Scan-N-Plan technologies are a suite of tools that enable real-time robot trajectory planning from 3-D scan data. Traditional industrial robot programming is performed using either online, teach-pendant programming or offline programming with a simulated version of the robot and work piece. The Scan-N-Plan approach overcomes limitations in traditional robot programming for applications that:

- Have highly variable part mixes such that hand programming is impractical
- Do not have CAD part models available
- Include flexible or deformable parts such that pre-programming is impossible
- Have part-to-part variability that is difficult to accommodate with static programming
- Require flexible part fixturing or no fixturing at all

These applications are representative of adaptable and flexible operations that respond dynamically to changes in part geometry or presentation — all with little or no human intervention. In addition, the dynamic nature of the trajectory generation permits real-time adaptation based on process feedback.

Traditional robot programming requires an expert-in-the-loop, which limits responsiveness to changes in the process:

**Current State**
- Requires human interaction (offline) for every programming change
- Unable to adapt to as-built condition
- Offline inspection increases scrap and limits adaptability

**Future State**
- Enables real-time adjustment to as-built condition
- Eliminates manual programming — operator just specifies tasks
- Enables process feedback/adaptation via automated inspection

Scan-N-Plan can be generalized to many different processes such as painting, surface finishing, deburring, inspection, and others. The ROS-Industrial Consortium is currently developing the technique for surface blending (sanding) and it has previously been deployed in robotic paint applications. Refer to the backside for a Robotic Blending case study.
Robotic Blending Focused Technical Project
Scan-N-Plan Case Study

Many metal fabrication processes including casting, machining, and welding produce parts with surface finish defects (i.e. pitting, mill lines, or weld spatter). Many processes are available to remove these defects including manual sanding, grinding, bead blasting, or vibratory polishing. In high volume applications, manual processing can lead to ergonomic or safety hazards. Also, inconsistency from operator to operator can lead to variations in product quality, excessive use of consumables, or inefficiencies. A solution is desired that combines the flexibility of a manual process with the repeatability and safety of the robotic system.

The ROS-Industrial Consortium has undertaken a multi-phase Focused Technical Project to develop open source Scan-N-Plan software for Robotic Blending. The results from Milestone 3 of the project are shown below.

1. SCAN

Figure 1: In seconds, Scan-N-Plan software enables CAD-free recognition of flat surfaces that are eligible to blend.

3-D Scanner

Work Pieces

2. PLAN

Figure 2: In less than one second, the software computes collision-free paths to blend each of the selected surfaces.

3. EXECUTE

Figure 3: The robot blends the surface of each work piece.

4. INSPECT

Figure 4: After blending, the system executes a quality assurance scan with a high resolution laser line scan sensor.