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Abstract	The REA accounting model developed by McCarthy conceptualizes the economic logic of the double-entry bookkeeping without referring to debits, credits and accounts. The conceptual core elements of the model are the economic resources, economic events and economic agents as well as the relationships that link the underlying stock flows according to the duality principle. In this paper the debit and credit notations are included as a meta concept to promote the model's understanding within the traditional accounting logic. By specifying additional economic resource types in form of liabilities and equity the model is completed with respect to the essential balance sheet positions, so that the REA accounting model is ready for accounting applications.

Keywords (separated by '-')	REA accounting model - Debit and credit - Liability and equity resources - ALE accounting model - Financial derivatives

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The REA Accounting Model: Enhancing Understandability and Applicability

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Abstract. The REA accounting model developed by McCarthy conceptualizes the economic logic of the double-entry bookkeeping without referring to debits, credits and accounts. The conceptual core elements of the model are the economic resources, economic events and economic agents as well as the relationships that link the underlying stock flows according to the duality principle. In this paper the debit and credit notations are included as a meta concept to promote the model's understanding within the traditional accounting logic. By specifying additional economic resource types in form of liabilities and equity the model is completed with respect to the essential balance sheet positions, so that the REA accounting model is ready for accounting applications.

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1 Introduction

For developing the REA accounting model, which is based on the constituting elements in form of resources (R), events (E) and agents (A), McCarthy started from the following considerations [11, pp. 559–560]: "It is a primary contention of this paper that the semantic modeling of accounting object systems should not include elements of double-entry bookkeeping such as debits, credits, and accounts. As noted previously …, these elements are artifacts associated with journals and ledgers (that is, they are simply mechanisms for manually storing and transmitting data). As such, they are not essential aspects of an accounting system. It is possible to capture the essence of what accountants do and what things they account for by modeling economic phenomena directly in the conceptual schema. Any double-entry manipulations desired by particular users can then be effected only in the external schemata presented to those users".

The REA accounting model was extended by Geerts/McCarthy [4, 5] to the REA business ontology. In this ontology the REA accounting model provides the accounting infrastructure, which is extended by the policy infrastructure that contains the future related elements needed for the formulation of business policies. Due to its origin in the information systems research it is obvious that the REA business ontology (including the REA accounting model) is used in the enterprise information system (EIS) literature (see e.g. Dunn/Cherrington/Hollander [3]) and the accounting information system (AIS)

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literature (see e.g. Steinbart/Romney [12]). But amazingly it does not appear in the accounting literature (see e.g. Harrison/Horngren/Thomas/Suwardy [6] and Horngren/Harrison/Oliver [7]).

This non-existence of the REA business ontology in the accounting literature leads to the two primary research questions of this paper:

- Why is the REA business ontology despite its conceptual merits not present in the traditional accounting literature?
- What has to be done in order to promote the understanding of the REA business ontology within the accounting community and to assure its applicability in the accounting domain?

To answer these questions the working and the requirements of the traditional accounting logic is analyzed. Then the identified requirements are compared with the conceptual elements of the REA business ontology to detect the shortcomings. Finally the REA business ontology will be modified to the "REA-based ALE accounting ontology", which conceptualizes the traditional accounting logic.

The paper is organized as follows. In the subsequent section the extension from the REA accounting model to the REA business ontology is shown. Next to that the traditional accounting logic is investigated. Due to its starting point in terms of the accounting equation, where the equality of assets (A) with liabilities (L) and equity (E) is postulated, the derived logic is called the "ALE accounting model". In the following section the REA-based ALE accounting ontology is derived by suitably adjusting the REA business ontology. In the final section the paper is concluded.

2 REA Business Ontology: Inclusion of Current and Future Events

In Fig. 1 the REA accounting ontology is modeled in form of a class diagram, which is used in the ISO/IEC 15944-4:2006 standard related to the Accounting and Economic Ontology (AEO) to model business transactions [10, p. 33] and by Abmayer/Schwaiger [1] to model REA-related ontologies. The accounting infrastructure of the REA business ontology consists of the REA accounting model. The focus of this infrastructure lies on the resource flows that occur in economic transactions between the involved agents. The duality relationship expresses the economic principle that scarce resources have a positive price that has to be paid in an exchange transaction. The linkage to the resources is termed as "resource flow", which in the REA business ontology can be an increment or a decrement event. Hruby [8] provides different examples of business patterns, where the increment and decrement event structure is applied.

The policy infrastructure allows the modeling of future related business policies and it is set on top of the accounting infrastructure. For simplicity reasons only the elements of the policy infrastructure, which are important for financial instruments accounting, are shown in Fig. 1. Economic contracts are defined as economic bundles of economic commitments, which fulfill the reciprocity principle. The reciprocity principle is the conceptual analogue to the duality principle and it relates to future events in the form

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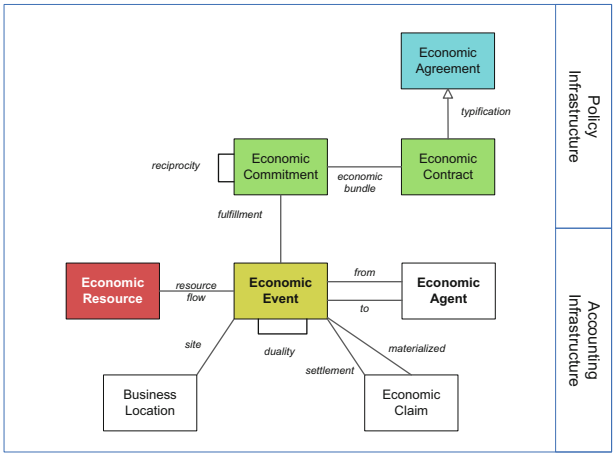

Fig. 1. REA business ontology (accounting relevant elements)

of economic commitments. The economic contracts are themselves specializations of economic agreements.

In this article future related elements of the policy infrastructure are used for extending the traditional accounting perspective. Traditionally current events are recorded over time and financial statements are generated thereof. With the additional elements the future commitments of financial assets, debt and equity instruments can be included as well.

3 Traditional Accounting Logic: ALE Accounting Model

The traditional accounting logic starts with the accounting equation, which specifies the resources of the enterprise as assets and the claims to those resources as liabilities and equity. The assets are owned and the liabilities are owed by the enterprise. The equity is the owner's claim to the net value of the enterprise, which is defined as the difference of the assets and the liabilities.

"The account category (asset, liability, equity) governs how we record increases and decreases. For any given account, increases are recorded on one side, and decreases are recorded on the opposite side. The following T-accounts provide a summary:

Assets	Liabilities and Owner's Equity
Increase = Debit | Decrease = Credit	Decrease = Debit | Increase = Credit

These are the *rules of debit and credit*. Whether an account is increased or decreased by a debit or a credit depends on the type of account. Debits are not "good" or "bad". Neither are credits. Debits are not always increases or always decreases - neither are credits" [7, p. 92].

In Fig. 2 the ALE categorization of resources is used to define the matrix, which contains all nine possible combinations of ALE resource changes. The nine combinations

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constitute the nine elementary accounting transaction types that have to be recorded in an enterprise. Their meanings are as follows:

1. accounting exchange on the assets side – e.g. acquisition transaction
2. balance sheet extension – e.g. debt financing transaction
3. accounting exchange on the liabilities side – e.g. refinancing transaction
4. balance sheet contraction – e.g. loan redemption transaction
5. expenses (balance sheet contraction) – e.g. depreciation expenses
6. expenses (balance sheet "neutral") – e.g. provisioning
7. revenues (balance sheet extension) – e.g. revaluation profits
8. revenues (balance sheet "neutral") – e.g. unused provision release
9. accounting exchange on the equity side – e.g. creation of equity reserves

Transaction Types		Credit		
		A-	L+	E+
Debit	A+	1	2	7
	L-	4	3	8
	E-	5	6	9

Fig. 2. Categorization of business transactions – 9 transaction types

In each accounting transaction two ALE resources are involved. The increment and decrement event structure of the REA business ontology works well for physical resources and cash. But the intuitiveness gets lost once resources related to liabilities and equity are considered. Let's take e.g. a debt financing transaction. The financial instruments involved in debt financing are distinguished from physical resources and cash by having contractually defined future commitments. In the debt financing transaction the loan stock is increased. At the same time the cash inflow increases the cash stock as well. As there are two increment events in this transaction the increment/decrement duality of the REA business ontology is violated. Consequently the increment/decrement notation is not useful in ALE accounting and it has to be replaced by the debit/credit notation. In this notation the debt financing transaction is recorded by debiting the cash resource for the cash inflow and crediting the debt resource for the future obligation.

In the traditional ALE accounting the future payment structures behind the obligations of financial assets, debt and equity instruments are not directly modeled. For this purpose the future related elements of the REA business ontology are suitable. The debt financing transaction constitutes an economic contract, which includes the future payments specified in the contract as commitments. As these future cash payments are outgoing payments from the perspective of the enterprise the commitments are credited.

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The inclusion of the economic contracts and commitments is useful for modeling financial derivatives (see Hull [9]) as well. These instruments normally cause problems in ALE accounting, because they are difficult to handle within the traditional accounting logic. The usage of the future related elements of the REA business ontology solves these difficulties by allowing the modeling of commitments on the asset side as well as on the liability side. For understanding the valueless property of some derivative instruments the present value restriction from the no-arbitrage theory (see e.g. Black/Scholes [2]) is important. Applied to swap contracts this principle says that if the present value of the debit commitments is equal to the present value of the credit commitments, then the value of the swap is zero. If this would not be the case, then arbitrage profits can be earned by engaging in the swap contract and performing the adequate swap duplication strategy.

4 REA-Based ALE Accounting Ontology: Integrating Finance into Accounting

In the previous section the requirements of the ALE accounting were identified in the context of recording ALE resource changes in the nine accounting transaction types according to the debit/credit notation. Furthermore the future related elements of the REA business ontology showed beneficial especially for explicitly modeling the payment structure of derivative and non-derivative financial instruments.

The REA-based ALE accounting ontology is a modification of the REA business ontology in order to include the requirements from ALE accounting. This ontology is presented in Fig. 3. The distinguishing features of the ALE accounting ontology in the accounting infrastructure are as follows:

- It includes the accounting transaction object, which is missing in the REA business ontology, as a composition of debited and credited ALE resource changes. The business transaction object is the conceptual starting point of accounting professionals and academics. Its inclusion anchors the ontology in the accounting domain.
- It uses the value restriction requirement related to debit events and credit events, which is also missing in the REA business ontology. This is the central attribute of the accounting transaction object.
- It uses the value flow relationship related to debit and credit events instead of the stock flow relationship related to increment and decrement events in the REA business ontology. The reason for this modification lies in the fact that not only resource flows have to be accounted for in the REA-based ALE accounting ontology. In accrual accounting the periodic income also includes profits and losses that result e.g. from changing resource prices. Such value changes occur without resource flows. On the other hand all resource flows are related to value flows, so that in the value flow relationship all accounting transactions can be recorded.
- It covers all resources related to the assets, liabilities and equity instead of the primary focus on physical assets and cash in the REA business ontology. The inclusion of all ALE resources is needed to cover all nine elementary accounting transaction types defined in Fig. 2.

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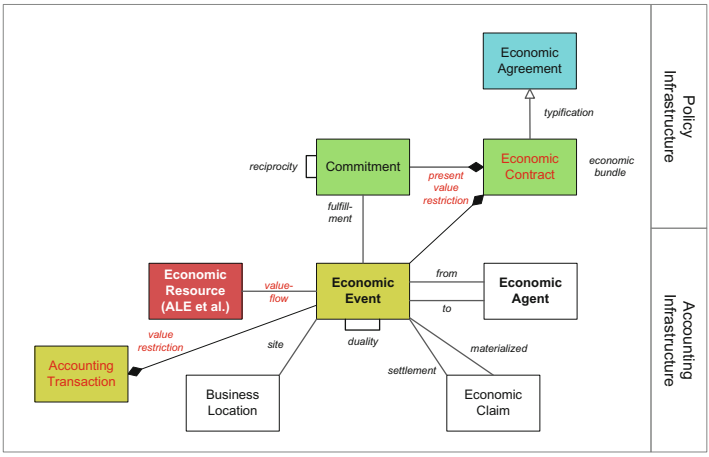

Fig. 3. REA-based ALE accounting ontology

The distinguishing features of the REA-based ALE accounting ontology in the policy infrastructure are as follows:

- It includes the economic contract object as a composition of commitments and economic events. The link to the economic events is important for modeling e.g. debt financing instruments, where cash is paid to the loan taker at the contract instantiation date against the commitment to pay it back in the future. If only economic events are included in the business transaction, then this is a spot market contract without future commitments. The swap contract is an example of an economic contract that contains only commitments, which are credited and debited.
- It allows an appropriate modeling of economic claims in terms of economic contracts. In the REA business ontology claims are seen as resulting from imbalances in related event sets. "However, in the outline of the generalized framework, resources were materialized as base objects while claims were not. In actual practice, this disparity in treatment may not always be warranted, especially when the processing requirements and decision usefulness of some claims are projected" [11, p. 571]. Economic contract models developed in the finance domain are nowadays the adequate representation of temporal imbalances in financial instruments. In this case the economic claim disappears and appears as an economic contract.

5 Conclusions

At the center of this article is the REA business ontology, which was developed by McCarthy [11] and Geerts/McCarthy [4, 5]. This seminal contribution inspires the enterprise and accounting information systems research, where the ontology is used to design enterprise and accounting databases. Amazingly, in the traditional accounting literature, which is the actual home base of the ontology, the ontology is mainly

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neglected. On the search for the underlying reasons the traditional accounting logic was investigated and its requirements were specified. Accounting professionals and academics think in term of accounting transactions, credit and debit events with respect to assets, liabilities and equity as well as value restrictions. These are exactly the elements of the double-entry bookkeeping that McCarthy explicitly avoided for being able to establish a generic framework, which can be used by accountants and by non-accountants at the same time.

In order to promote the understanding of the REA business ontology within the accounting community the inclusion of the double-entry bookkeeping elements in form of the debit and credit notation is unavoidable. The debit and credit linguistic terms are needed to give the increment and decrement events of assets, liabilities and equity a consistent interpretation within the ALE-based accounting equation. Consequently the main finding related to the two research questions is: *It is a primary contention of this paper that the semantic modeling of accounting object systems should include elements of double-entry bookkeeping such as debits and credits as well as all resource types related to assets, liabilities and equity.* Otherwise the understanding of the REA business ontology will not be promoted among accounting professionals and academics and its applicability will remain restricted to a subset of predominately asset related business transactions.

The extensions and modification of the REA business ontology needed to integrate the ALE accounting model resulted in the REA-based ALE accounting ontology. This ontology specifies the traditional accounting logic in terms of accounting transaction objects that contain the debit and credit events related to the changes of assets, liabilities and equity and that satisfy the value restriction property.

Beyond that the REA-based ALE accounting ontology is by its economic contract foundation also able to adequately integrate all kind of financial resources. Consequently this ontology constitutes a fusion of the accounting and the finance domains. Such a fusion is surly needed in current times, where many derivative instruments are considered off-balance. Modeling these products as economic contracts would bring them on-balance, so that its magnitudes and risk are explicitly shown to the benefit of the investors and other stakeholders. This special feature of the REA-based ALE accounting ontology might be a promising starting point for future legislation as well as for future enterprise and accounting systems research.

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