2IS55 Software Evolution

# Implementing evolution: Database migration

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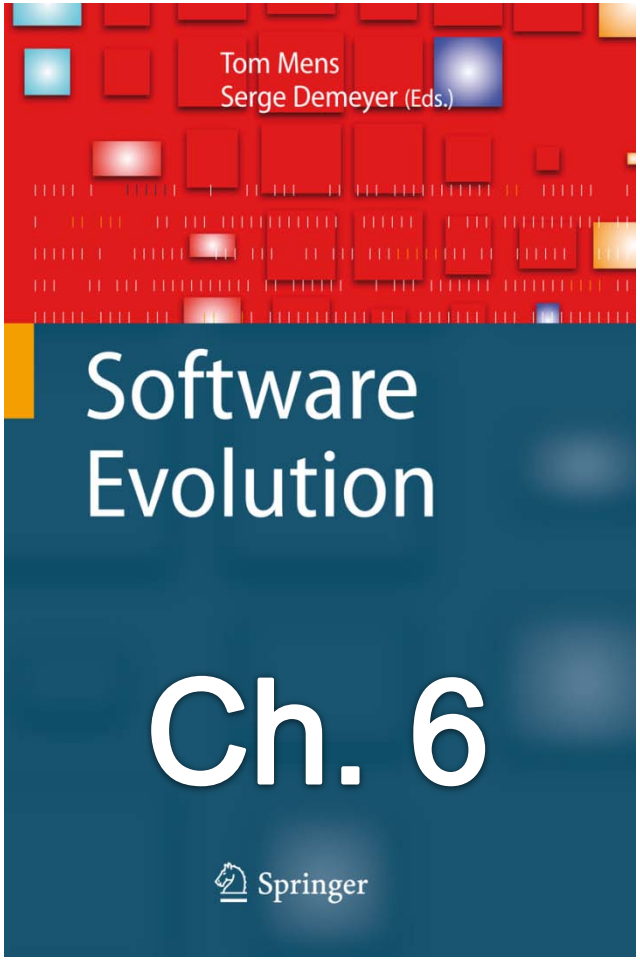
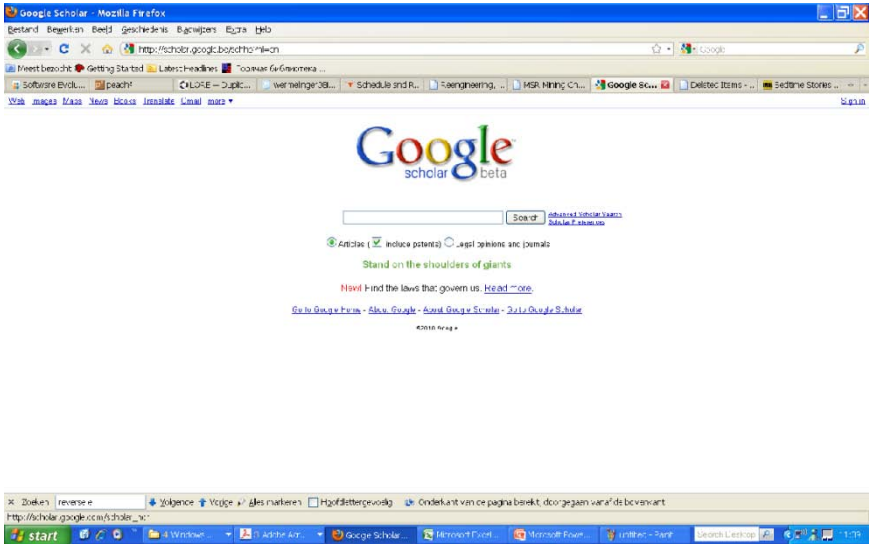
Where innovation starts

# Sources


Tom Mens
Serge Demeyer (Eds.)
Software Evolution
Ch. 6
Springer


Google Scholar - Mozilla Firefox
Google
scholar beta
Search
Stand on the shoulders of giants
Read more.

# Last week

- **Assignment 7**
  - **How is it going?**
  - **I’m off-line from May 27 till May 30.**

- **Assignment 8**
  - **Try ReqVis**

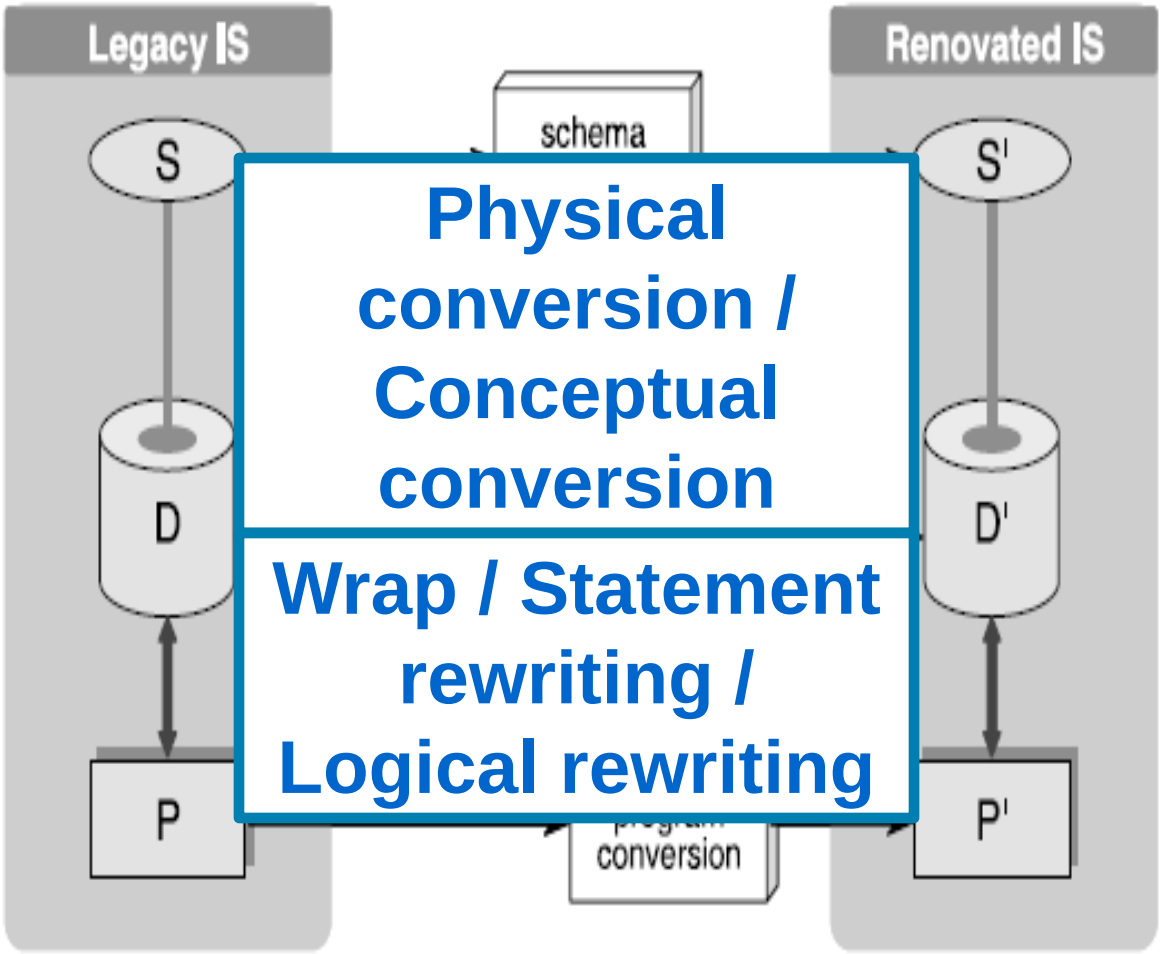
# Databases

- Central for information systems
- Contain major company assets: data
- Often developed using outdated technology

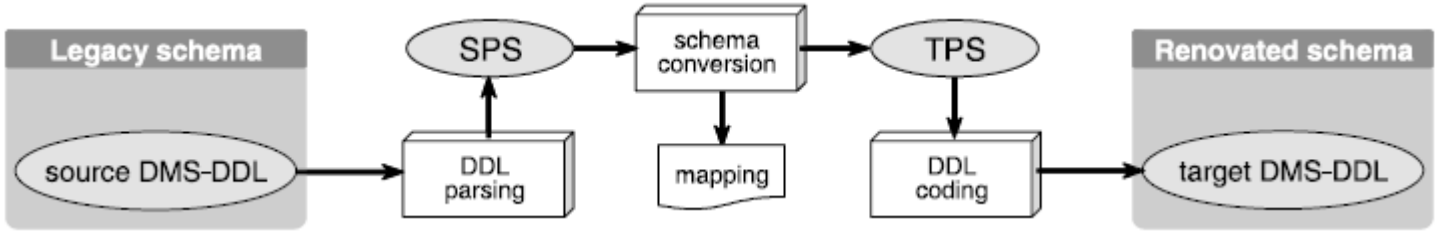
- Migration should
  - Preserve the data
  - Improve the technology used
    - Flexibility
    - Availability of skills

# Database migration

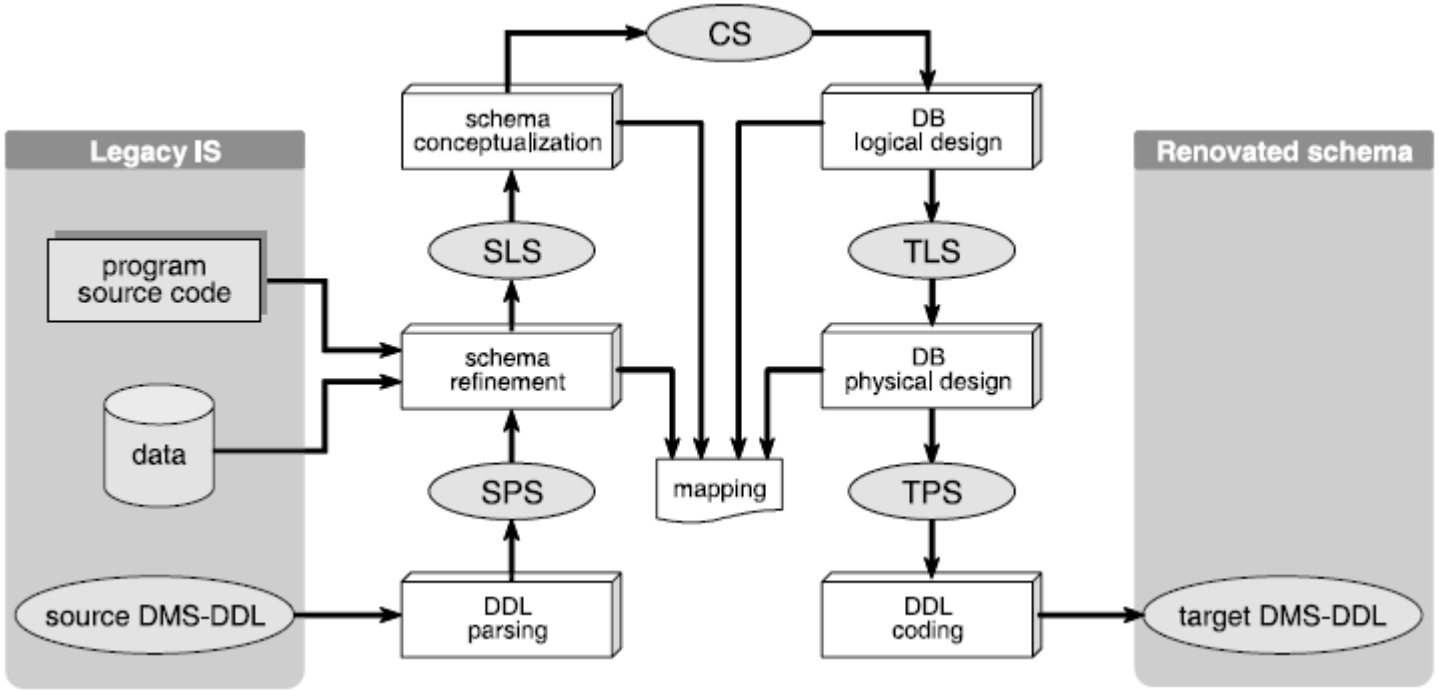
- **S – DB schema**
- **D – DB data**
- **P – data manipulation programs**



# Schema conversion: Physical vs Conceptual

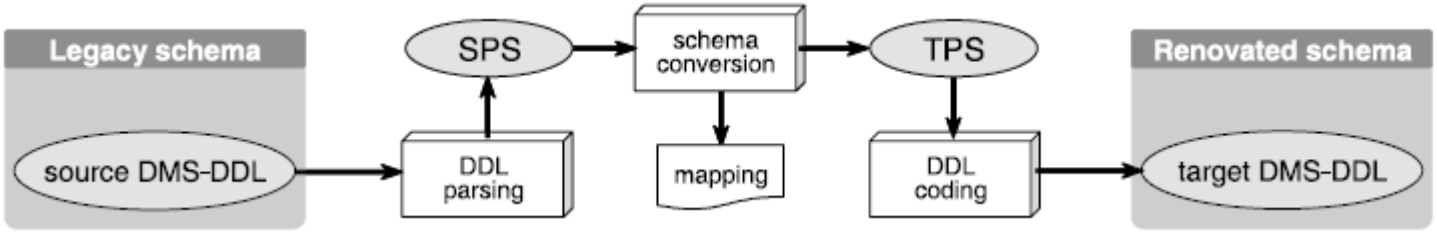



***Physical***




***Conceptual***

# Schema conversion: Physical




## COBOL

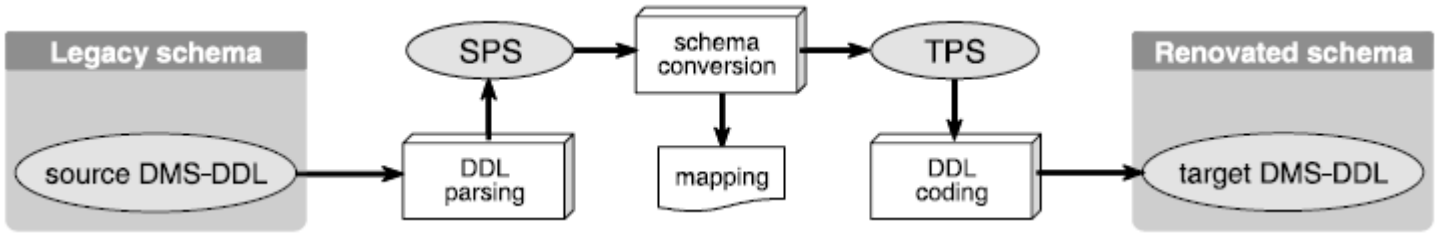
```
DATA DIVISION.
FILE SECTION.
FD PERSON-FILE
     DATA RECORD IS PERSON-ITEM.
01 PERSON-ITEM.
    02 PERSON-KEY.
        03 PERSON-ID PICTURE X(4).
    02 PERSON-NAME PICTURE X(20).
    02 PERSON-ADDRESS PICTURE X(20).
    02 PERSON-CITY PICTURE X(18).
```

## SQL

```
CREATE TABLE PERSON-ITEM
(PERSON-ID varchar(4) PRIMARY KEY,
 PERSON-NAME  varchar(20),
 PERSON-ADDRESS varchar(20),
 PERSON-CITY varchar(18))
```

**Advantages and disadvantages of physical conversion?**

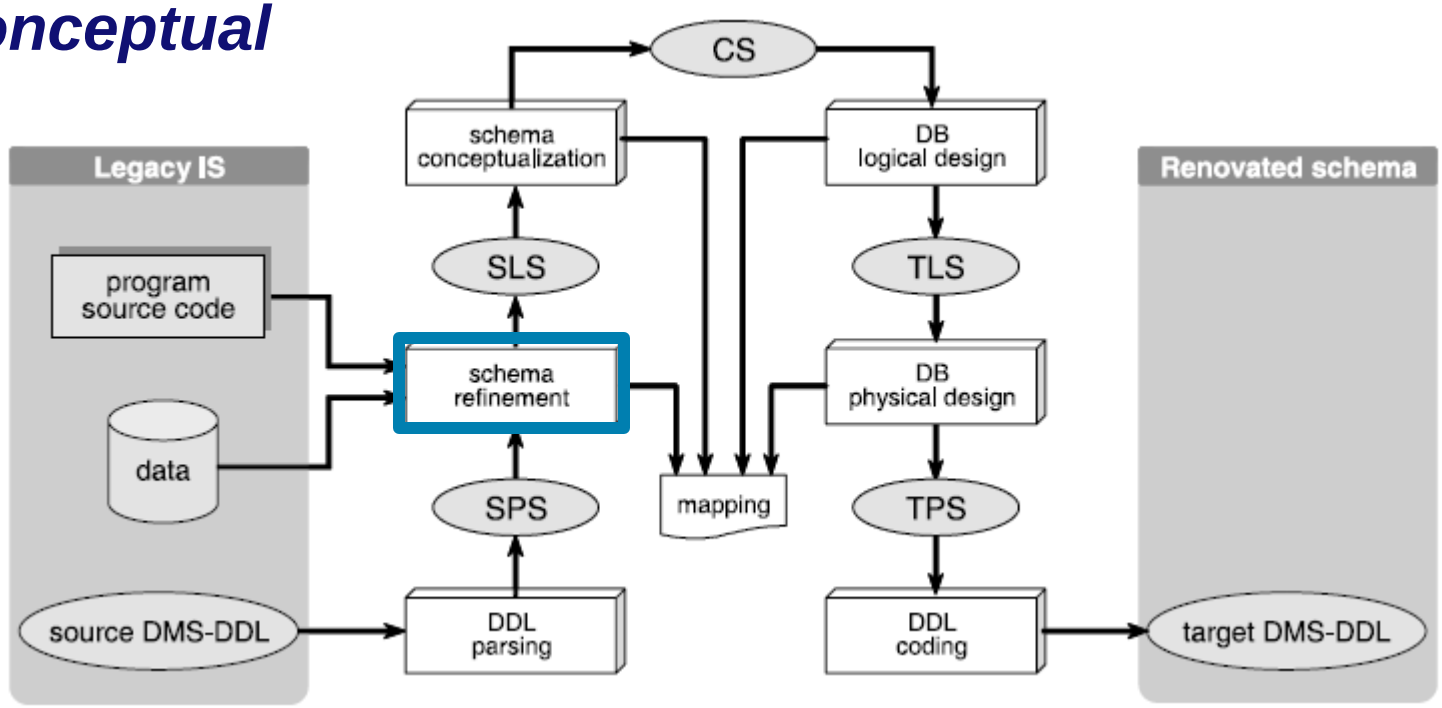
# Schema conversion: Physical




- **Easy to automate**
  - **Existing work: COBOL ⇒ relational, hierarchical ⇒ relational, relational ⇒ OO**
- **“Migration as translation” vs “migration as improvement”**
- **Semantics is ignored**
  - **Limitations of COBOL ⇒ Design decisions in the legacy system ⇒ Automatic conversion ⇒ the same design decisions in the new system**
    - **Risk: compromised flexibility**

# Schema conversion: Physical vs Conceptual

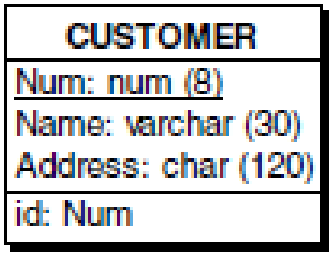
***Conceptual***

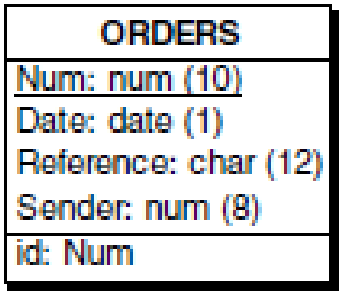



- **Refinement: Data and code may contain implicit constraints on the schema**
- **Conceptualization: Remove implementation details**

# Implicit constraints [Cleve, Hainaut 2008]

- **DB schema as defined by DDL commands**
- **Query**

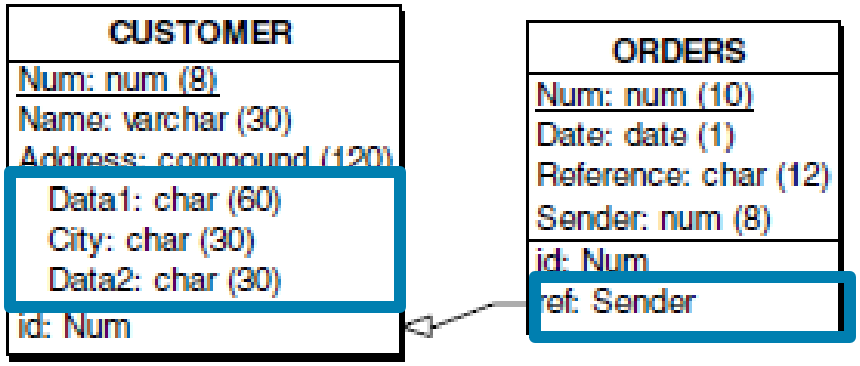



```
select substring(Address from 61 for 30) into :CITY
from CUSTOMER C, ORDERS O
where C.Num = O.Sender and O.Num = :ORDID
```

- **What are the implicit constraints implied?**

**Field refinement**




**Foreign key elicitation**

# Field refinement

- **Explicit**
  - **select substring(Address from 61 for 30) into :CITY**
- **Implicit: 4 code fragments**

**a) Local variable (“working storage”)_**

```
01 DESCRIPTION.
   02 NAME PIC X(20).
   02 ADDRESS PIC X(40).
   02 FUNCTION PIC X(10).
   02 REC-DATE PIC X(10).
```

**b) DB table (“file section”)**

```
FD CUSTOMER.
01 CUS.
   02 CUS-CODE PIC X(12).
   02 CUS-DESCR PIC X(80).
   02 CUS-HIST PIC X(1000).
```

**c)** `MOVE DESCRIPTION TO CUS-DESCR.`

**d)** `MOVE CUS-DESCR TO DESCRIPTION.`

- **CUS-DESCR and DESCRIPTION refer to the same data**
- **They should have the same structure**

# How can we elicit foreign keys?

- **Statically and dynamically**
  - **Do you remember the difference?**

- **Statically:**
  - **Parsing (easy for COBOL, difficult for Java)**
  - **M.Sc. thesis of Martin van der Vlist:**

  **“Quality Assessment of Embedded Language Modules”**

- **Dynamically:**
  - **Instrument the code**
  - **Capture traces**
  - **“Guess constraints”**

# Static approaches

- Look for programming clichés:
  - Data validation, modification, access
- Look at the attribute comparisons used
- Look at the variables produced by queries or imported to them

```
EXEC SQL
SELECT XAP626.HIA_HEFFINGSGRONDSLAG
        INTO :A4.HIA-HEFFINGSGRONDSLAG
FROM XAP626
WHERE (TO_CHAR(XAP626.HIA_DATUM_INGANG, 'YYYYMMDD')
                = :Q4.HIA-DATUM-INGANG
        AND
        XAP626.HIA_VOLGNUMMER = :Q4.HIA-VOLGNUMMER )
END-EXEC
```

# COBOL vs Java

## [vd Vlist, Roubtsov, Serebrenik, vd Brand 2009]

- COBOL: EXEC SQL END-EXEC quotes
- Java: Strings
  - Can be freely manipulated:

```
String sql = "SELECT cd.credit ";
sql += "FROM CustomerDetails cd" +
        "WHERE cd.category = " +
          this.getCategory();
if (this.restrict) {
          sql += " AND cd.restriction = 1";
}
sql += " AND cd.id = ?";
PreparedStatement s = this.con.prepareStatement(sql);
s.setInt(1, id);
ResultSet rs = s.executeQuery();
```

# Dynamic approaches

- **Look at the trace:**

```
select count(*) from CUSTOMER where Num = 'C400'
getInt(1) = 1
insert into ORDERS(Num, Date, Reference, Sender) values (456,'2008-06-20','PA601','C400')
select count(*) from CUSTOMER where Num = 'C152'
getInt(1) = 0
select count(*) from CUSTOMER where Num = 'C251'
getInt(1) = 1
insert into ORDERS(Num, Date, Reference, Sender) values (457,'2008-06-20','ST014','C251')
```

- **getInt(1) returns the number of tuples satisfying the preceding query**

- **What foreign key constraint can you guess here?**
  - **ORDERS.Sender = CUSTOMER.Num**

# Cardinality constraints: As defined

- **Local variable**
  - **Array of 20 elements**
- **DB attribute**

```
01 LIST-DETAIL.
  02 DETAILS OCCURS 20 TIMES
      INDEXED BY IND-DET.
    03 REF-DET-STK PIC 9(5).
    03 ORD-QTY PIC 9(5).
```

**Hainaut, Hick, Henrard, Roland, Englebert**

```
FD ORDER.
01 ORD.
  02 ORD-CODE PIC 9(10).
  02 ORD-CUSTOMER PIC X(12).
  02 ORD-DETAIL PIC X(200).
```

- **represent the same info** `MOVE LIST-DETAIL TO ORD-DETAIL.`

- **Hence, ORD can be associated to not more than 20 details (and not less than 0 details – trivial)**
  - **As defined**
  - **What about the use?**

# Cardinality constraints: As used

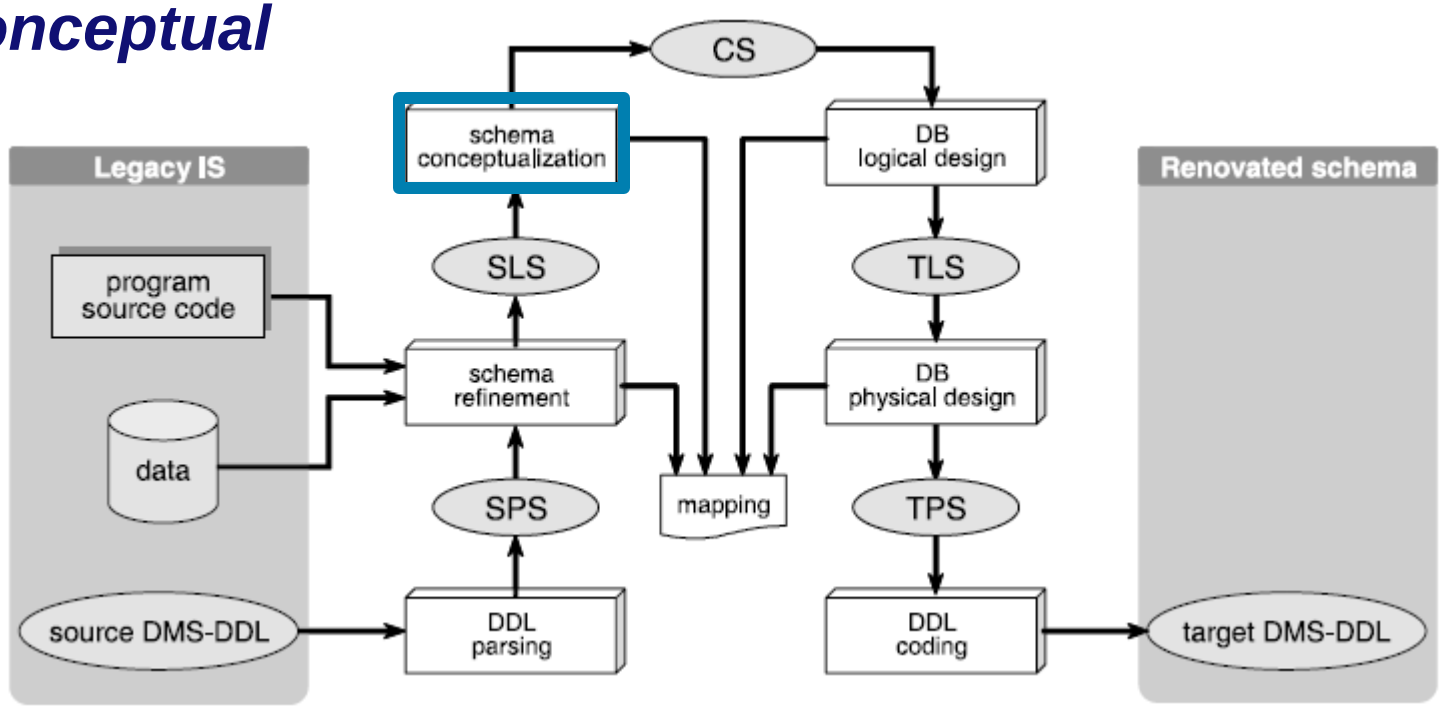
- **Look for list traversals: e.g., reading data**

```
SET IND-DET TO 1.
MOVE 1 TO END-FILE.
PERFORM READ-DETAIL
  UNTIL END-FILE = 0 OR IND-DET = 21.
MOVE LIST-DETAIL TO ORD-DETAIL.
```

- **Here: cardinality as used = cardinality as defined**
  - **Not always the case**

# Schema conceptualization

***Conceptual***




- **So far we only added complexity to the schema**