Representation

- Depiction of Reality with Symbols
  - People are real things
    - Identification cards (such as drivers licenses or social security cards) are representations of those people
      - Alternatively you could say identification cards are symbols that represent those people
    - What other representations of people can you think of?
    - Which of these is likely to be the best representation?
  - Computers are real things
    - What are some representations of computers?
    - Which of these is likely to be the best representation?

Models as Representations

- What is a model?
  - A model is a simplification of something in reality
    - Created for a specific purpose
    - Hides details that are not needed for that purpose
    - Examples: model car, architect's models – paper-based and 3-dimensional
- Why do we build models of enterprise systems?
  - We build models so that we can better understand the system we are developing.
  - Most enterprise systems are too large and complex for the average person to comprehend in entirety.
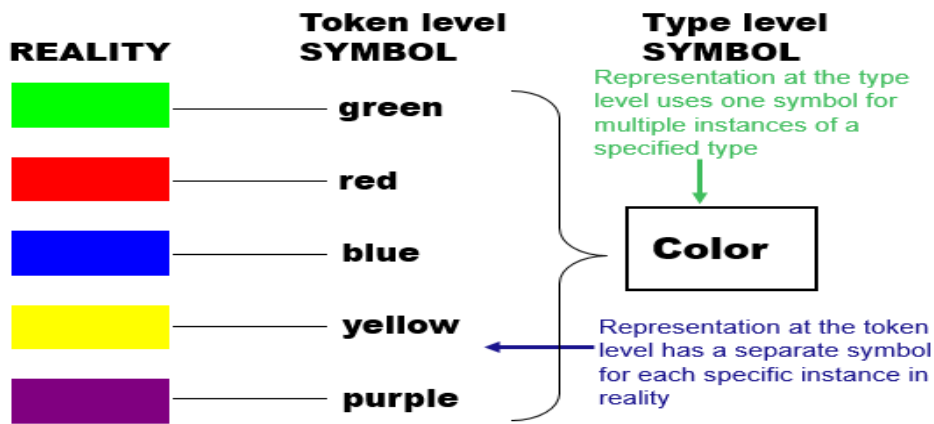
Representation in Information Systems

- In modeling enterprise systems our goal is to create representations of the "reality" of the business in a form that is computer-readable
  - We start by making a paper-based model with a set of symbols that have understood meanings and for which there are agreed upon procedures for translation into computer-readable form
  - We then translate the paper-based representation into a computerized information system
    - The information system is itself a representation of the business reality
    - The paper-based model is also a representation of the business reality

Principles of Modeling

- When creating or evaluating models, how do we determine what makes "good" models?
  - This is important because if a model provides an intermediate step toward a solution or developed tool, choices in modeling partially determine the solution or tool's effectiveness.
  - Good models resemble their underlying reality as completely as possible
  - Good models can be expressed at different levels of precision
  - They can be broken down into smaller pieces for closer examination of some features and aggregated for holistic views

Symbol Representations at Different Levels of Abstraction

REALITY **Token level SYMBOL** **Type level SYMBOL**

green

red

blue — **Color**

yellow

purple

Representation at the type level uses one symbol for multiple instances of a specified type

Representation at the token level has a separate symbol for each specific instance in reality

Source: Professor Bill McCarthy at Michigan State University; based on Geerts and McCarthy, "An Ontological Analysis of the Economic Primitives of the Extended-REA Enterprise Information Architecture" International Journal of Accounting Information Systems. 3:21. 1-16.

Are the objects below symbols or reality?

Are they "token" or "type" level objects?

Can you match the left-side objects to the corresponding right-side objects?

- Victoria Memorial Hall

- Lincoln Memorial

- Mount Rushmore

Queen Victoria George Washington Theodore Roosevelt Abraham Lincoln Thomas Jefferson

Are these objects symbols or reality?

Are they "token" or "type" level objects?

Can you match these objects to those on the previous slide?

---

name location yr finished   name birth death

Landmark —for— **Famous Person**

Landmark

Name	location	finished
Victoria Memorial	Calcutta	1921
Lincoln Memorial	Washington DC	1922
Mount Rushmore	South Dakota	1941

Famous Person

Name	Birth	Death
Thomas Jefferson	1743	1826
Abraham Lincoln	1809	1865
Theodore Roosevelt	1858	1919
George Washington	1732	1799
Queen Victoria	1819	1901

How might we represent the "for" relationship at the token level??

Landmark

Name	location	finished	For Person
Victoria Memorial	Calcutta	1921	Queen Victoria
Lincoln Memorial	Washington DC	1922	Abraham Lincoln
Mount Rushmore	South Dakota	1941	Abraham Lincoln, George Washington, Thomas Jefferson, Theodore Roosevelt

Famous Person

Name	Birth	Death	Landmark For
Thomas Jefferson	1743	1826	Mount Rushmore
Abraham Lincoln	1809	1865	Lincoln Memorial, Mount Rushmore
Theodore Roosevelt	1858	1919	Mount Rushmore
George Washington	1732	1799	Mount Rushmore
Queen Victoria	1819	1901	Victoria Memorial Hall

Landmark For Famous Person

Landmark Name	Person Name
Victoria Memorial	Queen Victoria
Lincoln Memorial	Abraham Lincoln
Mount Rushmore	Abraham Lincoln
Mount Rushmore	George Washington
Mount Rushmore	Thomas Jefferson
Mount Rushmore	Theodore Roosevelt

In Chapter 4 we will discuss which of these alternatives is the best in different situations

Object Patterns

- Pretend you are moving to a new city, and you need a place to live.
- An apartment complex in this city will provide you with two years of free rent, but you can only move in AFTER you design a database to capture its operational data and satisfy its enterprise information needs.
- You don't want to pay rent for long, so you decide to get a head start before you even start traveling to the new city.
- You know the first step in database design is to create a list of entities and relationships between them.

> What is on your list of entities and relationships for the apartment complex?

> How did you know what to include, when you have never been to that city or to that apartment complex before?

- Even when we don't have knowledge about something in reality, if we have knowledge (either first-hand or second-hand) about something similar in reality (and we know it is similar) we can apply our knowledge of the familiar object or situation to the unfamiliar object or situation
- This is "pattern-based thinking"
- In conceptual modeling, an object pattern is called a "stereotypical constellation of entities"
  - In other words, a group of entities and relationships between them that we expect to exist in the underlying reality
- At the business process level, REA is such a pattern, specifically created to represent enterprises and to serve as a foundation for integrated enterprise information systems

Script Patterns

- Recall a story you have heard many times before
  - **Once upon a time**
    - A boy met a girl
    - They fell in love
    - They got married
    - They lived happily ever after
  - **This story is known as "The Romance Script"**
    - Other variations exist, but certain parts are necessary (e.g. falling in love) to qualify as an instance of the romance script
- How does the "tragic romance script" vary from the romance script?
  - Can you think of an example of a story based on the tragic romance script?
  - How about a second example?
- Script patterns, similar to object patterns, involve "pattern-based thinking" applied to sequential activities

Business-Entrepreneur Script

- I get some money
- I engage in value-added exchanges
  - Purchase raw materials
  - Purchase labor
  - Manufacture finished goods
  - Sell finished goods
- I pay back money and live off profit

Meet Frankie

- Frankie is a 10 year old entrepreneur
- He is a big fan of sports trading cards
- He has a great idea for making money
  - Buy cards in bulk
  - Buy sleeves in bulk
  - Put cards in sleeves
  - Sell single sleeved cards at a profit to other sports trading card fans

Note: this example is for illustration purposes only and ignores legal issues Frankie would face (e.g. sales license, taxes, etc.)

- He is a really great dad...... but
- He doesn't think Frankie's idea is good because
  - Frankie has no money
  - Frankie has no time to sort and assemble cards (because of too much homework)

- Aunt Frances is Frankie's favorite aunt
- She has plenty of money and no kids of her own
- She is willing to lend some of it to Frankie
- She will charge interest, though, to make it a "real" business transaction; otherwise Dad will say "no"

- Sally is 6 years old and is in 1st grade
- First graders don't have much homework
- She is pretty smart, and trustworthy too
- She is willing to work for Frankie for 2 cents per assembled card

- Melissa, Steven, Anthony, and Kyle
- They are sports card fans who are willing to pay fairly high prices to get the cards they want, and they are willing to pay cash
- There exist many more potential customers besides these four

- Okay, Frankie, you have shown initiative and I will allow you to try this scheme of yours. I will even be your supplier since you don't have a credit card.
- Cards will cost you $3 per pack if you buy 24 packs at a time. Sleeves will cost $7.50 for a box of 250. Those costs include shipping and sales tax. You must pay me as soon as the cards arrive. Also, you must pay Sally as soon as she does her work, not after you sell the cards.

It's a Deal!

The business begins....

- Frankie borrows $180 from his Aunt Frances. He agrees to pay her 10% annual simple interest.

And then.....

- Frankie buys 48 packs of cards and 2 boxes of card protector sleeves from his dad. This purchase costs Frankie $159 in cash.
  - 48 card packs x $3 per pack
  - 2 boxes of sleeves x $7.50 per box

And then.....

- Sally takes all 432 cards out of their packages (9 cards per pack x 48 packs), puts them into card protector sleeves, and sorts them by type (super-rare, rare, common, etc.)
- Frankie pays her the agreed upon $8.64 ($.02/card x 432 cards)

And then....

- Slowly, but surely, over the next 3 months, Frankie sells all 432 cards. The total revenue he generated was $400.

At the End of the 3 Months...

- Frankie repays his Aunt Frances $180 and pays her $4.50 in interest ($180 x .10 x 3/12 = $4.50).

What was Frankie's profit?

Net Sales =	$400.00
- COGS	$165.60
= Gross Margin	$234.40
- Interest Expense	$ 4.50
= Net Income	$229.90

- Note: COGS = $144.00 raw cost of cards sold + $12.96 cost of sleeves used (432 sleeves x $.03 per sleeve) + $8.64 direct labor

What is Frankie's Ending Balance Sheet?

Cash	$227.86	
Inventory	$ 2.04	
Total Assets		$229.90
Liabilities	$ 0.00	
Retained Earnings	$229.90	
Total Liab + Equity		$229.90

- Cash = $180 in from financing + $400 in from sales - $159 cash paid for purchases - $8.64 cash paid for wages - $184.50 paid for financing
- Inventory = 68 card sleeves remaining x $.03 per sleeve
- Retained Earnings = $0 beginning balance + $229.90 net income - $0 withdrawals

Frankie's Script

1. Borrow money
2. Buy raw materials (cards and sleeves)
3. Buy labor
4. Produce finished goods (sleeved cards)
5. Sell finished goods
6. Repay borrowed money
7. Repeat steps 2-5, only resorting to steps 1 and 6 as needed

Scripts and the REA Ontology

- The business-entrepreneur script is also called a Value Chain, which we will discuss more later.
- The value chain is a sequence (chain) of scenes
  - Each scene is a business process (transaction cycle)
  - Each scene is represented by a pattern (REA)
- The REA ontology is a combination of script patterns and object patterns that together enable us to model enterprises and to understand and work with existing enterprises models

Enterprise Ontologies

- What is an "ontology"?
  - An attempt to define what things exist in the world in general; a branch of metaphysics dealing with the nature of being
- What is an "enterprise ontology"?
  - An attempt to define what kinds of things in enterprises need to be represented
- Why do we need ontologies?
  - Ontologies improve communication, sharing, and reuse of information
  - For current information systems and e-business, these three concepts are very important!

REA Ontology Levels

- Value System Level (object-based pattern)
  - Examines enterprise in context of its external business partners
  - The combination of value systems of business partners forms a supply chain
- Value Chain Level (script-based pattern)
  - Connects business processes of an enterprise via the resource flows between the processes

REA Ontology Levels

- Business Process Level (object-based pattern)
  - A pattern to which the reality of most (perhaps all) enterprises conform
    - The key is mapping the objects in the enterprise to the pattern in order to generate the model from which a database is designed
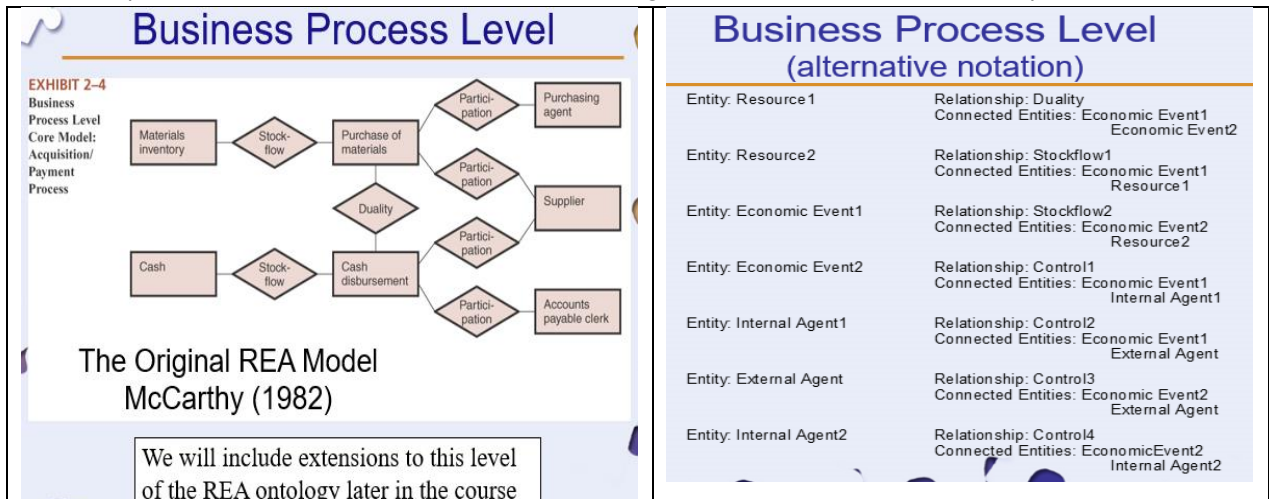- Task Level (script-based pattern)
  - Many different possible scripts exist
    - REA does not dictate specific tasks to be performed in achieving an enterprise's business processes

Value System Level

Places the enterprise in the context of its resource exchanges with external business partners

EXHIBIT 2–2
RSWS Value
System Level
REA Model

Value Chain Level

Illustrates the enterprise's internal business processes and the resource flows between them

EXHIBIT 2–3
RSWS Value
Chain Level
REA Model
(Summarized Version)
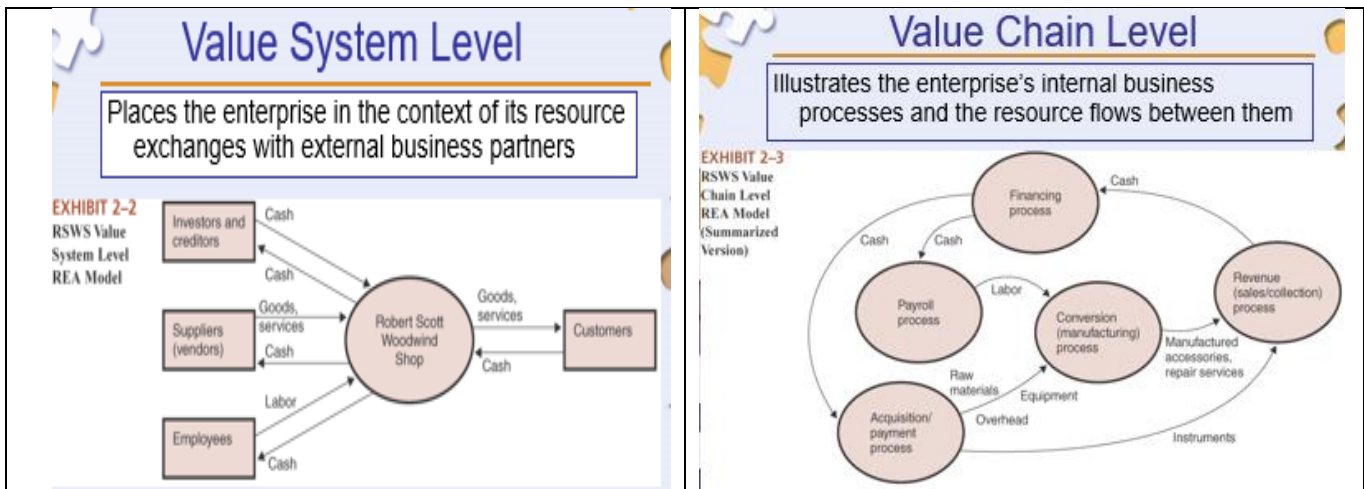
Business Process Level

- Entities
- Resources
- Economic Events
- Agents (internal and external)
- Relationships
- Stockflow (relationships between resources and events – increase or decrease)
- Duality (relationships between increment and decrement economic events)
- Control (relationships between events and the agents that participate in them)

Business Process Level

EXHIBIT 2–4
Business
Process Level
Core Model:
Acquisition/
Payment
Process

The Original REA Model
McCarthy (1982)

We will include extensions to this level
of the REA ontology later in the course

Business Process Level
(alternative notation)

Entity: Resource1   Relationship: Duality
                                 Connected Entities: Economic Event1
                                                     Economic Event2
Entity: Resource2   Relationship: Stockflow1
                                 Connected Entities: Economic Event1
                                                     Resource1
Entity: Economic Event1   Relationship: Stockflow2
                                 Connected Entities: Economic Event2
                                                     Resource2
Entity: Economic Event2   Relationship: Control1
                                 Connected Entities: Economic Event1
                                                     Internal Agent1
Entity: Internal Agent1   Relationship: Control2
                                 Connected Entities: Economic Event1
                                                     External Agent
Entity: External Agent   Relationship: Control3
                                 Connected Entities: Economic Event2
                                                     External Agent
Entity: Internal Agent2   Relationship: Control4
                                 Connected Entities: EconomicEvent2
                                                     Internal Agent2

Database tables Derived From Business Process Level

EXHIBIT 2–5   RSWS Business Process Level Database Tables: Acquisition/Payment Process

Cash

Account Number	Account type	Account Location
1223	Checking	Fourth-Second Bank
3445	Petty cash	File drawer, room 222
4556	Payroll imprest	True American Bank

Cash Disbursement

Disbursement ID	Date	Amount	Cash Account	Supplier ID	APClerk ID
CD1	November 5	$1,230.00	1223	S2	E8
CD2	November 5	$9,778.65	4556		
CD3	November 6	$2,476.00	1223	S3	E9

Materials Inventory

Item ID	Description	Standard Unit Cost
M210	Cork set, standard oboe	$5.00
M220	Spring set, standard oboe	$9.00
M321	Cane, ½" width × 12" length	$1.00

Purchase

Purchase ID	Date	Amount	Supplier ID	PurchAgent ID	Disbursement ID
P1	November 1	$1,230.00	S2	E2	CD1
P2	November 1	$2,476.00	S3	E2	CD3
P3	November 3	$ 500.00	S1	E3	

Materials Inventory—Purchase

| Item ID	Purchase ID	Quantity Purchased	Actual Unit Cost
M210	P1	66	$5.00
M220	P1	100	$9.00
M220	P2	200	$9.00
M321	P2	676	$1.00

Task Level

May be depicted in various formats such as a fishbone diagram (with tasks listed in an ordered sequence), a system flowchart, a data flow diagram, a process model (with swim lanes), etc.
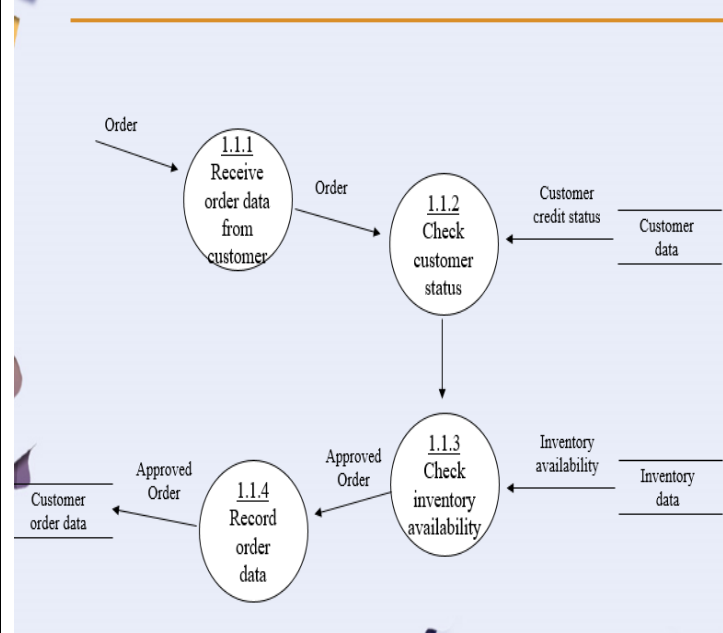
– No pattern is available, tasks are enterprise specific
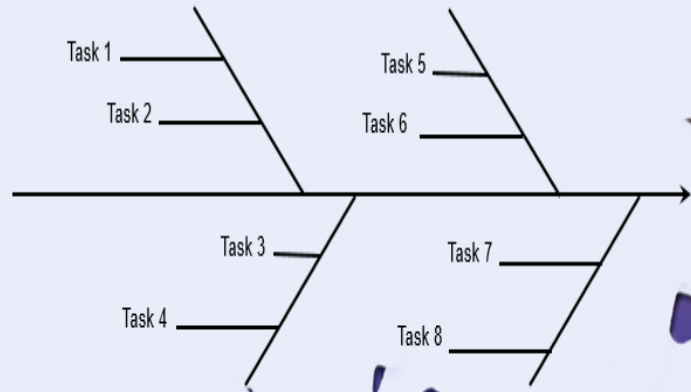
Example System Flowchart
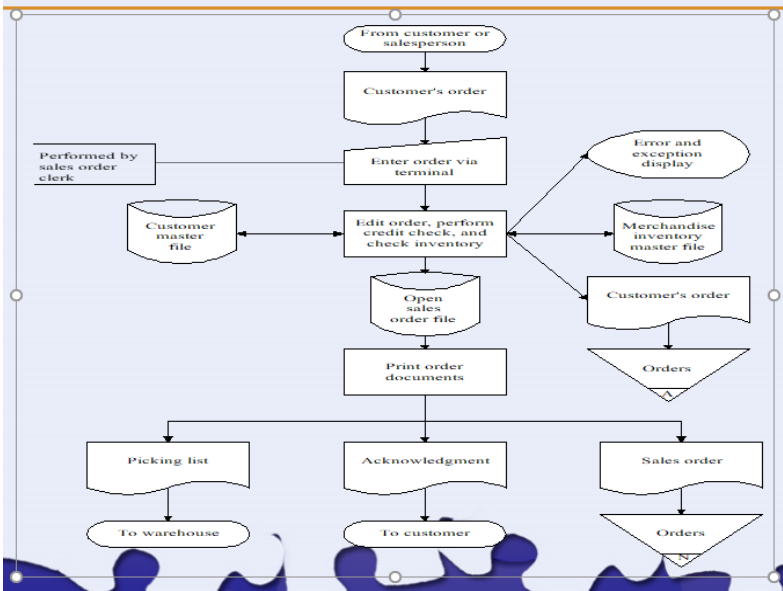
Example Data Flow Diagram

SUMMARY

- Modeling is a useful tool for minimizing complexity and enabling us to develop enterprise wide system solutions
- Good models use symbols that represent reality as closely as possible
- Object Patterns are stereotypical constellations of things and relationships between them
- Script Patterns are stereotypical sequences of events, and can be thought of in terms of scenes, actors, props, and roles
- A combination of object and script patterns can be used to model enterprise systems
    - the REA Enterprise Ontology provides such an approach, modeling enterprises at the value system, value chain, business process, and task levels