Computers and Knowledge

Franz J. Kurfess

Computer Science Department
California Polytechnic State University
San Luis Obispo, CA, U.S.A.

CAL POLY

Acknowledgements

*Some of the material in these slides were developed for a lecture series sponsored by the **European Community***

*under the **BPD program***

*with **Vilnius University***

as host institution

CAL POLY

Use and Distribution of these Slides

These slides are primarily intended for the students in classes I teach. In some cases, I only make PDF versions publicly available. If you would like to get a copy of the originals (Apple KeyNote or Microsoft PowerPoint), please contact me via email at fkurfess@calpoly.edu. I hereby grant permission to use them in educational settings. If you do so, it would be nice to send me an email about it. If you're considering using them in a commercial environment, please contact me first.

Overview Computers and Knowledge

- Motivation
- Objectives
- Evaluation Criteria
- Chapter Introduction
  - Bridge-In
  - Review of relevant concepts
  - Overview new topics
  - Terminology
- Data, Information, Knowledge
- Knowledge Management
- Computer Support
- Example: Great Pyramids
- Case Study: KM for Course Preparation

Logistics

- Introductions
- Course Materials
  - textbook
  - handouts
  - Web page
  - CourseInfo/ Blackboard System and Alternatives
- Term Project
- Lab and Homework Assignments
- Exams
- Grading

The Proliferation of Knowledge

- Wall street
  - no physical assets
  - make money by utilizing knowledge about investment opportunities
- consultants
  - have knowledge about some specialized tasks
  - tell customers what to do
  - may be gone by the time their solutions are found to be flawed
- "energy brokers"
  - companies that don't own any physical facilities, but buy and sell energy
  - made enormous profits during the 2000/2001 energy crisis

Background

- How much knowledge do you manage?
  - in your job
    - student
    - instructor
    - researcher
  - in your private life
- What are your roles concerning knowledge?
  - consumer
  - facilitator
  - producer

Motivation

- the amount of information and knowledge available increases steadily
  - it becomes difficult to keep track of relevant knowledge
- the demands for applying knowledge to a particular task also become stronger
  - job expectations
  - competitive pressure
- the benefits from utilizing knowledge become greater

Objectives

- be aware of the role of knowledge in professional and private life
- understand the impact of knowledge (or lack of it) for important decisions
- understand the necessity for knowledge management to deal with the large amount of knowledge and information
- explore the role of computer-based tools and technologies for knowledge management

Terminology

- Data
- Information
- Knowledge
- Wisdom

Data, Information, and Knowledge (DIK)

- good overview:
  - Liew, A. (June 2007). Understanding Data, Information, Knowledge And Their Inter-Relationships. Journal of Knowledge Management Practice, Vol. 8, No. 2 . http://www.tlainc.com/articl134.htm
- often visualized as "knowledge pyramid"

Data

- described by schematic arrangements
  - e.g. data bases, tables, spreadsheets
- contents of fields (slots cells) are the data values
  - values are meaningless without the schema

Information

- data together with the relevant context
  - context may be explicit or implicit
  - examples:
    - train schedule
    - addresses, phone numbers
    - instructions for preparing a recipe

Knowledge

- knowledge characteristics
  - meaningful only with respect to humans
  - context-sensitive
  - may be elaborate
  - may be explicit or tacit
    - explicit knowledge consists of documented facts
      - frequently objective
      - can be “spelled out”
    - tacit knowledge is in people’s heads
      - frequently subjective
      - surfaces through interaction

[Knowledge Ability 1998]

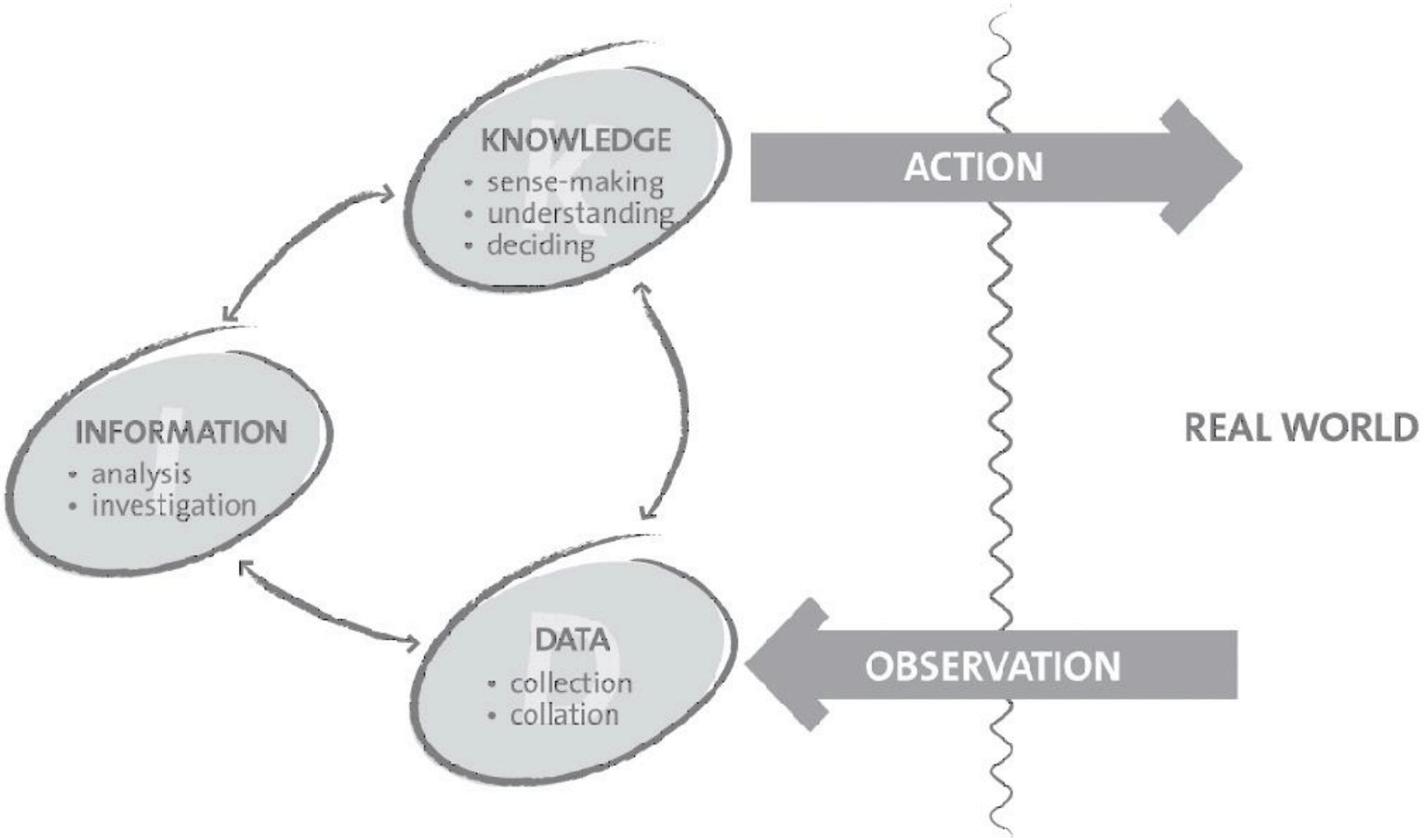
Wisdom

- requires aspects beyond knowledge
- factors relevant for wisdom [Etzold 2008]
  - social competence
  - openness
  - intensive learning and practical experiences
  - education
  - talent for mentoring

DIK Pyramid

http://healeylibrary.wikispaces.com/space/showimage/knowledge_pyramid.jpg

DIK as Graph



http://delarue.net/blog/wp-content/uploads/2007/08/kmmodel.JPG

What is Knowledge Management?

- information technology perspective
  - computers as support tools for dealing with large quantities of knowledge and information
- business perspective
  - benefits for organizations
- philosophical perspective
  - epistemology: what is knowledge?

Knowledge Management Definitions

- Karl-Erik Sveiby (Organization Theorist)
  Knowledge Management is the art of creating value from an organization's intangible assets.
- John Gundy, Knowledge Ability (KM Company)
  Knowledge Management is the process of placing knowledge under management remit.

[Sveiby 2000]

Computer Support

- capabilities
- limitations
- human-computer interaction aspects

Capabilities

- speed
  - lots of simple operations at extremely high speeds
- storage capacity
  - approaching Terabytes for personal computers
- methods
  - algorithms to perform specified functions
  - limited errors
  - objective

Limitations

- semantic gap
- very limited learning
- no “common sense”
- effective use of computational power
  - speed
  - storage capacity

Semantic Gap

- practically all computer operations performed at the syntactic level
  - "symbol manipulation"
- no consideration of (intended) meaning
- humans automatically interpret items under examination
  - "parasitic interpretation" of symbols (names)

Human-Computer Interaction

- computers are essential tools when humans deal with knowledge
- the current support to let humans utilize knowledge effectively is very limited
  - syntax-oriented search (strings/key words)
  - storage
  - organization largely done by humans
  - tool limitations
    - only suitable for professionals
    - limited capabilities

Example Computers and Knowledge: The Great Pyramids

- using computers to explore potential solutions to the mystery of how the Egyptian pyramids were built
  - information storage
    - documents, facts, ...
  - interpretation of information
  - knowledge organization
  - knowledge presentation and visualization
  - knowledge verification

Knowledge and the Great Pyramids

- How did the Egyptians build these monumental edifices?
- technology available at the time
- theories about building pyramids
- plausibility of these theories

Available Technologies

- soft metals, mostly copper
  - no iron
- logs, beams
  - apparently no wheels
- sculpted blocks of stone
  - maybe early forms of concrete

Pyramid Theories

- over time, a number of different theories (hypotheses) have bee proposed
  - outer ramp
    - long ramp leading to the current level
    - increased as the pyramid grows
  - inner ramp
    - outer ramp for the lower levels, used up for higher levels
    - spiral inner ramp, together with levers and counterbalances
  - lifting mechanisms
    - machines that allow the lifting of the large blocks to

Convincing Arguments

- What does it take to convince you about the plausibility of a theory?
  - common-sense explanations: may sound good, but gloss over important issues
  - diagrams: illustration of essential methods
  - models: computer-based, small-scale
  - scientific papers: peer reviewed, calculations, incomprehensible to ordinary mortals
  - simulations: 3D CAD, animated, physics engines
  - reconstruction: building (parts of) the real thing

Case Study: KM for Course Preparation

- easy case: re-use existing material
  - text book, presentation material, student assignments, exams, projects
- difficult case: brand-new course
  - no existing material suitable for teaching purposes
  - existing sources
    - research monographs, edited volumes, related text books, conference proceedings, journal special issues, articles, technical reports, white papers, company brochures, Web pages

Course Development as KM Application

- problem
  - development of a course outline
  - identification of relevant material
  - extraction of relevant knowledge
  - integration of various knowledge pieces
    - different representation media
      - paper (books, journals)
      - microfilm
      - digital (electronic versions of books, journals, etc; Web pages; data bases, computer programs)
  - presentation of knowledge
    - presentation medium
  - identification of evaluation criteria
  - development of exercises

Tools for Course Preparation

- course outline — *brain, paper, editor, spreadsheet*
- identification of material — *brain, paper (printed material), search engines, library catalog/DBs*
- organization of material — *brain, folders, labels, directories, files*
- extraction of knowledge — *brain, paper, text editor, helpers*
- integration of pieces — *brain, presentation program, helpers*
- presentation of knowledge — *brain, presentation program*
- evaluation criteria — *brain, text editor*
- development of exercises — *brain, text editor, helpers*

- *color scheme*
  - *red: brain green: paper yellow: computer support*

Deficiencies of tools

- much of the tedious work is left to the instructor
- little support for important knowledge management activities
- primitive tools are used for high-level tasks
  - directories, file names for the categorization of knowledge items

References

[Etzold 2008] Sabine Etzold, *Alte an die Arbeit*. Zeit, 6. März 2008, S. 34. (Article on the work of Prof. Ursula Staudinger on aging and wisdom).

Liew, A. (June 2007). *Understanding Data, Information, Knowledge And Their Inter-Relationships*. Journal of Knowledge Management Practice, Vol. 8, No. 2 . http://www.tlainc.com/articl134.htm

Important Concepts and Terms

cognitive science
computer science
data
information
interpretation
knowledge
knowledge management
knowledge pyramid
learning
semantics
syntax
wisdom

Summary Computers and Knowledge

- with the increase in the amount of information and knowledge, knowledge management will play a very important role in our professional and personal lives
- although a lot of knowledge is available in digital form, computer support for KM is mediocre
- many basic techniques and methods have been developed, but their integration into easily usable systems and tools is still