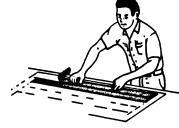


# Automated Tape Lamination

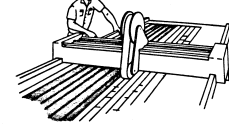
ver 1

## Tape Lay-up Methods

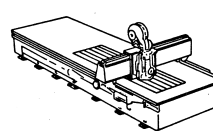
Hand Lay-up



Hand-assisted Flintstone

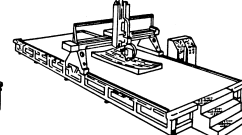


(a) Numerically Controlled Machine



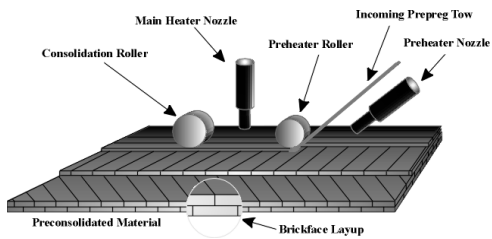
(c)

(b) Numerically Controlled Machine Lay-up Directly on Tool

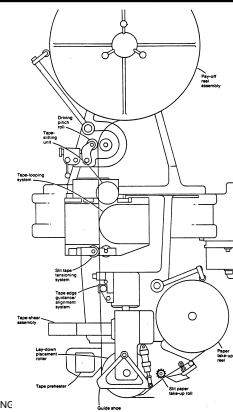


(d)

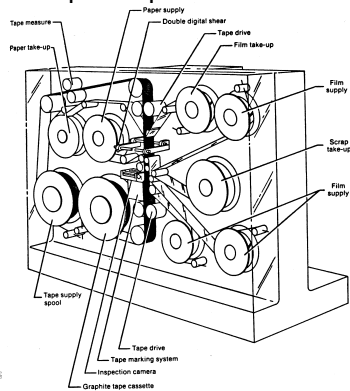
## Automated Tow Placement - Thermoplastics



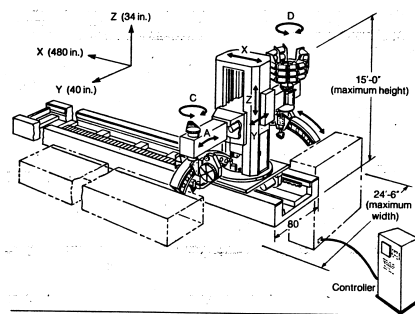
## Atlas Tape-Laying Head



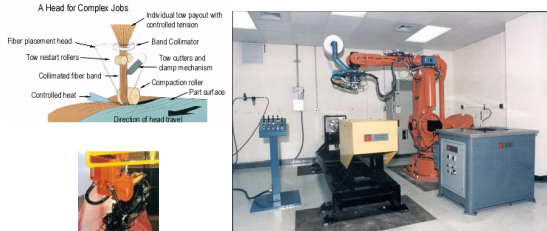
## Access Tape Preparation Machine



## Combination Tow/Roving Placement and Tape Placement Machine

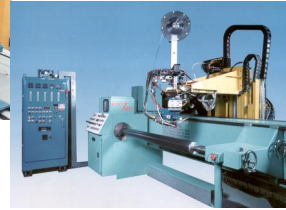


## Robotic Thermoplastic ATP Machine

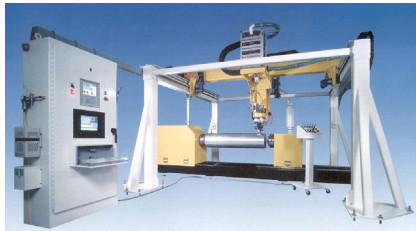


NASA Langley

## Filament Winding Thermoplastic ATP Machines



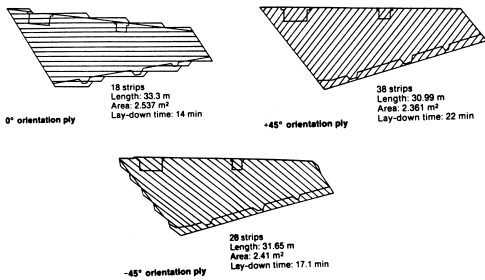
## Filament Winding Thermoset ATP Machine



## Large ATP Machine



## Three Full Plies of Composite Tape Laid Up In 0°, +45°, and -45° Orientations



## Typical Parts



## Automated Tape Lamination Evaluation

- **Investment**
  - High Capital equipment
  - "Normal" tooling
- **Materials**
  - Mostly paper-backed UD thermoset tape
  - Some thermoplastic tape (requires hot head)
  - Multiple towpregs recently (more complex shapes without wrinkling)
- **Processing**
  - Can be fast
  - Low labor
  - Hazards remote
- **Quality**
  - High mechanical properties
  - Defects low
  - Consistent parts
- **Products**
  - Low volume
  - Moderate areas
  - Simple contours
  - High cost (maybe not in the future)