TABLE 1. An intelligent approach to predictive registration improvement.

Process	Data collection point (no ?)	Tool	What information is the "data" giving us?	Knowledge / Insight that is relevant to registration
PreCAM Stackup builder			Proprietary or in house systems for designing the material stackup	A "database" or file that contains the material attributes of the entire stackup
		↓ **CAM – scale factor prediction** ↓		
Artwork release	Data collection*	Video CMM to measure artworks before use	Measurement and understanding of linear and non linear distortion of artwork prior to use.	Plotter calibration, environmental, processor and film stabilization effects.
Inner layer imaging / UV expose	Data collection	UV exposure unit (or LDI)	SPC data - artwork scale and alignment	Modern systems provide excellent alignment and SPC scale data showing variation within and between production lots.
AOI	Data collection	AOI system	Identification and categorization of defects.	Currently provides limited or no registration information - dependent on system
PEP and/or Automated lamination systems	Data collection	Integrated multi-camera measurement system	Scale errors on every panel processed. SPC data available	A vital monitor of material and (prior) process variation – pre lamination.
Post-lamination optimizer	Data Collection	X Ray Drill, Intelligent Drilling system Or X Ray Coordinate Measurement Machine	Scale errors on (optionally) every layer of every panel processed. SPC data available.	The critical point where one can first measure the cumulative scale errors locked in after lamination and verify layer to layer alignment An opportunity to compensate scale factor prior to drill to maximize yield.
X Ray inspection for 1st off drilled panels	Visual only	Visual X Ray system (e.g. Glenbook and similar)	Registration errors	Limited long term benefit – purely reactive analysis.
Laser Drill	Data Collection	Skive target alignment available	Real time feedback of inner layer scale factor for layers 2 and n-1.	In some SBU systems measurement of inner layer targets by skiving may eliminate some post lamination optimization.
Drilling	Neither	Drill	limited	Limited
		Subsequent processes are not discussed in this article		