

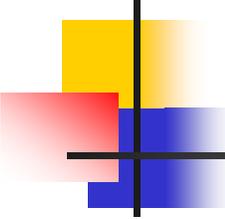


Continuous Twin-Screw Processing Technology Overview

Kirk Newman

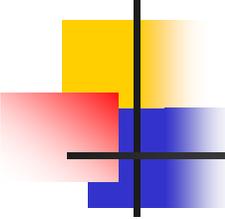
Connie Murphy

May 2001



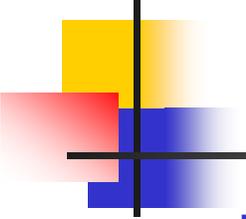
Weapon System Needs

- Improved performance
 - Greater standoff
 - Smaller packaging
 - Improved lethality
 - Greater safety
- Reduced Life-cycle cost
 - Reduced dependence of cost on volume
 - Longer service life
- Continued availability
 - Less environmental impact during manufacture
 - Flexible manufacturing



Continuous Processing Objectives

- Continue to provide leading edge energetic solutions
- Reduce cost of facility ownership
- Reduce time and cost to take products from R&D to manufacturing
- Improve safety of operations and materials
- Reduce environmental impacts
- Enhance transition of technology to industry

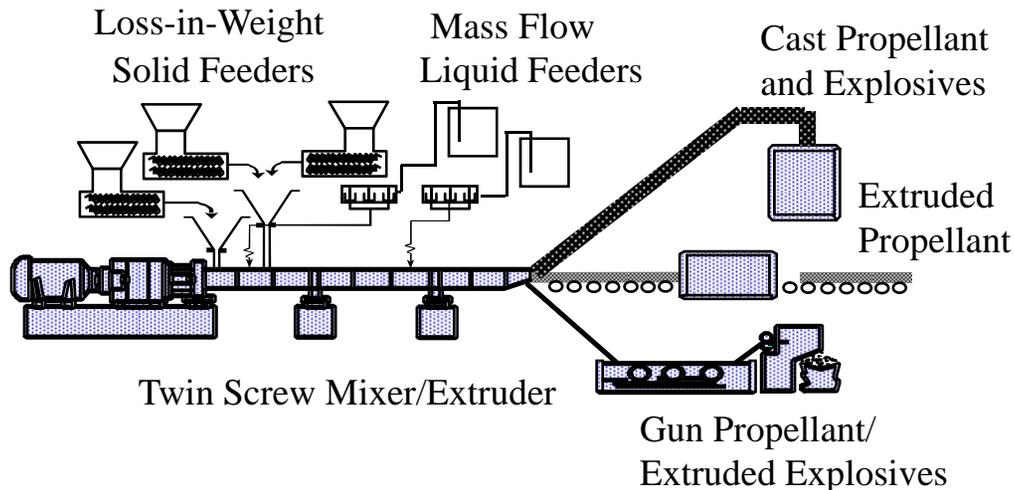


Approach

- Establish a continuous processing scale-up capability
 - Clextral 88-mm extruder
 - Product development capability
- Enhance technical capability at pilot scale
 - W & P 40-mm extruder (MD), and Teledyne Readco 2-in compounder (Yorktown, VA)
 - Process research and development
- Develop research scale capability
 - Theyshon 20-mm extruder
 - Formulation research
- Establish a manufacturing science program

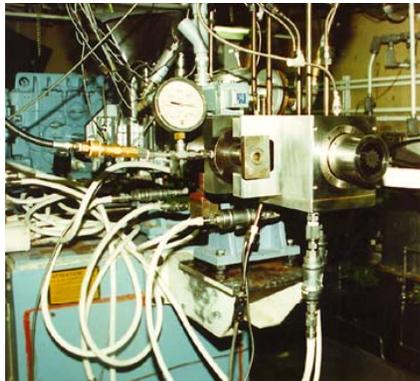
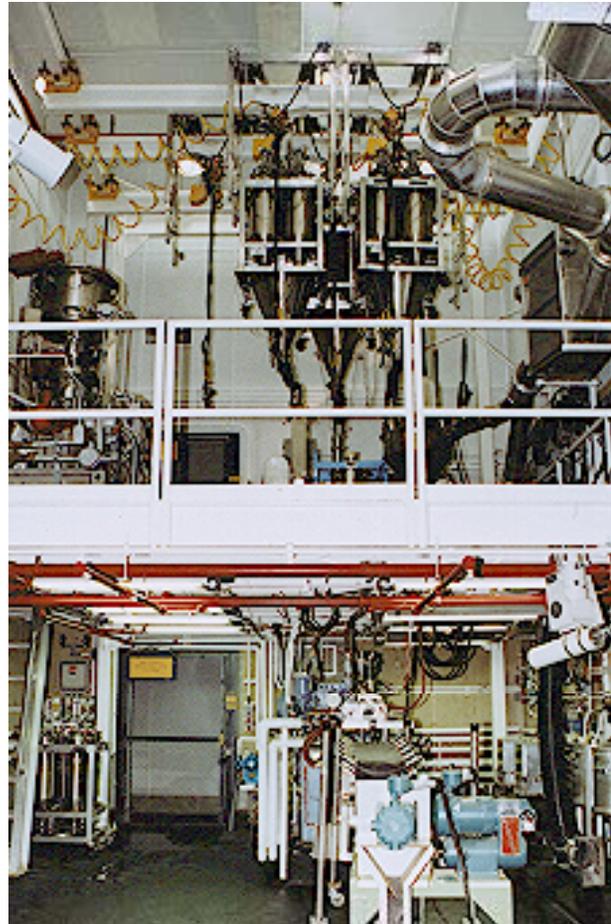
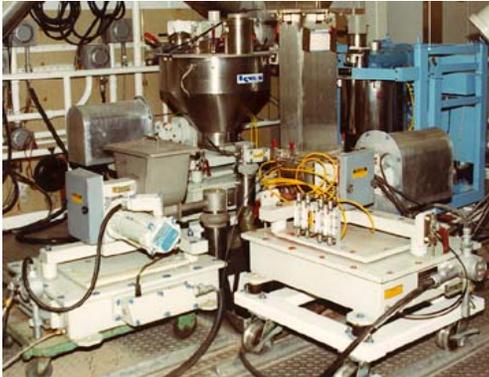
Continuous Processing Scale-Up Facility

- FY 99 MILCON P-158
- Clextral 88-mm extruder
- Product development capability
- Operational in Spring 2002



- Scale-up continuous processing technology
- Validate and quantify benefits
- Transition technology to industry
- Transition new materials from R&D into use
- Support variety of energetics requirements (first being nitramine propellant for Navy guns)

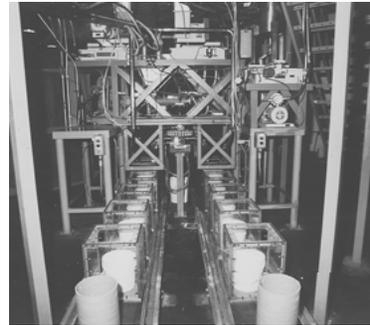
Pilot Scale Facility (Indian Head, MD)



W&P 40-mm extruder
Building 1119

- New products
 - Double base propellants
 - Functionally graded energetics
 - Co-layered gun propellants
 - High solids explosives
- New capabilities
 - GEM propellant molding system
 - Operation in Summer 2001
 - Gun propellant strand handling & cutting system
 - Operational in Summer 2001
 - Co-extrusion
 - 37-mm extruder, operational in approx. 9 months

Pilot Scale Facility (Yorktown, VA)

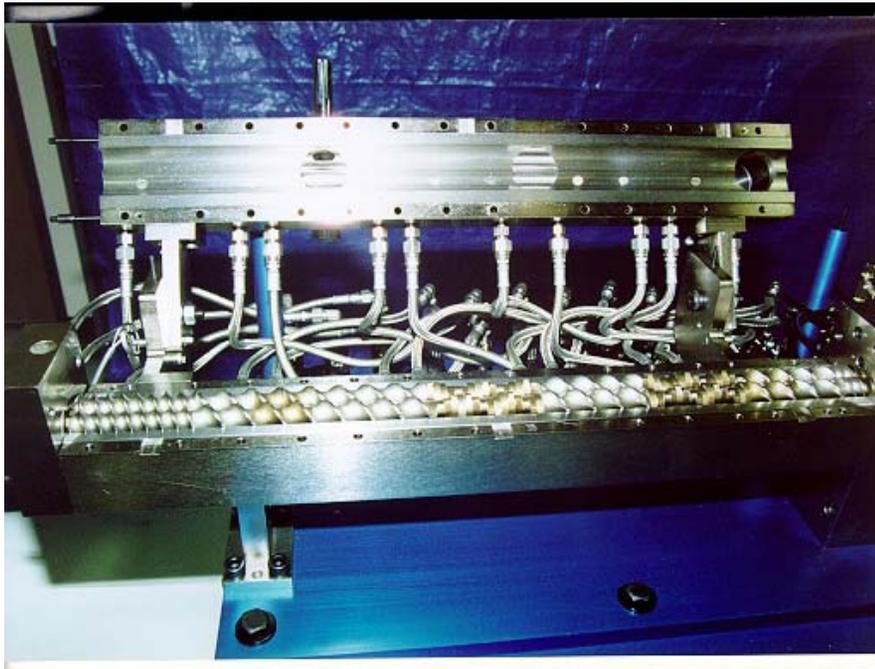


Teledyne Readco
2-in compounder
Building 1755



- Products
 - Polyurethane PBX
 - Polyarcylate PBX
 - Warhead loading demos
- Capabilities
 - Automated vacuum casting
 - Real time QA based upon feed forward PC/PLC control of LIW feeder data
 - Injection Loader system
 - high solids PBX
 - high quality
 - versatile
 - submunitions
 - warheads
 - explosive rope

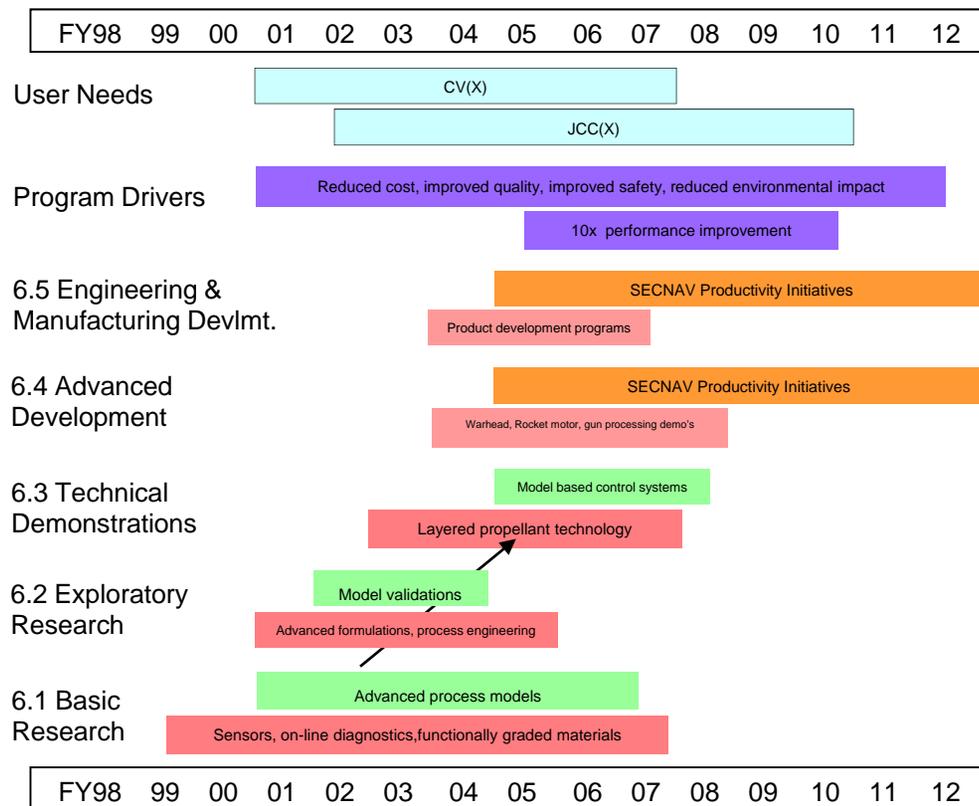
Research Scale Capability



- Formulation development
 - Need to formulate for the continuous twin-screw process
 - Utilize torque rheometer
 - Currently installing 20-mm twin screw capability for initial formulation studies
 - Operational in approximately 6 months
- Begin to address scale-up issues

Manufacturing Science

Indian Head Continuous Processing Technology Roadmap - Under Construction



S&T program in energetics manufacturing focusing on continuous processing

■ Areas of interest

- Second generation mathematical models
- Enhanced rheological characterization
- New sensors for on-line process and quality analysis
- Improved process understanding
- Data management