

**Development of a Framework for the
Reduction of Manufacturing Defects in a
Composite Material Process**

by

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DECLARATION OF THESIS

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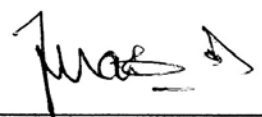
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LIST OF ABBREVIATIONS

ADOE	Advanced Design of Experiments
ANOVA	Analysis of Variance
APT	Actual Production Target
Avg	Average
°C	Degree Celsius
C	Percent decrease of moisture content
σ	Standard Deviation
CCD	Central Composite Design
CLT	Core Locating Template
CRD	Completely Randomized Design
CTE	Coefficient of Thermal Expansion
DMA	Data Mining Analysis
ETA	Minitab's Notation for a Median.
°F	Degree Fahrenheit
FAC	Factorials
FEP	Fluorinated Ethylene Propylene
FFD	Fractional Factorial Design
FG	Fiber Glass
FMEA	Failure Mode and Effects Analysis
FRP	Fibrous-glass Reinforced Plastic
HG	“Hydrargyrum” meaning “liquid silver” (also used for inches of Mercury)

IM-R	Individual Moving Range Chart
LCL	Lower Control Limit
LM	Lay-up-Mould
LSL	Lower Specification limit
Max	Maximum
MIL	Military Standard
MIN	Minimum
n	Number of Parts
NDT	Non-Destructive Testing
OFAT	One-Factor-At-A-Time
Psi	Per Square Inch
PTC	Part Thermocouple
QFD	Quality Function Deployment
QRWP	Quality Resident Work Plan
REV	Revision
RFI	Resin Film Infusion
RSM	Response Surface Methodology
R & R	Repeatability and Reproducibility
RTM	Resin Transfer Molding
SDE	Statistical Design of Experiment
SPC	Statistical Process Control
SPD	Split Plot Design
TC	Thermocouple
UCL	Upper Control Limit

USL	Upper Specification Limit
W_d	Weight of Rub-strip after Drying
W_J	Weight of Rub-strip after Water Jet Cutting

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GLOSSARY OF TERMS

Bleeder	a nonstructural layer of glass fabric material used to allow the escape of excess gas and resin during cure. The bleeder material is removed after the curing process is completed
Blocking	is the important design technique used when the nuisance source of variability (batch to batch, machine to machine, day to day and shift to shift) is known and controllable
Breather	a loosely woven or nonwoven material that acts as a continuous vacuum path over a part but does not come in contact with the prepregs material
Capability	the natural or common-cause variability of a process or characteristic. It can be determined only after a process or characteristic is in statistical control.
Center points	is the mid value of lower and upper ends of the factor in design, to incorporate center points is a useful extension of two-level factorial and fractional factorial designs. The center point runs provide a check for process stability
Compaction	the application of a temporary vacuum bag and vacuum to remove trapped air and compact the lay-up

Composites material	two or more dissimilar materials working together such as fibers and resins to create a product with exceptional properties not present in the original material
Confounding effects	when the main effects are aliased with 2 – factor interaction (2FI) is called confounding effects
Cpk	a ratio that compares the engineering tolerance width to the capability, or spread, in the output of the process, taking into account any lack of centering. Sometimes referred to as “process performance”. Larger Cpk values indicate better process capability
Core depression	a localized indentation or gouge in the core, can be avoided by proper material handling
Curvature	to replicate the center points at random intervals in the design provides estimates of pure error and curvature
Debulking	the application of a temporary vacuum bag, vacuum pressure and heat to remove trapped air and compact the lay-up
Effect	the change in average response when a factor goes from its low end to its high end
Experimental run	is a specific combination of test levels of the input factors that are used in the experiment
Fiber	a continuous elongated material. The basic role of the fibers is to provide strength and stiffness to composites
Foldover	to clear the main effects from the 2 – factor interaction (2FI) a complete foldover of every factor in design is performed

F-value	is the mean sum of squares divided by error sum of square. This is a signal to noise ratio for each factor in the model. High value mean a large and detectable signal (mean SS/errors SS)
Honeycomb material	an unique, light weight, cellular structure made from either metallic sheet or non metallic materials
Input factor	is a variable in the process that can be changed in a controlled manner by the experimenter and that is thought to affect the response variable called “ <i>controllable</i> ” variable
Interaction	is the effect of one variable depends on values of one or more other variables
Laminates	continuous-fiber composites are laminated materials in which the individual, plies of prepregs are oriented in directions that enhance the strength of the laminates
Main effects	the change in response caused by changing a single factor (individual effects of each factors on response in the design)
Mean	overall average of all the response data
Mean square	an estimate of the block variance, calculated by sum of squares divided by block degrees of freedom (SS/DF)
Nuisance variable	is a variable that can affect the response variable but that can not be effectively controlled also called noise variable, or “ <i>uncontrollable</i> ” variable. If nuisance factors can be measured they are called covariates. Examples of nuisance variable are raw material differences, ambient temperature