thing is included as a component, then it may itself have its own charcterizing aspects included as well. These meta-level and meta-meta-level considerations of aspects are further evaluated in the next iteration of characterization.

An area-composition is specified by three categories of elements:
- the *primary things*, ie. the things being connected
- the roles involved in the connecting associations
- all other things necessary to make the meaning of the components explicit *in a given context* and thereby enabling a proper understanding of the area and its related elements.

The first two of these categories are called the *direct* or *area-forming elements* and the last category the *indirect* or *area-explaining elements.*

5. The role perspective (Second iteration)

Applying some of the concepts introduced in the component-perspective above we can now rephrase the most important aspects of the concept »*role-association*«:
- A role-association is *a selective area-composition comprising three primary things*: a subject, an object and a role, where the role is an instance of a certain *role-type* defined by a property of the subject. (See fig. 3a).
- A role-association, alternatively, is *a selective area-composition of two primary things*: a subject and a predicate, such that the predicate *characterizes* the subject. (See fig. 3b).
- A predicate is *a (sub-)composition of a role-association* comprising two things: the involved role and the object. (See fig. 3b).

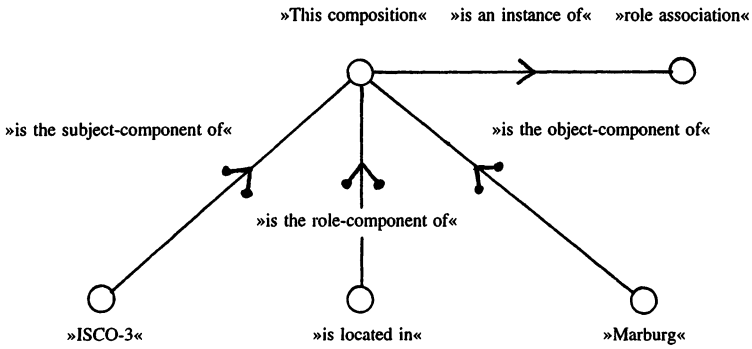

Figure 3a A role-association described as a one-level composition.

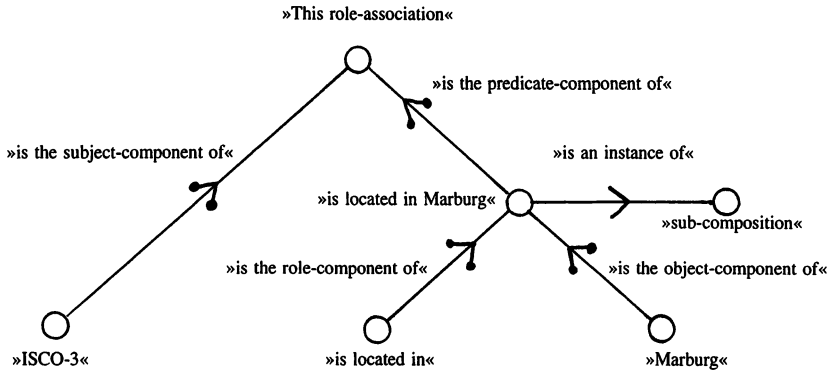

Figure 3b A role association explained as a two-level composition.

The role in an association is defined by a *»role-type«*, which as any other type is a set of properties that characterize each of the instances. One of these role-characterizing properties defines the type of the involved subject-thing, and another one the type of the object-thing. Thereby they contribute to what it means "to submit a paper". For example, for the role type »is submitted to« they define that the subject must be of the type »intended scientific paper« and the object of the type »conference«. These constraints means that a thing like »Marburg« never could be a subject and neither an object-component of an association with »is submitted to« as the role. Marburg, simply, is neither a paper, nor a conference. The concept »role-type« is furthermore characterized by a property defining *how many different object-things* that can be involved in associations *for any given subject-thing*. This is equivalent with one of the two (opposite directed) cardinality aspects of relationships known from information modelling.

In section 2 it was made clear that before a role can become effective in an association, then as well the subject as the object must exist. But there is still one more requirement: *An activity must be executed* that causes the role-association as a thing itself to be brought into existence. This is reflected by still another characterizing property of the role-type - one specifying *the type of activity that causes corresponding role-associations to be created.* Within the limits of this paper we must refrain from elaborating on this dynamic aspect. But a few remarks are important, because they concern the concepts *identity* and *state* of a thing, and it just happens that »role-association« is the key-concept necessary to explain them and also to give a sensible answer to the classical question: When does a particular thing exist, and how much can it change and still remain the same thing? (For a discussion of this problem see for example [Ken 78]).

The identity of a thing is very closely related with existence, but it should not be confused with the concept *an identification* (or name) of the thing. (A person, for example, exists regardsless of a name and will not loose identity by ignoring or forgetting his or her social identification number). Identity of a thing is *the set of aspects* that makes it possible to distinguish the thing from other things, but that doesn't mean that it always is possible in practice to be explicit about what constitutes the identity. (Each bee in a swarm and each three in a wood has its own identity, but how should they be described?) The concept state has no meaning in itself. It must always be *the state of a thing.* Furthermore, in order to make sense when a person describes a state for other persons, it must be of a thing, where there is no doubt about what the identity of the thing is.

As suggested in [Lin 92] it seems useful from *a pragmatical point of view* to define the identity

of a thing and the state of it by *two disjunct sets*, respectively, *of characterizing predicates* belonging to associations where the thing is the subject. Used as a feasible pragmatical criterion we can then say, that the composition of *all* the identity-associations must be brought into existence in connection with the activity that creates the thing, and the associations must remain *invariant* during the whole lifetime of the thing. Otherwise the thing cease to be that thing. The members of the state set, on the other hand, may be brought into or out of existence in connection with any activity operating on the thing in question. Some of these state-associations may be created in connection with the activity that brings the thing itself into existence. Others are created or deleted in connection with state-changing activities later on during the lifetime of the thing. The point is that *the thing will remain the same thing as long as the identity set of associations remain invariant.*

6. The characterization perspective (Second iteration)

We shall now as the second excercise in explaining the two kinds of aspects, properties and predicates, move to the *conceptual meta-level* and once more apply the role principle:

The popular term 'meta-model', which is often used in this connection, is one more example of bad terminology. The reason is that what people talk about when they use the term in practice, is a description - or, if one prefer it, a model - of *concepts to explain concepts*. But it is *not* as the term says "a model of models". A more appropriate term, therefore, would be 'model of meta-concepts' or 'meta-conceptual model'.

We shall look at »to characterize« (or »to be an aspect of«) as another universal role-type expressing that the subject *plays the role of characterizing* the object. We have seen that central for a role-type are the two properties specifying the type of the subject and the type of the object. For this particular role-type the subject is the thing that plays the role of being an aspect of the object-thing. For example the thing »location« is the subject playing the role of being *a characterizing property* of the universal thing »conference«, and the thing »is located in Marburg« is the subject playing the role of being *a characterizing predicate* of an object that is the particular thing »ISCO-3«. These examples are fully in acco.dance with regarding *»is an aspect of« as a super-type* of the two (universal) role-types *»is a property of«* and *»is a predicate of«* corresponding to the two possible kinds of of characterizing.

For the universal role-type *»is a property of«* there is no restriction on the object-type, because as well universal things as particular things are characterized by properties. (Remember that in this excercise the aspect is the subject that plays the universal role of characterizing the object as illustrated in fig.4). As regard the type of the subject, we will declare that *only universal things can play the role of being a property*. Since we have already distinguished between properties and predicates as two kinds of aspects, this requirement seems to be well in accordance with what in practice plays the role as a property. (See fig.4).

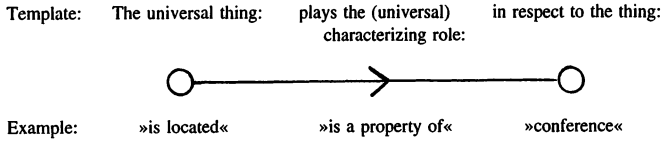

Figure 4 The thing »is located« is characterizing the thing »conference« as a property.

For the universal role-type »*is a predicate*« the object must belong to the category »particular things«, because only such things are characterized by predicates. The type of the characterizing subject, on the other hand, is very specific and must necessarily belong to the category »predicate«. And there is a further constraint: the role-component in the predicate-(sub-)composition must be reflected in a corresponding *property-aspect* of the thing being characterized (the object in fig.5). This property is exactly the one that defines the role-type. This may be easier to understand if we again shortly descent from the meta-level and look at our example: One particular subject - the (composition-)thing »is located in Marburg« plays the (universal) role »is a predicate« of the particular object-thing, »ISCO-3«. This - as we saw above - is well in accordance with the constraint that »ISCO-3« is an instance of the type »conference« (cf. fig.4), and this type comprises the property »location«. And »location« is exactly the thing that is the the key to understand, what it means "to be located", ie. it is the property of »conference« that defines the role-type »is located«

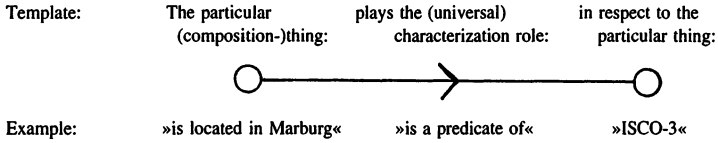

Figure 5 The composition »is located in Marburg« characterizing »ISCO-3« as a predicate

From the discusion of things playing roles as properties of other things it should be easy to see that it is rather un-natural and will only cause explanatory problems *if properties should be regarded as belonging to a special ontological category* that is *exclusive* with another ontological category: "ordinary" things, ie. things that can be attributed some of the properties, as suggested in the approach by Bunge [Bun 77] and supported among others by Wand and Weber [WaW 89]. The main argument for not making this exclusive distinction is that in order to understand something that is conceived as a property, we must be able to think of it as itself having its own (property-characterizing) properties. We will only be able to understand what a certain property means, if we know and understand all the properties characterizing the property-thing itself. For example, we can only understand what the association »ISCO-3 is located in Marburg« means if we know the properties behind the role-type »is located«, and this again requires that we understand the properties of things like »location«, »topology«, »geometrical space«, etc. each of which again are things with their own characterizing properties etc. etc.

Thus, as a conclusion we can state: *Properties are not a-priori.* But *a property is a role played by a certain universal thing* that characterizes at least one other thing. But being such a characterizing thing means that it - just like all other things - is characterized by its own properties.

7. The composition perspective (Second iteration)

We shall now explore the last of the three composition categories and the corresponding part-of role »contributor to a systemic composition«. To explain systemic compositions we shall take a

starting point in FRISCO's *system concept* as explained in [FRI 90] and [FRI 92]. It is based on Checklands notion of a *system-viewer* and *system as a subjective thing* [Che 81].

The definition on p.2 of [FRI 92] states:

> "*A system* is a conception of an area called *the system domain* where the elements are seen as related such that they form *a whole*, that is conceived as having at least one so-called *systemic property* in relation to *the environment* that is not possessed by any of the elements, but which they contribute to".

Now, applying the concepts developed here we can rephrase the definition:

> *A system* is a realization (by the system-viewer) of an area-composition - *the system domain* - that is conceived as *a whole* - a single thing having its own (systemic) properties that are not possessed by any elements of the system domain, but which are completely determined by them.

It should be noted that the term 'domain' reflect another example of a universal role-type. Being a domain is a role played by an area in respect to an activity. For example the domain of a mathematical mapping-operation or as here the domain which Checkland's "system viewer" *conceives* as a whole - as a system with its own systemic properties.

The detailed descriptions of the system-concept in [FRI 90] and [FRI 92] together with the concepts developed here gives us an appropriate tool to realize and be more explicit about what *in general* characterizes system-types (for example such types as »mechanical system«, »organisational system«, »communication system« etc.). This tool, of course, should also be used to be explicit about the system type denoted 'information system' - or rather each of the concepts denoted so (cf. [FRI 90]). 'Being explicit' means that *for each* such type of information system claimed to be relevant (ie. useful to consider and learn more about), *a description of the following three kinds of aspects* must be produced and a number of associated questions must be answered:

- Aspects characterizing *the category of areas* that as *system domains* can be vieved as being an information system:

  For example: Is the domain just a computer, or is it an organisation, or is it a part of an organisation in inter-action (co-action?) with a composition of computers and other IT-equipment? Which kinds of actors and activities belong to the domain? Which kinds of activities are carried out in the domain?

- *The systemic properties* which the system viewer associate with the composition of the area - with the thing conceived as a whole, ie. with an information system of that kind. (That in turn also includes the properties necessary to explain each of the suggested systemic properties).

  For example: Which types of interaction goes on between the system and the environment, and which types of operands of activities in the system are passing across its border with the environment? Is it data? Could it be information? (If so, how should 'passing across' be understood?)

- *The relationships* between, on the one hand, *the systemic properties* and, on the other hand, *the properties of the elements of the system domain* including those defining the roles played by them in respect to each other.

  Examples of questions here must await a proper answering of questions like those above.

Honestly, do we in our area have such *commonly recognized* and well understood descriptions and answers available as a basis for future consolidation efforts?

8. The role-perspective (Third iteration)

During the presentation here, in particular of the role-perspective, the reader may have asked: How are roles and relationships related? More specifically: Are they related in the same way as in the so-called "object-role" model [Fal 77] that is behind the well-known NIAM-approach [NIA 83]. Let's answer the NIAM-question first:

The binary relationship-type described as relating *two* (NIAM-)object-types A and B is *a composition of two role-types* with A as the (role-)subject-type and B as the (role-)object-type and vice-versa, respectively. Apparantly in this case the answer is yes: The two involved roles reflect the same relationship just viewed from the two opposite directions. This is also reflected in practice the in the verb-phrases typically used as names for the role-types. The cardinality aspect of each of these role-types, that must be considered in information modelling situations, is also taken care of in NIAM, (although it appears graphically in a rather non-intuitive form).

If we then turn to the general question about relationships versus roles, the following holds: A binary relationship-type can be regarded as a composition of two role-types specifying *the same pair of things* (entity-types) - 1: as subject and object - 2: as object and subject for the two roles. In other words: if there is a relationship between two things (entities) then these two things play two semantically related, but opposite directed roles i respect to each other. This is also the case when the relationship-type is reflexive and expresses that a single entity-type plays two opposite roles in respect to itself.

Whether n-ary relationship types are relevant for information modelling, is an issue that over time has caused much dispute. If they are allowed, as they are in some information modelling approaches, and if they even are allowed to be characterized by further properties, then the key question is: Why not just model them as entity types?

Well, this question is entirely a pragmatical one, and the answer is just a matter of taste. But there is a real problem behind it: Most information modelling approaches in practice *lack a general feature to describe compositions*. In practice a lot of entity-types are in fact compositions, and they ought to be defined by means of some defining *combination-symbol* properly linking the different part-entity-types with the composition-entity-type. (The lack of a combination symbol may otherwise tempt people to describe such entity-types as n-ary relationship-types). A combination symbol can also be used to indicate those role-types that define *the identity of an entity-type* as distinguished from those that only contribute to the states (cf. the discussion in section 5).

9. The world looked upon as two hierarchical structures of things

An extra perspective of characterization and composition

In the introduction to this paper the two plain words in English: 'anything' and 'everything' were used to denote key concepts of the "Weltanshauung" behind the realizing principles. It is interesting to note that these two words also represent the roots of *two universal hierarchical organisations of things*. It is interesting because these organisations are exactly based on the characterization and the composition principles discussed in this paper. The hierarchies constitute *two mutually supplementary structures* that may help better to survey things and

better to understand them in respect to each other. They are supplementary, because a certain thing can be element in both structures, and *we can learn different things from each one*. Both structures are areas of the type »ordered network«. *For each structure* the following rules hold:
- every node of the network corresponds to a certain primary thing of the area, and there is one and only one node for every thing in the world
- there is only one top node corresponding to the root thing
- there is *only one kind* of connecting hierarchy-link between the nodes, and it corresponds to a certain universal role-type
- all nodes are connected.

In the following each of the two hierarchies will shortly be outlined.

10. The characterization hierarchy

(Third iteration of the characterization perspective)

The top node in the characterization hierarchy - the root »anything« - corresponds to *the ultimate super-type* of things. It is the only kind of thing in the world characterized by »nothing« - ie. with no characterizing aspects (ignoring the tautological property »is a thing«). All other things in the hierarchy are characterized in two ways:
- by a set of aspects that *is specific* for the corresponding node
- by the set of aspects *"inherited" by set-union* via the connecting links from nodes *above*.

One part of the hierarchy (including the top node) comprises *universal things* only. It corresponds to a conventional type-hirarchy. Each node in this sub-structure defines a type that is *a sub-type* of any of the things corresponding to possible nodes connected with it *upwards* in the hierarchy, while it is *a super-type* of any of the things corresponding to the possible nodes connected with it *downwards* in the hierarchy. (See fig. 6).

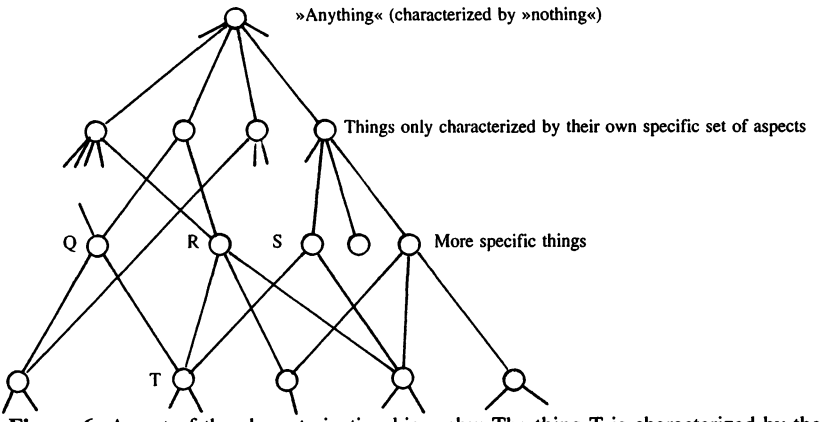

Figure 6 A part of the characterization hierarchy: The thing T is characterized by the (set-) union of its own specific set of aspects with those aspects inherited via the connecting links from the three things Q, R and S.

But the hierarchy can also be thought of as incorporating *particular things*, and they constitute another part. A particular thing will be connected upwards to *all* the universal things of which it is an instance, and all the characterizing properties of the particular thing will then be inherited (set-union wise) from these universal things. The specific set of aspects for the node *will be all the predicates characterizing the particular thing*,

By combining universal and particular things in the same characterization hierarchy it seems that the rule about only one kind of hierarchy-link has been violated. The link upwards between universal things is the role-type »is a sub-type of« (the so-called ISA-relationship), while it between a particular and a universal thing is the role-type »is an instance of«. (It seems irrelevant to consider inheritance between particular things). However the two kinds of links are, in fact, just *sub-types of the more general role-type »inherits aspects«* (or apparantly as here: a sub-type of the role-type »inherits properties«. However, see the note at the end of this section).

A structure like the one described here that integrates all things in the world in a single characterization hierarchy is in principle identical with an application of mathematical lattice theory. This is nicely described and formally evaluated by Schmeltz Pedersen. In his approach [Ped 94], (which, in fact, inspired to the present hierarchical perspective of characterization and composition), the nodes of the lattice are also allowed to be connected by special *lateral* links between the nodes, and this corresponds to ordinary relationships between things. Thereby the structure (or in practice a part of it) is similar to a description of an information base (the particular things) *together* with a model of the underlying information structure (the universal things). This is further evaluated in [Ped 95]. Interesting here is that all such lateral links that connect a certain node across the inherit-links - these connections do, in fact, define *the sets of aspects* that is *specific* for the corresponding thing. This is valid as well for universal as for particular things.

Late during the preparation of the final version of this paper a doubt or an idea appeared, which however, there was no time to elaborate on it (or check it for originality): Could it be that the classical distinction between universal and particular things is not absolute, but one depending on some *border* between abstraction levels? Could it be, that being particular or being universal is just *a role played by a certain thing in a certain (conceptual) context?* Take for example the universal thing »systemeering concept«. It is universal for a number of particular systemeering things (notions/concepts etc.) like »entity-type«, »activity-type«, »data-type«, »event-type«, etc. Then take one particular of these instances of »systemeering concept«, for example »data-type«. But *this particular thing also happens to be universal*, namely for particular data-types like »integer type«, »pointer type«, »record type«, etc. And again, in a certain context the particular instance »record type« is itself universal for things like »customer record«, »order record«, »employee record«, etc. This notion of a possible relativity in the universal/particular-distinction may be a tool for providing sensible explanations of a possible *real* difference (or no difference?) between the concepts *abstraction* and *generalization*.

11. The composition hierarchy (Third iteration of the composition perspective)

The top node in the composition hierarchy - the root »everything« - corresponds to *the ultimate composition*, ie. the world itself. All other things in the hierarchy are *parts of the world* - either directly or via intermediate sub-compositions. The connecting hierarchy-links, therefore, represent the *part-of role*, such that the thing corresponding to a given node plays the role of being *a part of* all the things represented by nodes connected with it *upwards* in the hierarchy. (A given thing can be conceived as being a part of more than one thing). Similarly, the thing corresponding to a given node is *a composition* of all the things corresponding to the nodes connected with it *downwards* in the hierarchy.

In the simplest version of a composition hierarchy the connecting part-of role deteriorates to the *member-of-set role*. But just as the characterizing hierarchy may combine universal and particular things by applying the general »inherits-aspects-from« role as the hierarchy-link and utilize explanatory lateral connections to define what is specific for a given thing, it seems feasible here to a certain degree to incorporate the *element-of-area* role as well. In a graphical representation of the composition structure the distinction between these two kinds of part-of roles could be shown by means of corresponding specific link-symbols, while the area-specific part-part roles could be indicated as lateral connections. However, there will probably be problems with incorporating the specific aspects of the third category: »contributor to system« into the hierarchy. Showing this in a separate notation may be more feasible.

Finally, a few reflections on a special (and very tricky) thing: the concept *nothing*. Where in the two hierarchies should »nothing« be placed? Semantically closely related words like 'void', 'empty', 'null' and our common intuition clearly indicate that it is a relevant question. An associated rather philosophical question is: Is »nothing« a universal or a particular thing, cf. the phrase 'a piece of nothing' or a certain null-value in a database record compared, for example, to the statement in fig. 6: 'Anything (characterized by nothing)', which is meaningful for the absolute super-type. But then, »nothing« is a thing playing the role as property, and a property is a universal thing. Last, but not less troublesome: Is »nothing« a part of a composition? Of any composition? Anyway, in order to reach a conclusion, we must here leave this »nothing« behind us!

Well - what did we, really, leave behind us?

12. Conclusion and some afterthoughts

It has been the purpose of this paper to explain and elaborate on three of a number of useful *realizing principles*. The three principles are:
- that one thing may play certain roles in respect to certain other things
- that one thing may characterize certain other things
- that one thing may be a composition of certain other things.

It turns out that the two last principles correspond to *two universal role-types*, respectively, instances of which can be played by things in respect to other things. *But that should not be regarded as an argument for the role-principle being more fundamental than the other principles*. That this is not the case has been demonstrated by the applied iterative approach, from which it is clear that the involved concepts are mutually dependent in several different ways. Most prominent among the relationships that connect the principles into *a complex conceptual network* are the following:
- A role of a certain type is defined by a property of the (subject-)thing playing the role.
- A property is not belonging to a special ontological category, but is a characterizing role (of a certain universal kind) that is played by one thing in respect to another.
- Composition parts may play roles in respect to each other that may influence their part-of roles and also properties of the composition as a thing itself - as a system.
- A role-association is a composition of three related things: one (subject-)thing that plays a certain role - ie. the second thing - in respect to a third (object-)thing.

The description of the three principles and the associated fundamental concepts has not been based on any specific IS-oriented concepts, and it has been carried through in common language

with a minimum use of formalisms. The reason is the belief that in order to establish a common platform for the understanding of our specific concepts, the main conceptual sources are not to be found within our own area, but rather *in a wide spectrum of quite general concepts and universal principles* that are well represented in common language. Another reason is that the advantages of mathematical formalisms cannot be properly utilized *unless the concepts behind the terms in the formal expressions are well understood.* In fact, it requires a deep understanding of the assumed underlying concepts and principles in order really to get more insight from an applied formalism. It is claimed that the paper contributes to a common understanding of some of the above mentioned general and universal concepts and principles, and it is claimed that by means of the iterative approach applied here a first part of a platform for understanding has been created. When other parts are properly established, (for example by succesful results from the FRISCO-group), the platform can then be used to build future work upon, that aims at the many IS-specific concepts which still rely much on tacit knowledge, and which are far from being well understood in common.

The work on this fundamental level has revealed - as probably demonstrated - that things basically are related in very complex ways, and that our quest for insight - even partially - ultimately must be based on infinite regression. We can gain insight in this complexity, only if we repeatedly ask questions like: "What kind of role is that?", "What are the characterizing properties?" and "How is it composed?". If continously we ask such questions, and if we insist on getting explicit answers in order to reveal some of the individual tacit knowledge, then some day we may have established a common conceptual foundation, where it will make sense to consolidate views.

But until we reach that stage, a final warning may be appropriate. It is from the more than thousand years old Indian philosophical poem "Bhagavad Ghita":

A little knowledge leads to dogmatism,
a little more to questioning,
and a little more takes us praying.

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