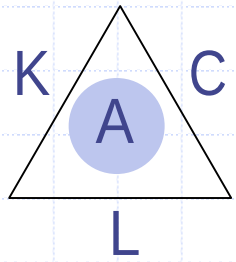
Soar-based Technology: A Perspective



Robert Wray

Soar 21

5 May 2001

Soar Technology

Soar-based Technology

- Soar has been around a while now…
  - Research programs in several different areas of science have used Soar
  - Research often leads to applications
    - What technologies have been developed in/for Soar?
    - What applications have been developed?
    - Is there/Can we create a technology infrastructure that everyone in the community can leverage for future R&D?
    - (What should applications be telling us about the enterprise of “Soar science?”)
- This talk: Review some areas of research
  - Biases
    - Technology perspective (artifacts)
    - Soar-based perspective (not infrastructure/tools)

Soar: Major Areas of Interest

A. Processes for general intelligence
   - Explore the architecture

K. Knowledge-level reasoning/performance
   - Explore the generality of the architecture

C. Models of human cognition
   - Explore what the architecture relates about human cognition

L. Integration of learning and reasoning
   - Explore how the architecture aids/drives adaptation

Soar:Recent Research (90's)

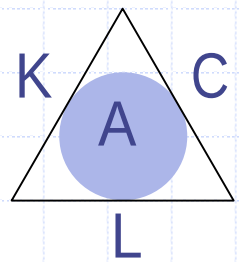
A. Processes for general intelligence
   - Soar 8 (ensure consistency in asserted knowledge)

K. Knowledge-level reasoning/performance
   - STEAM (model of teamwork)

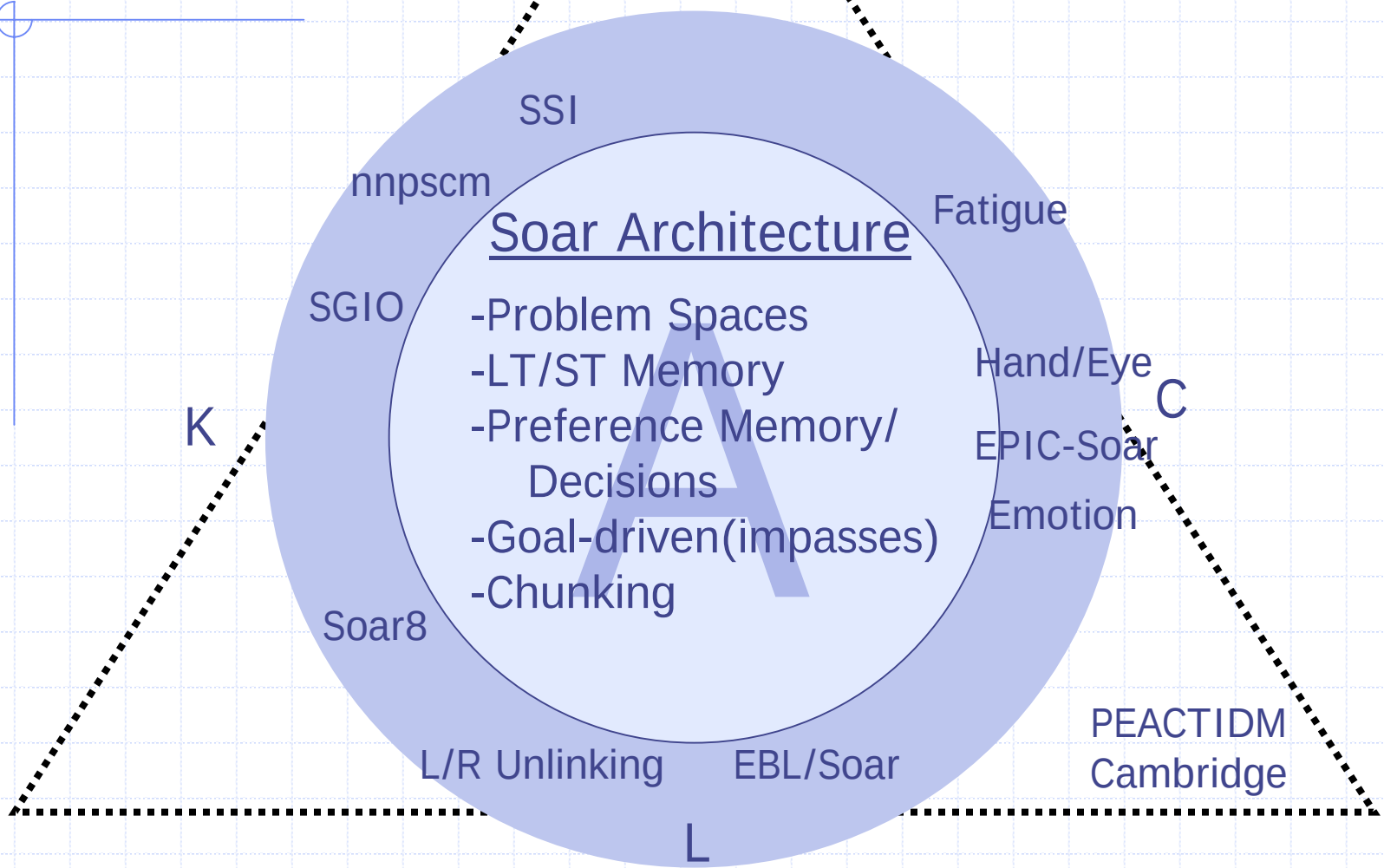
C. Models of human cognition
   - NL-Soar, NASA Test Director, Soar-Hand/Soar-Eye

L. Integration of learning and reasoning
   - IMPROV (correcting errors in knowledge via learning)

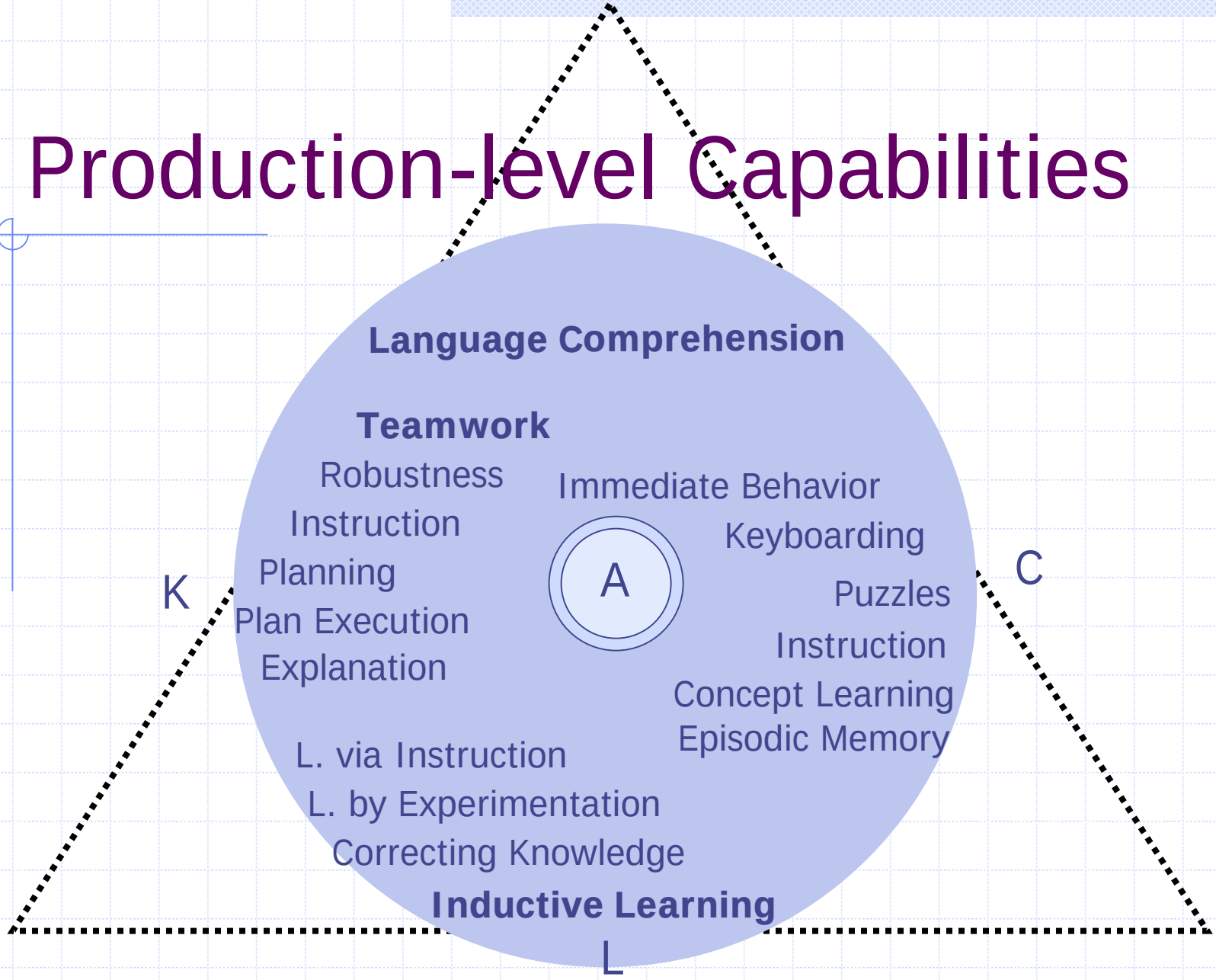
Let's look at a lot of examples...



Soar Architecture Technology

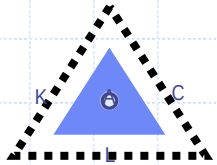


Production-level Capabilities



Production-level Technology

- Architectural technology generally transfers to the entire community
- Production capabilities have not transferred
  - Few systems seem to incorporate previously existing production-level capabilities
    - Is there “re-inventing the wheel” at the production level?
  - Little production-level technology has been “componentized”
    - Exceptions:
      - Inductive Learning: Data Chunking
      - Teamwork: STEAM
      - Language: NL-Soar
  - Can production-level capabilities really be transformed/represented as reusable technology?



Experimental/Research Systems

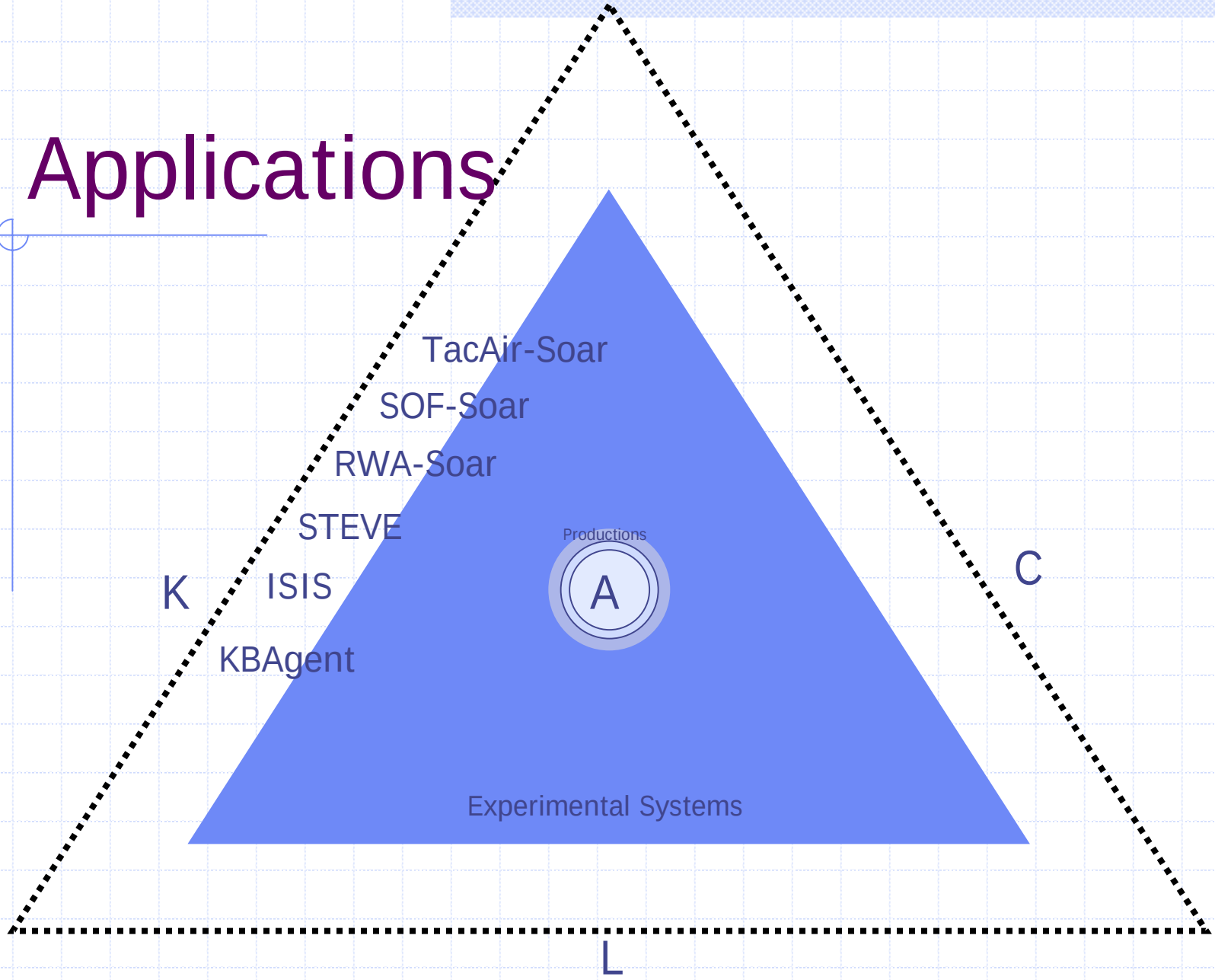
- Multitude of research systems
  - Examples
    - K: TacAir-Soar
    - L: IMPROV
    - C: NASA Test Director
- Systems provide a testbed to study phenomena of interest to the researcher

Experimental systems are usually so specialized that they seldom provide standalone technology that others can utilize in their work...have (generally) not been a source of technology.

Applications

- Artifacts that have use outside of the pursuit of research questions
- Reusable technology is critical to the development of applications
  - Provides a way to move research successes into applications more easily, quickly, cheaply, etc.
- An important result of scientific endeavor
  - *"Applications provide crucial ingredients for the overall basic scientific enterprise. They provide the successes that convince the polity that the science is worth supporting. [Applications] establish what is worth predicting, what accuracy is sufficient, what regularity is worth remembering. They establish when a theory should not be discarded."*
    [Newell, *UTC*]

Applications



What do applications reveal?

- Soar is finding a niche in knowledge-level, (soft) real time performance? HBR?
  - TacAir-Soar (*fait accompli*?)
- Why is learning not used in applications?
  - Not needed by users/customers?
  - Verification and validation issues?
  - Will Soar8 lead to more applications with learning?
- No HCI/cognitive science applications?
  - Newell thought HCI would be Soar's "killer app"
    - Recent developments: Soar-Eye/Hand, EPIC-Soar
      - Only now is there a sufficient technology base on which to build HCI applications?

Other Infrastructure

"Building application domains creates a community with a large investment in ease of use, and hence with a willingness to expend the effort to make the tools to make [supporting and invigorating a theory] happen."
[Newell, *UTC*]

- Knowledge Acquisition
  - TAQL
  - KnoMic
- Development Tools
  - Visual Soar
  - sdb
  - ...
- GUIs and Interaction
  - Standard General I/O
  - Tcl/tk
  - Agent Communication Language implementation by Soar 22?

Other Research in the 1990's

A. Processes for general intelligence
   - Reasoning under uncertainty, probabilistic methods

K. Knowledge-level reasoning/performance
   - Agent revolution: communication, interoperability, general representations, applications

C. Models of human cognition
   - Sub-symbolic mechanisms (connectionism, ACT-R)

L. Integration of learning and reasoning
   - Agent-based reinforcement learning

Do we/can we/how do we get similar results in a Soar framework?

Conclusions

- Past 10 yrs: Soar has matured from an "in-the-head" reasoning system to a fully situated architecture
  - Evidence for mechanisms of general intelligence
- Can we truly leverage disparate work?
  - How do we package production-level capabilities?
    - OO metaphor → methodology?
  - What other technologies are critical to develop? Tools?
- What will be/should be the application focus for the next 10(?) years?
  - *"Soar will survive [other approaches and theories] as long as there is a domain for which Soar is being used and for which [the other approaches] are not particularly relevant. If Soar turns out to be no good for applications…. it simply fades away."* [Newell, *UTC*]