MATERIALS SCIENCE MONOGRAPHS, 29

PROGRESS IN ADVANCED MATERIALS AND PROCESSES

Durability, Reliability and Quality Control

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SOCIETY FOR THE ADVANCEMENT OF
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FOREWORD

During the five earlier Conferences organized by the European Chapter of SAMPE (Society for the Advancement of Material and Process Engineering) many promising properties and applications of advanced materials were reported on. The 6th European SAMPE Conference, held in The Hague-Scheveningen in the Netherlands continues this tradition. At present, of the advanced materials, it is particularly those based on advanced fibre-reinforced polymer composite materials that are enjoying increasing application, especially within the field of aerospace engineering. Outside that field, interest in these materials is growing but at a rather slow rate.

In order to create more confidence in the engineering world in advanced materials as efficient replacements for conventional durable materials, the programme of the Conference placed much emphasis on three themes: Durability, Reliability and Quality Control of advanced materials and processes.

This proceedings volume offers a collection of papers selected by the technical programme committee from the many valuable contributions that were offered. For the first time, the European Chapter of SAMPE has entrusted the publication of the Proceedings to a professional publisher: Elsevier Science Publishers of Amsterdam. By inclusion of this volume in their series Materials Science Monographs, a world-wide readership is offered to the authors.

Many thanks must be extended to the authors, to the sponsors, to the members of the various committees involved in the organization, and to the publishers, for their efforts towards the realization of this valuable result.

Robert J. Schliekelmann
Chairman
6th International European Chapter SAMPE Conference

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Progress in Advanced Materials and Processes: Durability, Reliability and Quality Control, edited by G. Bartelds and R.J. Schliekelmann
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ATTITUDES DON'T COST MONEY

BY

A.A. BATALI

BOEING INTERNATIONAL CORPORATION

ABSTRACT

CANDID OBSERVATIONS AND CHALLENGES TO SAMPE DELEGATES ARE DEVELOPED THROUGHOUT THIS KEYNOTE ADDRESS. THESE ARE BASED ON THE AUTHORS EXPERIENCES IN TECHNOLOGY TRANSFER, INCLUDING QUALITY SYSTEMS AND PROCESS CONTROL IMPLEMENTATION AT EUROPEAN AEROSPACE SUB-CONTRACTORS AND RAW MATERIAL PRODUCERS. THE EXPERIENCES RELATED ARE WEIGHED AGAINST A BACKDROP OF CULTURAL DIFFERENCES AND WORK VALUES.

I AM WITH THE BOEING COMPANY. OUR PRODUCTS ARE COMMERCIAL AIRCRAFT, WELL KNOWN THROUGHOUT THE WORLD FOR BOTH QUALITY AND QUANTITY. OUR PLANES FLY MANY MILLIONS OF MILES PER DAY IN EVERY COUNTRIES COLORS BY EVERY NATIONALITY TO EVERY LOCATION. INTERNALLY WE HAVE AN INTENSE PRIDE AND CONCERN IN THE PRODUCTS WE BUILD, OF THE RATE WE BUILD THEM, OF THE COSTS OF THEIR PRODUCTION AND OF THE QUALITY EXPECTED, DEMANDED AND ATTAINED. EXTERNALLY, WE HAVE OVER 1500 SUB-CONTRACTORS AGAIN FROM THROUGHOUT THE WORLD SUPPLYING US IN VARIOUS FORMS OF DESIGN AND SUB-CONTRACT ACTIVITY. THOSE OF YOU WHO DEAL WITH US KNOW OUR SUB-CONTRACT PHILOSOPHY WELL - A QUALITY PRODUCT, AT COMPETITIVE PRICES, ON SCHEDULE. IN 1975 WE HAD ONLY 15-20 SUB-CONTRACTORS IN THE U.K. AND EUROPE, SUPPORTING OUR PRODUCTION. AT THE PRESENT TIME WE HAVE 125.

MY INTENTION DURING THIS PRESENTATION IS TO:

1. GIVE SOME OBSERVATIONS, BOTH CRITICAL AND POSITIVE, BASED ON OUR EXPERIENCES AND ASSISTANCE GIVEN IN THE DEVELOPMENT OF MOST OF THESE 125 COMPANIES QUALITY AND PROCESS CONTROL ACTIVITY.

2. TO COMPARE THE ATTITUDES WE'VE HAD TO DEAL WITH TO THOSE OBJECTIVES WE HAVE DEMANDED.

3. TO CHALLENGE YOU IN YOUR MANAGEMENT AND TECHNICAL CAPACITIES TO MEET THE EVER INCREASING QUALITY AND RELIABILITY DEMANDS OF QUALITY ATTITUDES AND DISCIPLINES IN THE DEVELOPMENT AND USE OF MATERIALS IN THE PRODUCTION ENVIRONMENT.

OBSERVATIONS - CRITICAL/POSITIVE

THE OIL CRISIS HAS HAD A DRAMATIC EFFECT ON EVERY FACET OF LIFE. SINCE THAT CRISIS BEGAN AND CONTINUES, THE EVER INCREASING COSTS FOR PRODUCTION AND FOR MATERIALS HAVE BEEN ALARMINGLY STUDIED BY EVERY PROFIT ATTAINING COMPANY IN THE WORLD. CUTTING PRODUCTION COSTS HAS BECOME A 'BYWORD' OF INDUSTRY.

THE ADVANCEMENT OF MATERIALS MORE AND MORE EMPHASIZED.

THE ADVANCEMENT OF PRODUCTION AND PROCESS AUTOMATION MORE EMPHASIZED.

THE ADVANCEMENT OF INTEREST IN MATERIALS (AND ORGANIZATIONS THAT PROMOTE THEM) MORE EMPHASIZED.

THE REAL CHALLENGE OF THESE COST CUTTING EFFORTS IS THAT OF MAINTAINING A PRODUCT 'FIT FOR USE', A QUALITY PRODUCT, EVERY DAY MORE DEMANDED BY SOCIETY AND COMPETITION. THE DEMAND IS INCREASING. THERE IS NO NEED TO CONTINUE TO TRY TO JUSTIFY THE EXISTENCE OF QUALITY - PERHAPS REDEFINE IT, BECAUSE EACH DAY MORE AND MORE PEOPLE AT LIFE'S EVERY LEVEL ARE CONVINCED OF ITS VALUE TO SALES AND THE CONSUMER. THE COMPETITION OF PRODUCTIVITY AND QUALITY FROM WORLD MARKETS IS NOW UNDERSTOOD AS VERY REAL.

AT BOEING OUR CONTRACTS ARE BASED ON BOTH QUALITY AND COST. THOSE OF YOU WHO HAVE DEALT WITH US KNOW HOW TOUGH THIS CAN BE. FIRST, FROM THE QUALITY STAND POINT WE INSIST ON SYSTEMS THAT CONTROL THE PRODUCT FROM PURCHASING AND RECEPTION OF RAW MATERIALS TO SHIPMENT OF THE FINISHED PRODUCT. THESE SYSTEMS REQUIREMENTS CREEP INTO EVERY FACET OF A COMPANIES OPERATIONS; UNTIL NOW THEY HAVE INCLUDED FORMAL CONTROLS OF PROCEDURES, RECORDS, MEASUREMENT AND TEST EQUIPMENT, PROCUREMENT, MANUFACTURING AND MANUFACTURING PLANNING, TESTING, TRAINING AND INSPECTION.

INITIALLY HERE IN EUROPE THE CONCEPT OF IMPOSITION OF SYSTEM REQUIREMENTS THROUGH THE CONTRACT WAS A NEW CONCEPT. IN ALL COMPANIES WE ARE DOING BUSINESS WITH THERE WAS INITIALLY SOME FORM OF PROCEDURAL SYSTEMS. IN ALL, THOUGH WE HAVE HAD TO SPEND CONSIDERABLE TIME HELPING TO FURTHER DEVELOP AND FORMALIZE THE ADDITIONAL DISCIPLINED SYSTEMS THAT WE REQUIRE., IN MOST CASES THERE WAS AN UNDERSTANDING OF THE NEED FOR SUCH SYSTEMS, RARELY A RELUCTANCE TO INCORPORATE OUR STANDARDS. THERE WAS AN UNDERSTANDING OF THE IMPORTANCE OF THE VALUE OF THESE SYSTEMIZED ACTIVITIES TO CONTINUALLY ASSURE PRODUCT REPRODUCEABILITY AND DESIGNATED QUALITY.

TO TRANSCEND FROM THE INDIVIDUAL CRAFT ORIENTED MANUFACTURING METHODS THAT MADE EUROPE SO FAMOUS TO THE DISCIPLINED ORDERLY ARRANGEMENT OF METHODICAL PREPLANNED PROCEDURALLY CONTROLLED ACTIVITY HAS AND CONTINUES TO BE OUR GOAL. NOT TO DE-EMPHASIZE CRAFTSMANSHIP ONLY TO REDIRECT IT, DISCIPLINE IT TO ASSURE CONSISTENCY, REPRODUCEABILITY, TRACEABILITY AND CONTINUED FABRICATION TO DESIGN REQUIREMENTS. OUR METHODS TO ACHIEVE THESE GOALS HAVE BEEN OF A HELPFUL STANCE. IN EVERY CASE OUR REQUIREMENTS HAVE BEEN ACCEPTED. IN EVERY CASE THE DISCIPLINE HAS COME SLOWLY. WE HAVE TRIED TO BUILD ON THE QUALITY OF THE INDIVIDUALS WORKMANSHIP. EUROPEAN WORKMANSHIP HAS BEEN HISTORICALLY CONSIDERED EXCELLENT, HOWEVER, WE OFTEN FOUND INDIVIDUALS BUILDING OUR PRODUCTS "BETTER THAN THE DRAWING" SIMPLY BECAUSE OF THEIR SKILLS AND THE INDIVIDUAL DECISION THAT "I CAN DO IT BETTER". THIS SAME INDIVIDUALISTIC SPIRIT HAS BEEN A CONSIDERABLE PROBLEM IN IMPOSING THE DISCIPLINES OF THE WRITTEN SYSTEMS. THE INDIVIDUAL SPIRIT HAS HAD TROUBLE FOLLOWING AN ESTABLISHED SET OF WRITTEN GUIDELINES. EVEN ONCE THESE SYSTEMS HAVE BEEN ESTABLISHED AND REFINED, OUR CONTINUED PROBLEM IS ASSURING THEY ARE FUNCTIONING ON THE SHOP FLOOR.

SECONDLY, AS PART OF THE QUALITY FUNCTION WE HAVE ALSO INSISTED THROUGH OUR CONTRACTS ON CONTROLS THROUGH THE MANUFACTURING OPERATIONS OF THOSE ITEMS THAT ARE CRITICAL TO FUNCTION BUT ARE NOT "INSPECTABLE" IN THE SENSE THAT WE KNOW IT. THIS PHILOSOPHY IS BASED ON THE NEED FOR THE CONTROL OF THE PRODUCTION PROCESS IN THE MANUFACTURE OF NEW MATERIALS AND THE CONTROL OF THE MANUFACTURING PROCESS WHEN USING THESE MATERIALS IN PRODUCTION OF ELEMENTS AND ASSEMBLIES.

WE AS THE PRIME CONTRACTOR HAVE ALWAYS ALLOWED ACCESS OF OUR SUB-CONTRACTORS TO OUR SPECIFICATIONS SYSTEM WHICH INCLUDES PURCHASING AND PROCESS REQUIREMENTS. IN THE CASE OF PROCESS SPECIFICATIONS THIS ACCESS ALLOWS FROM WITHIN OUR COMPANY AN EXTENSION TO OUR SUB-CONTRACTORS OF BOTH THE MANUFACTURING TECHNOLOGY AND THE REQUIRED QUALITY CONSIDERED AS ESSENTIAL FOR PRODUCTS TO MEET DESIGN CRITERIA. WE

SHARE THE TECHNICAL METHODS WE HAVE DEVELOPED WITH THE SUB-CONTRACTOR TO EXTEND THE HIGH LEVEL OF QUALITY WITHIN OUR OWN SHOPS TO THAT OF THE SUB-CONTRACTOR. WE SHARE IT AS WELL TO ASSURE CONSISTENT PRODUCTION RELIABILITY. ESSENTIALLY WE EXTEND OUR OWN QUALITY REPUTATION TO OUR SUB-CONTRACT BASE OF OVER 1500 COMPANIES ACCOMPLISHING CRITICAL PROCESSING THROUGHOUT THE WORLD. WE SHARE WITH EACH SUB-CONTRACTOR IN EVERY COUNTRY OUR TECHNOLOGY AND APPLICATION OF TECHNOLOGY TO CURRENT MANUFACTURING METHODS THAT HAVE BEEN DEVELOPED WITHIN OUR ENGINEERING, MANUFACTURING AND QUALITY DEPARTMENTS.

SOME EXAMPLES OF THIS TECHNOLOGY TRANSFER SEEM NOW IN ORDER TO BETTER DEFINE THIS ACCESS TO OUR SYSTEM.

ESSENTIALLY OUR CONTROLS ARE EXTENDED EVEN TO PRODUCTION OF CERTAIN RAW MATERIALS. WITH GRAPHITE RAW MATERIALS WE PLACE CONTROLS ON THE FIBER MANUFACTURER, ON THE FABRIC MANUFACTURER AND ON THE PREPREGGER. WITH GRAPHITE PRODUCTS WE DEMAND RECORDED CONTROLS THROUGHOUT MANUFACTURING OF THESE MATERIALS IN ADDITION TO QUALITY REQUIREMENTS, RECEPTION TEST OF RAW MATERIALS, STORAGE CONTROL AND LABORATORY TESTING IN PROCESS AND OF THE FINAL PRODUCT. IN ADDITION WE EXTEND OUR CONTROLS TO CADMIUM PLATE OR ANODIZING AS SURFACE FINISH REQUIREMENTS. WE IMPRESS OUR OWN SOLUTION CONTROLS, SURFACE PREPARATION SOLUTIONS, TEMPERATURE ALLOWABLES, VOLTAGE LIMITS AND CONTROLS. IN ADDITION, WE EXTEND OUR CONTROLS TO BONDING OF METALS. WE IMPOSE SPECIFIC SURFACE PREPARATION METHODS, SOLUTION CONTROLS, TEMPERATURE CONTROLS, ADHESIVE PRIMER CONTROLS, ADHESIVE APPLICATION METHODS AND CURING CONTROLS AND THE USE OF APPROVED RAW MATERIALS.

OVER AND ABOVE THIS WE HAVE REQUIRED PROPER IMPLEMENTING PROCEDURES IN THE LOCAL LANGUAGE TO ASSURE OUR PROCESSES WERE ACCOMPLISHED CONSISTENTLY TO THE REQUIREMENTS OF OUR SPECIFICATION SYSTEM AND THAT TEST AND INSPECTION RECORD WERE AVAILABLE TO SUBSTANTIATE HISTORICALLY OUR REQUIRE-

MENTS. HERE AGAIN IT HAS BEEN THE PHILOSOPHY OF MY COMPANY AND THE EFFORTS OF OUR ORGANIZATION IN THAT COMPANY TO GIVE FULL CO-OPERATION IN THE DEVELOPMENT OF THESE "PROCESS CONTROL" ACTIVITIES. WE FEEL THAT THESE CONTROLS ENHANCE OUR COST ANALYSIS BY ADDING STABILITY TO DESIGN AND PRODUCTION.

I MERELY GIVE YOU THESE EXAMPLES TO FORTIFY OUR ACTIVITY. WE ARE CONVINCED THIS PHILOSOPHY IS EFFECTIVE AND CONTRIBUTES TO OUR SUCCESS IN THE AIRPLANE BUSINESS. WE DO NOT IMPOSE THESE REQUIREMENTS ON A SPORADIC BASIS; EVERY COMPANY WHO IS BUILDING PRODUCTS UNDER OUR SUB-CONTRACTS UMBRELLA ANODIZES THE SAME WAY, TO THE SAME REQUIREMENTS AND PROCEDURES, METAL BONDS THE SAME WAY TO THE SAME REQUIREMENTS, PRODUCES GRAPHITE STRUCTURES THE SAME WAY TO THE SAME REQUIREMENTS. IT MAKES NO DIFFERENCE IN WHICH COUNTRY, WHETHER SPAIN, ITALY, FRANCE OR THE U.K. THE REQUIREMENTS ARE THE SAME - THIS AS I PREVIOUSLY MENTIONED IS AN EXTENSION OF THAT SAME ACTIVITY THAT GOES ON WITHIN OUR OWN PRODUCTION ENVIRONMENT.

WHAT THEN ARE SOME OF MY OBSERVATIONS AND EXPERIENCES RESULTING FROM HELPING DEVELOP THIS SECOND CONCEPT AT MANY COMPANIES IN THE U.K. AND ON THE CONTINENT?

RARELY WHEN WE HAVE INITIATED CONTRACTS IN EUROPE IS THERE A MANAGEMENT UNDERSTANDING OF THE "PROCESS CONTROL" WE REQUIRE. IN THE FIRST INSTANCE WE HAVE HAD TO SPEND CONSIDERABLE TIME EXPLAINING OUR TECHNICAL REQUIREMENTS, THE NEED FOR THIS TYPE OF CONTROL AND THE REASONS FOR THESE REQUIREMENTS.

WE HAVE HAD TO ASSURE MANAGEMENTS UNDERSTANDING OF THE NEED FOR LABORATORY SUPPORT OF THESE TECHNICAL REQUIREMENTS. THIRDLY WE HAVE HAD TO IDENTIFY THE NEW OR REVISED FACILITIES NECESSARY TO SUPPORT THESE TECHNICAL REQUIREMENTS. IN MOST CASES, MOST MANAGERS IN EVERY COUNTRY HAVE BEEN ANXIOUS TO IMPLEMENT THIS ACTIVITY ONCE THEY UNDERSTOOD THE

TECHNOLOGY UPGRADING OUR CONTRACTS WERE IMPOSING. FOR SURE WE HAVE MANY FRIENDS IN THE LABORATORIES OF THESE COMPANIES BECAUSE OF THEIR NEW FOUND STATUS RESULTING FROM OUR IMPOSITIONS. AGAIN THE IMPACT WAS FELT AT TOP LEVELS, ONCE NEW PROCESSING FACILITIES WERE DEFINED NECESSARY TO MEET THE TECHNICAL REQUIREMENTS. MACHINE SHOP COSTS NOW WERE HIGHER WHEN INCLUDING THE SHOT PEENING EQUIPMENT, THE N.D.T. EQUIPMENT, THE HEAT TREATING EQUIPMENT AND THE LABORATORY NECESSARY FOR SUPPORT.

WE HAVE FOUND IT NECESSARY THEN TO MAINTAIN AN EXTREMELY PROFESSIONAL FAIRNESS IN OUR RELATIONSHIPS. WE HAVE APPROACHED IMPLEMENTATION OF THESE REQUIREMENTS WITH EMPATHY AND THIS SAME EMPATHY HAD TO CONTINUE NO MATTER WHAT THE FRUSTRATIONS. THESE ATTITUDES HAVE BEEN EXTREMELY VALUABLE. OUR FRUSTRATIONS WILL ALWAYS CONTINUE WITH LANGUAGE, THE USE OF TRANSLATORS AND INTERPRETERS; OUR FRUSTRATION OF UNDERSTANDING/EXPLAINING TECHNICAL CONCEPTS AS ONE OF THE MOST DEMANDING. OUR FRUSTRATIONS OF UNDERSTANDING EUROPE'S MANY CULTURES IN ORDER TO MEANINGFULLY BUILD ON OUR REQUIREMENTS WITHIN THE FRAMEWORK OF THE HABITS/RULES SO DIFFERENT WITHIN EACH COUNTRY. THESE UNDERSTANDINGS HAVE BEEN AND WILL CONTINUE TO BE ESSENTIAL IN OUR BUSINESS DEALINGS IN ORDER TO REALISTICALLY ACHIEVE WHAT OUR SYSTEM DEMANDS.

WE HAVE FELT YOUR FRUSTRATIONS. IMPLEMENTING SPECIFICATION REQUIREMENTS FROM A MULTITUDE OF PRIME FOREIGN CONTRACTORS IS A MONUMENTAL TASK. DEALING ONLY IN ENGLISH HAS BEEN YOUR VERY REAL TASK. YOUR ATTEMPTS AT UNDERSTANDING OUR MENTALITY, ANOTHER TASK EQUALLY REAL.WHAT WE HAVE IMPOSED IN THE AREA OF PROCESSING HAS INCLUDED OUR DESIGN CRITERIA AND CONTROLS FOR HEAT TREATMENT OF STEELS AND ALUMINIUM, DESIGN CRITERIA AND CONTROLS FOR CHEMICAL PROCESSING, OUR CONTROLS FOR NON DESTRUCTIVE TESTING, OUR DESIGN CRITERIA AND CONTROLS FOR MATERIALS TREATMENTS IN BONDING, AND GRAPHITE PRODUCTION. ALL THESE SAME ITEMS I'VE NOTICED WILL BE DISCUSSED DURING THIS SAMPE CONFERENCE. YOU HAVE ACCEPTED THESE IMPOSITIONS. YOU ARE USING THESE SAME

IMPOSITIONS IN PRODUCING OUR PARTS AS WELL AS THOSE OF OUR COMPETITORS, SO THESE REQUIREMENTS MUST BE GOOD.

THESE ARE SOME OF MY SIMPLE OBSERVATIONS I PROMISED EARLY ON IN THIS PRESENTATION. THESE ARE AS WELL SOME OF THE COMPARISONS OF CAPABILITY TO WHICH WE HAVE BEEN EXPOSED AND THE ATTITUDES YOUR COMPANIES AND MINE HAVE DEVELOPED RESULTING FROM OUR INTERCHANGES.

AS AIRPLANE MANUFACTURERS, WE HAVE DONE MORE TO MAKE THE WORLD SMALLER IN DISTANCE THAN ANY OTHER INDUSTRY EXCEPT TELEVISION. WE HAVE HELPED YOUR INDUSTRIES DEVELOP THROUGH VARIOUS TRADE AGREEMENTS RESULTING FROM SALES OF OUR PRODUCTS. WE HAVE IMPOSED OUR REQUIREMENTS THROUGH OUR CONTRACTS. YOUR COUNTRIES INDUSTRIES HAVE RESPONDED BY IMPLEMENTING OUR REQUIREMENTS IN AN EFFORT TO UPGRADE YOUR CAPABILITIES, BOTH TECHNICAL AND PRODUCTION, TO UPGRADE TECHNOLOGY AND TO DEVELOP AND MAINTAIN A TALENTED WORK FORCE. YOU HAVE RESPONDED WITH AN INTENSE PRIDE IN OUR BUSINESS RELATIONSHIPS AND A COMPETITIVELY PRICED PRODUCT.

THE THIRD ISSUE AND THE ONE I WOULD LIKE TO CLOSE THIS PRESENTATION WITH IS A CHALLENGE TO YOU - THE TECHNICAL COMMUNITY.

OUR SUB-CONTRACTORS HAVE RISEN TO OUR CHALLENGE AND HAVE MET OUR REQUIREMENTS. IN MANY CASES THEY STRIVE TO IMPROVE ON THESE REQUIREMENTS AND TO CONTINUE TO BROADEN THEIR EFFORTS TO DEVELOP OUR PRODUCTION AND TECHNICAL DISCIPLINES.

THE QUALITY OF THE PRODUCTS YOU DELIVER TO US IS AS HIGH AS FROM ANYPLACE IN THE WORLD.

THE INTEGRITY BEHIND THE QUALITY OF THE PRODUCTS YOU DELIVER TO US IS AS HIGH AS FROM ANYPLACE IN THE WORLD.

THESE ATTITUDES MUST CONTINUE AND EXPAND.