Using CORBA Messaging, Real-Time Event Service and ORB Concurrency Models in a Real-Time Embedded System

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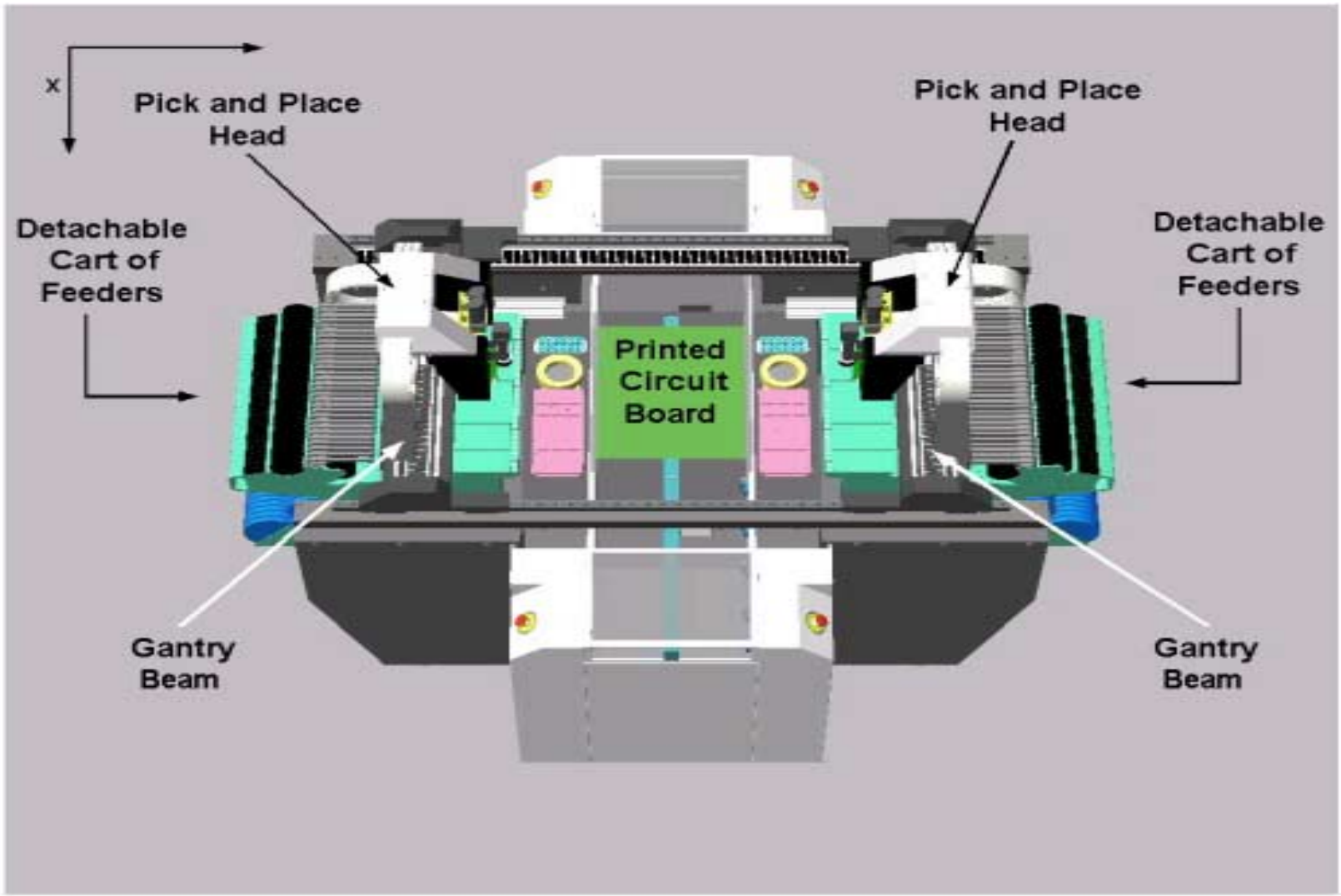
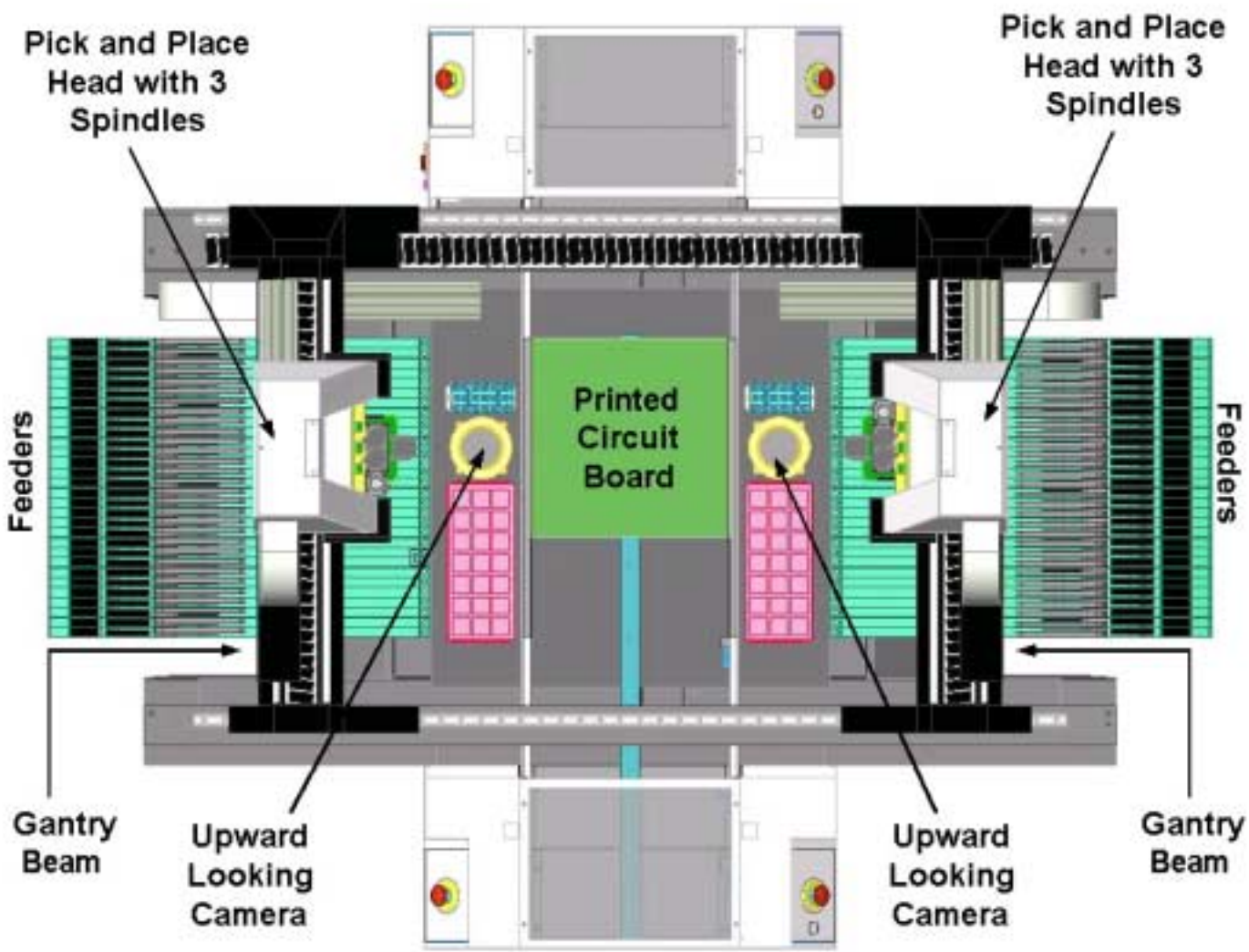
Surface Mount Technology (SMT) Automated Assembly Equipment

Machines that combine high speed and precise positioning and placement of devices onto printed circuit boards

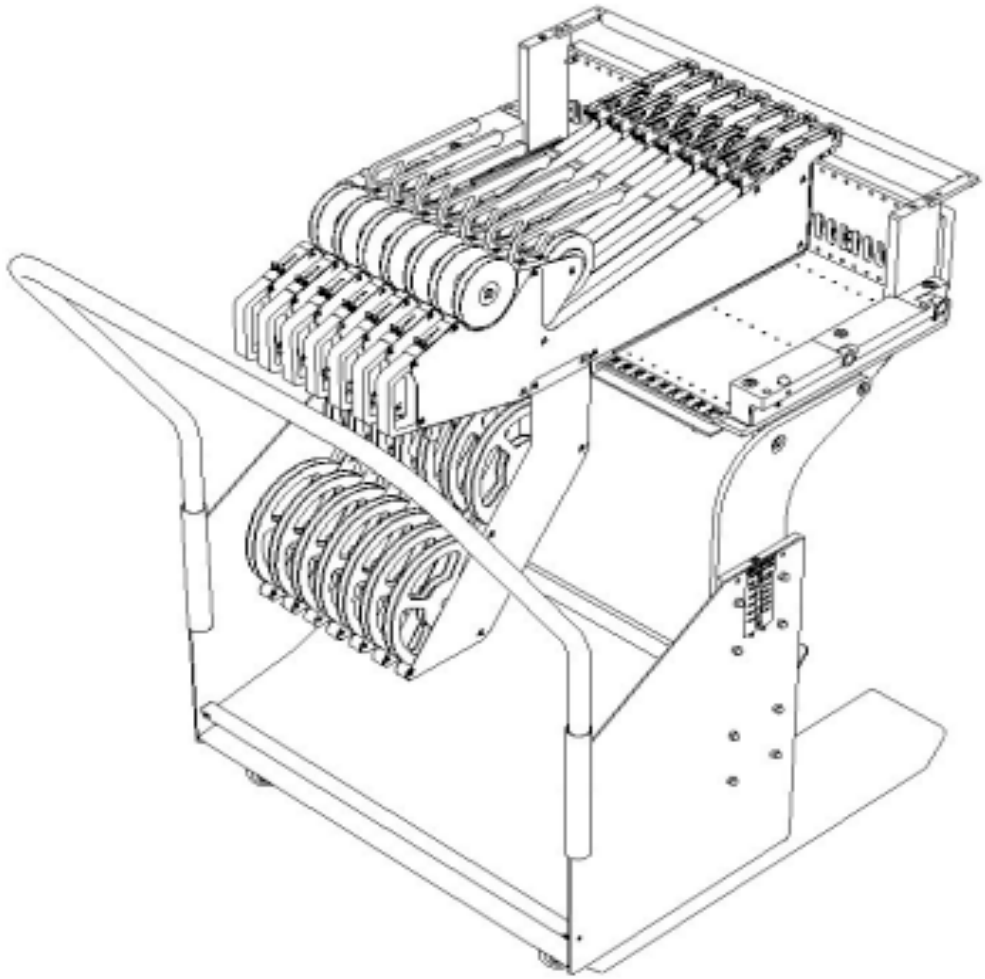
Under the hood:



A Closer Look



The Cart Subsystem



Concurrent Tasks

- **Motion Control**
- **Vision**
- **Update**
- **Feeder Actuation**
- **GUI**

SMT Assembly Equipment Industry Dynamics

- **Increased Global Competition**
- **Increased Performance Requirements from Customers**
- **Integrated Manufacturing Environment**
- **Shorter Time-to-Market Windows**

Reasons for “Going Distributed”

- **Separation of concerns**
- **Increased performance requirements**
- **Modularity requirements**
- **Third party software platform requirements**

CORBA Features Used:

- **Two-way Synchronous Method Invocations**
- **Naming Service**
- **CORBA Messaging (AMI and Client-Side Timeouts)**
- **Real-Time Event Service**
- **COSEvent Service**
- **Interoperable functionality with a Java ORB**
- **Advanced use of the POA**
- **ORB-Controlled Concurrency Model**

Two-way Synchronous Method Invocations

- **The problem we are trying to solve**
- **Simplification of programming for non-networking programmers**
- **object->operation() model key for fast development – very well received by programmers new to distributed systems**
- **Selective Ignorance with Object References – pointers on steroids**
- **Keep effort on the problem domain of picking and placing parts, not on the solution domain.**
- **Program the machine as if it were one system.**
- **CORBA implementation meets the real-time constraints of out problem domain.**

Naming Service

- **The problem we are trying to solve**
- **Primary bootstrap mechanism for all parts of the machine.**
- **Used in conjunction with DHCP server**

CORBA Messaging (AMI)

- **The problem domain – maps directly to "fire and forget" messaging model. Vision System, Feeder System, Cart System**
- **Need response but not right now**
- **Decoupled invocation from execution simplifies application programming. Obviates the need for the application to supply the mechanism. Simpler compared with application level solutions.**
- **Works well in conjunction with concurrency models on the server side – Thread-Pool Reactor**
- **Callback model obviates polling.**
- **Performance**
- **Choice of AMI strategies maps to our problem domain**
  - **Servant-per-AMI-call strategy (i.e. use a different reply handler for each request)**
  - **Activation-per-AMI strategy (i.e. use the POA dynamic activation mechanisms to distinguish between all requests)**
  - **Server differentiated-reply strategy (e.g. return some kind of request ID from the server)**

CORBA Messaging (QoS Framework)

- **The problem domain – maps directly**
- **Parts of the machine become disconnected regularly and routinely in the course of running the machine.**
- **Once again, pushed the responsibility onto the ORB infrastructure and thus off of the application code. Simpler faster development**
- **Localize timeouts only to the areas that require it – ORB, Thread and Object level policies.**
- **More control over distributed system idiosyncrasies**

Real-Time Event Service

- **The problem domain – smart distributed observer pattern needed between Cart, Controller, Host Systems**
- **More control over event notification – using subscription and filtering**
- **Certain performance-critical systems cannot be bothered with all events**
- **Handles ill-behaved suppliers and consumers**
- **Benefits**
  - **More Efficient Event Management**
  - **Less Network Traffic**
  - **Simpler Application Programming**
  - **Decreased Consumer Load**

Use of C++ ORB with Java ORB

- **Allows powerful, responsive user interfaces for embedded systems with no keyboard or display**
- **embedded system microweb server serves back Java applet which thereafter communicates with server via CORBA calls.**
- **Interoperable with the main C++ ORB framework of the machine.**
- **Aid in development/testing**
- **Used by tech support**
- **Used by manufacturing personnel for monitoring.**
- **COSEvent Service**

Portable Object Adapter

- **The problem domain – Cart example**
- **Use of servant activators simplifies application programming while economizing resources**
- **Hierarchy of POAs**
- **Reference-counted servants**

ORB Concurrency Model

- **The Problem Domain – The cart as an example**
- **Thread-Pool Reactor**
- **Simplification of programming at the application layer – borrow multiple threads from the ORB infrastructure upcalls. Simpler compared with alternatives without it.**
- **In combination with client-side AMI, ORB concurrency model on the server side gives us a complete working-out-of-the-box framework that solves a large portion of our programming concerns.**

Conclusion

- **Benefits of intuitive mapping onto the object->operation() paradigm.**
- **Fast Development – use of CORBA services**
- **CORBA Messaging directly maps to problem domain**
- **Problem at hand is one of application-problem-domain programming combined with integration of ORB enabled subsystems. Much easier than reinventing it all.**
- **CORBA meets our real-time and performance requirements while providing many other benefits**
- **CORBA Middleware vital for our real-time embedded application.**