Foreword

This book on fatigue, combined with two other recent publications edited by Claude Bathias and André Pineau[1], are the latest in a tradition that traces its origins back to a summer school held at Sherbrooke University in Quebec in the summer of 1978 which was organized by Professors Claude Bathias (then at the University of Technology of Compiegne, France) and Jean Pierre Bailon of Ecole Polytechnique, Montreal, Quebec. This meeting was held under the auspices of a program of cultural and scientific exchanges between France and Quebec. As one of the participants in this meeting, I was struck by the fact that virtually all of the presentations provided a tutorial background and an in-depth review of the fundamental and practical aspects of the field as well as a discussion of recent developments. The success of this summer school led to the decision that it would be of value to make these lectures available in the form of a book which was published in 1980. This broad treatment made the book appealing to a wide audience. Indeed, within a few years, dog-eared copies of "Sherbrooke" could be found on the desks of practicing engineers, students and researchers in France and in French-speaking countries. The original book was followed by an equally successful updated version that was published in 1997 which preserved the broad appeal of the first book. This book represents a part of the continuation of the approach taken in the first two editions while providing an even more in-depth treatment of this crucial but complex subject.

It is also important to draw attention to the highly respected "French School" of fatigue which has been at the forefront in integrating the solid mechanics and materials science aspects of fatigue. This integration led to the development of a deeper fundamental understanding thereby facilitating application of this knowledge

1. C. BATHIAS, A. PINEAU (eds.), *Fatigue of Materials and Structures: Fundamentals*, ISTE, London and John Wiley & Sons, New York, 2010.
C. BATHIAS, A. PINEAU (eds.), *Fatigue of Materials and Structures: Application to Design*, ISTE, London and John Wiley & Sons, New York, 2011.

to real engineering problems from microelectronics to nuclear reactors. Most of the authors who have contributed to the current edition have worked together over the years on numerous high-profile, critical problems in the nuclear, aerospace, and power generating industries. The informal teaming over the years perfectly reflects the mechanics/materials approach and, in terms of this book, provides a remarkable degree of continuity and coherence to the overall treatment.

The approach and ambiance of the "French School" is very much in evidence in a series of bi-annual international colloquia. These colloquia are organized by a very active "fatigue commission" within the French Society of Metals and Materials (SF2M) and are held in Paris in the spring. Indeed, these meetings have contributed to an environment which fostered the publication of this series.

The first two editions (in French), while extremely well-received and influential in the French-speaking world, were never translated into English. The third edition was recently published (again in French) and has been very well received in France. Many English-speaking engineers and researchers with connections to France strongly encouraged the publication of this third edition in English. The current three books on fatigue were translated from the original four volumes in French[2] in response to that strong encouragement and wide acceptance in France.

In his preface to the second edition, Prof. Francois essentially posed the question (liberally translated), "Why publish a second volume if the first does the job?" A very good question indeed! My answer would be that technological advances place increasingly severe performance demands on fatigue-limited structures. Consider, as an example, the economic, safety and environmental requirements in the aerospace industry. Improved economic performance derives from increased payloads, greater range and reduced maintenance costs. Improved safety, demanded by the public, requires improved durability and reliability. Reduced environmental impact requires efficient use of materials and reduced emission of pollutants. These requirements translate into higher operating temperatures (to increase efficiency), increased stresses (to allow for lighter structures and greater range), improved materials (to allow for higher loads and temperatures) and improved life prediction methodologies (to set safe inspection intervals). A common thread running through these demands is the necessity to develop a better understanding of fundamental fatigue damage mechanisms and more accurate life prediction methodologies (including, for example, application of advanced statistical concepts). The task of meeting these requirements will never be completed; advances in technology will require continuous improvements in materials and more accurate life prediction schemes. This notion is well illustrated in the rapidly developing field of gigacycle

2. C. BATHIAS, A. PINEAU (eds.), *Fatigue des matériaux et des structures*, Volumes 1, 2, 3 and 4, Hermes, Paris, 2009.

fatigue. The necessity to design against fatigue failure in the regime of 10^9 + cycles in many applications required in-depth research which in turn has called into question the old, comfortable notion of a fatigue limit at 10^7 cycles. New developments and approaches are an important component of this edition and are woven through all the chapters of the three books.

It is not the purpose of this preface to review all of the chapters in detail. However, some comments about the organization and over-all approach are in order. The first chapter in the first book[3] provides a broad background and historical context and sets the stage for the chapters in the subsequent books. In broad outline, the experimental, physical, analytical and engineering fundamentals of fatigue are developed in this first book. However, the development is done in the context of materials used in engineering applications and numerous practical examples are provided which illustrate the emergence of new fields (e.g. gigacycle fatigue) and evolving methodologies (e.g. sophisticated statistical approaches). In the second[4] and third[5] books, the tools that are developed in the first book are applied to newer classes of materials such as composites and polymers and to fatigue in practical, challenging engineering applications such as high temperature fatigue, cumulative damage and contact fatigue.

These three books cover the most important fundamental and practical aspects of fatigue in a clear and logical manner and provide a sound basis that should make them as attractive to English-speaking students, practicing engineers, and researchers as they have proved to be to our French colleagues.

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3. C. BATHIAS, A. PINEAU (eds.), *Fatigue of Materials and Structures: Fundamentals*, ISTE, London and John Wiley & Sons, New York, 2010.
4. This book.
5. C. BATHIAS, A. PINEAU (eds.), *Fatigue of Materials and Structures: Application to Design*, ISTE, London and John Wiley & Sons, New York, 2011.