

# Overview of Successes in the ATS Materials & Manufacturing Support Program

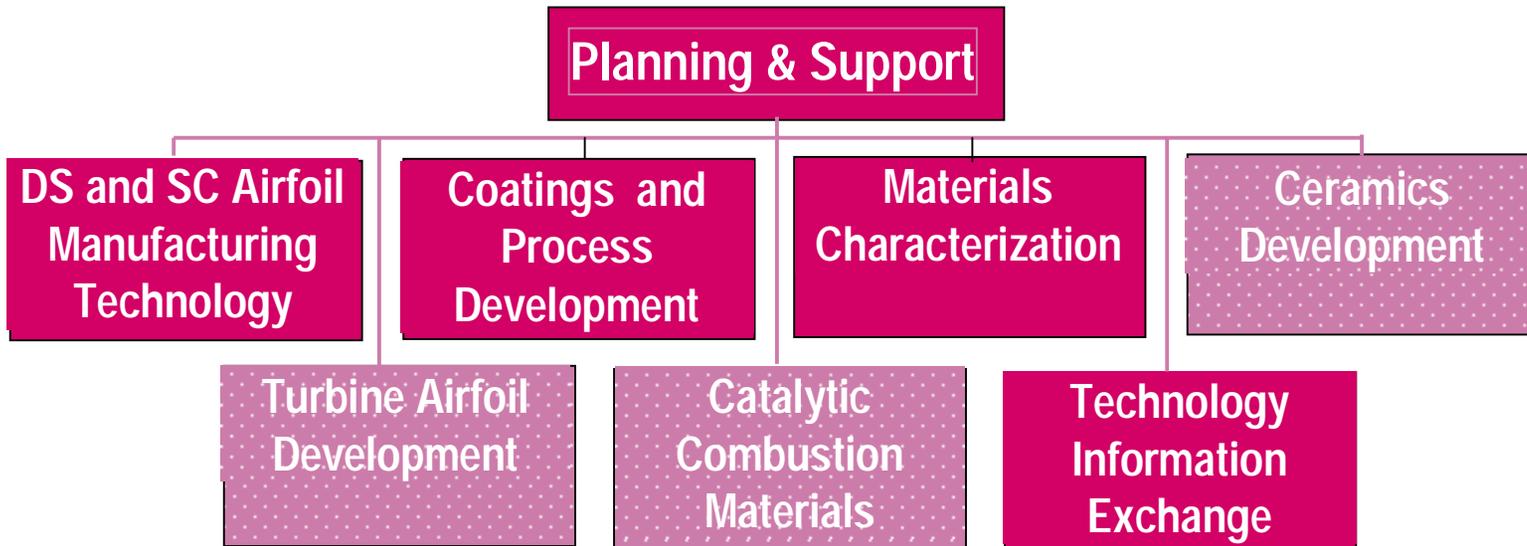
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# Aims of the Materials & Manufacturing Support Program

- Intended to complement the efforts of the ATS teams by addressing materials and manufacturing issues where the required techniques, facilities and expertise are not available to any single company
- Predominantly aimed at mid- to longer-term needs
- Based on an assessment of needs expressed by OEMs and suppliers

# Implementation

- Prioritization
- Definition of programs to address identified needs
  - RFP route
  - formation of teams
  - fiscal management and technical oversight
  - *successes are the result of team efforts*



# Manufacture of Single Crystal Superalloy Castings

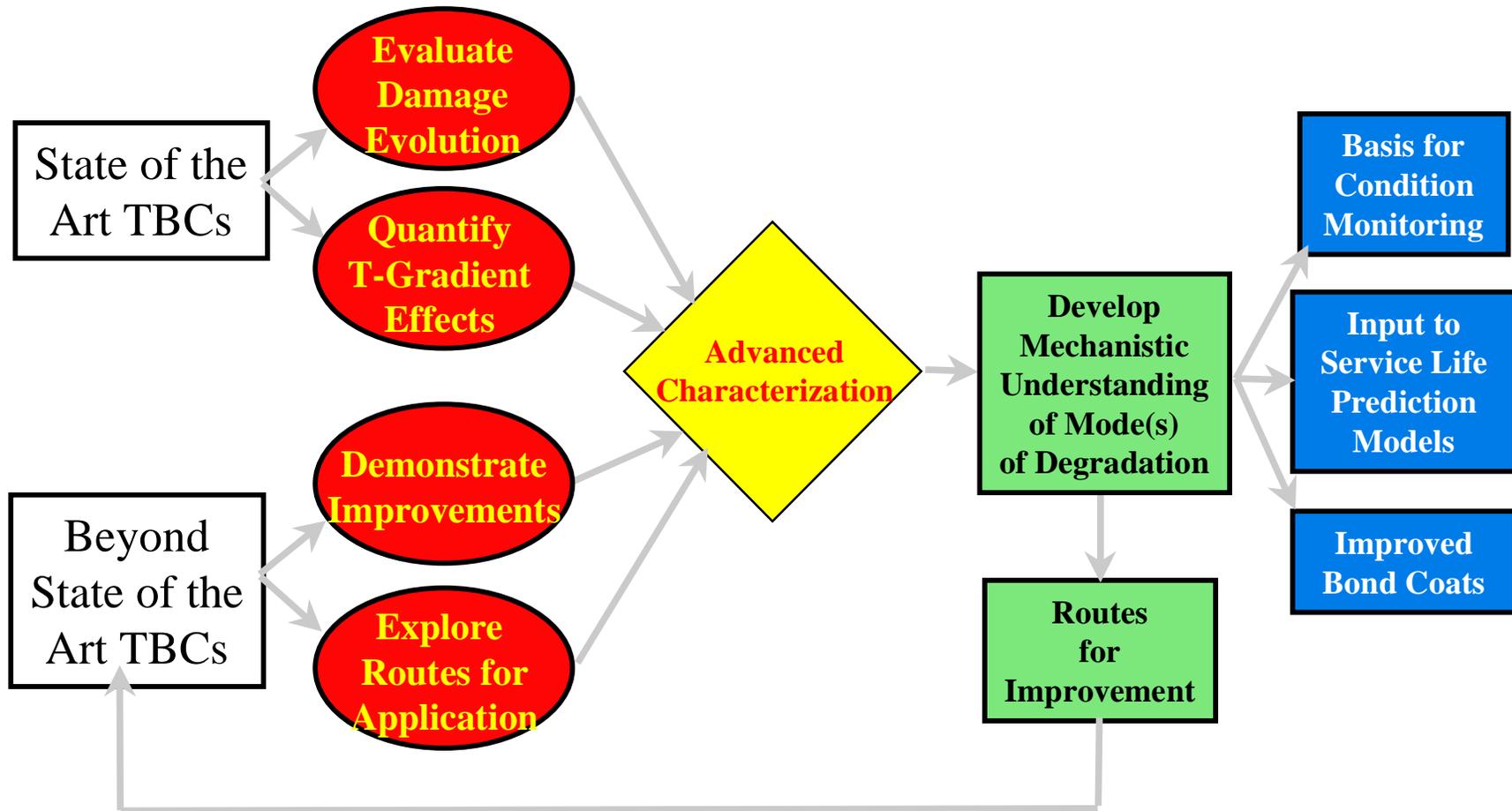
- Scale-up of processes used for aircraft components (**Howmet & PCC Airfoils teams**)
  - *large castings; low-S castings; improved cores*
- Modifications to optimize VIM SC process for IGT components (**Howmet team**)
  - *heat flow management, mold materials*
- High thermal gradient variant (**GE team**)
  - *reduced casting time; improved control of microstructure—defect-free airfoils; improved cores and molds*
- Fabricated airfoil approach (**Siemens Westinghouse team**)
  - *eliminate need for cores, improved control of wall thickness; evaluate cost effectiveness*

# Improved TBC Performance and Manufacturing

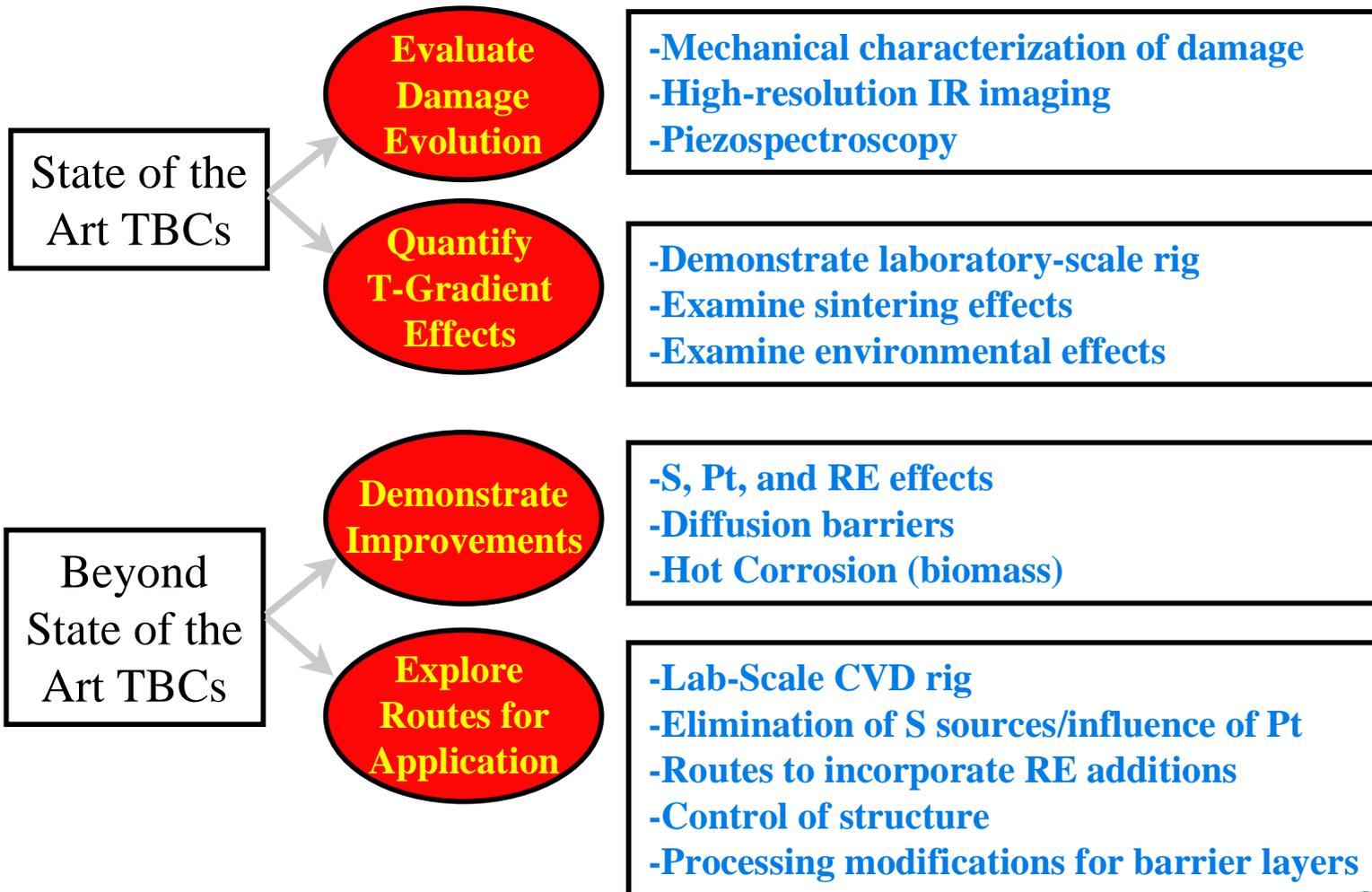
Programs addressed needs for improved performance, cost-effective processing, repair, and life-prediction:

- **Siemens Westinghouse team**
  - new ceramic with improved resistance to sintering
  - new BC compositions
  - TBC spallation monitor
- **UTC/Pratt & Whitney team**
  - improved BC and ceramic topcoat
  - rainbow test results

# National Laboratory Internal Program on Materials Characterization



# National Laboratory Internal Program on Characterization of TBCs



# Ceramics: Monolithics and CMCs

- ORNL-led team developed long-term (10,000 h) creep and creep rupture data for monolithic SiC and Si<sub>3</sub>N<sub>4</sub>, as well as SiC-SiC and SiC-Al<sub>2</sub>O<sub>3</sub> composites
- Provided characterization for:
  - Si<sub>3</sub>N<sub>4</sub> (AS800) blades run in a Solar Turbines Centaur engine ( 960h, FOD)
  - test stand exposure of SN88 vanes at Solar Turbines (failure after 68h, chem. instability)
  - AS800 vanes run in a R-R Allison 501-K engine ( no failures in 815h, recession)
  - as-fabricated hollow SN282 vanes in UTRC program for FT8
- Industry-NL team conducted tests of SiC-based CFCCs for use as GT combustor liners
  - laboratory exposures
  - field tests run for >12,000h (Texaco, Bakersfield)
  - application in the Solar Turbines Centaur 50s engine in the Malden Mills (Lawrence, MA) power plant (" 8,000h+)---*handout*
- Continuing team effort to develop EBCs for non-oxide ceramics

# Technology Information Exchange

- Organized/participated in TBC workshops
  - Organized sessions at major conferences
  - Presented papers at specialist meetings
  - Open literature publications
- *see compilation of NL publications on TBCs (handout)*

# National Laboratory-Industry Collaboration

- This is considered a major success
- Initiation of collaborative efforts among NLs and industry
  - *use of specialized facilities for measurement or processing*
  - *improved technical dialogue*
- Improved awareness of NL capabilities that are available to the industry, the incorporation into industry-led team efforts, and the development of one-on-one collaborations
- Some examples of interactions:
  - *General Electric; Howmet; Pratt & Whitney UTRC; Rolls Royce Allison; Siemens-Westinghouse; Solar Turbines; Stoneybrook*
  - *ATS Fellowships; HTML User Programs; MOUs; CRADAs; Joint Proposals; Funded Research/Work for Others---handouts*

# Detailed Results from the ATS Materials & Manufacturing Support Program

- **Single crystal manufacturing:**
  - *presentations by Howmet and GE*
- **TBCs:**
  - *presentation by P&W; posters; TBC publications list*
- **Monolithic ceramics and CMCs:**
  - *presentation by Solar; posters; Malden Mills handout*
- **Facilities and techniques (and how to access them):**
  - *posters, handouts*