



中国2010上海世博会 园区夜景照明规划与设计研究

Lighting of Expo 2010 Shanghai China

郝洛西 林怡 胡国剑 李勋栋 著



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序

作为人类文明成果的荟萃，世博会自159年前诞生至今，一直是崇尚创新、追求进步、倡导和谐的领航者与标杆。随着科技进步及文化生活的多样性，人类的生活时空已得到了极大程度的拓展。夜晚的城市空间愈发成为城市生活中最具活力与魅力的时段之一。因此，以“城市，让生活更美好”为主题的上海世博会，将把夜间作为展示城市美好生活的重要时空，呈现高科技发展成果与深切人文关怀交汇下的城市夜景发展的成果与愿景。

同济大学建筑与城市规划学院视觉与照明艺术研究中心，在郝洛西教授的带领下，自2006年始便投入了以世博会为平台的城市照明技术应用与创新设计的研究工作中。该团队先后承担了和世博会有关的多项科研课题，涵盖灯具的研发、照明技术的创新应用、照明新能源和新技术集成、城市区域夜景规划与设计理论等多个环节。其研究不仅注重技术、理念上的突破，同时充分结合我国照明领域发展的需求与导向，将高效节能、生态环保的照明技术与理念融入其科研成果中，在世博会这一面向全世界的舞台上，充分展现了来自中国照明科研工作者对城市照明发展所作的努力。

郝洛西教授及其学术团队，始终坚持科研、实践紧密结合的教学模式，开创了“研究性设计”的教学方法，充分调动建筑与城市规划学院不同层次学生的创造性、开拓性，将其与照明专业知识的学习紧密融合起来；在科学研究与日常的设计实践互相渗透的过程中，使理论知识的应用与社会实际需求的满足达到高度的统一。在这一教学模式的引领下，出自郝教授学术团队及其课程学习的多项成果，已转化为世博园内多种的照明产品和光艺术作品得以实施。这正是“学有所用，学以致用”精神的体现，也是“产、学、研相结合”模式之优势所在。

2010年上海世博会已成功开幕，其夜景建设无疑为世博增添了一道靓丽的风景线，成为世人争相一睹的胜景。以“中国2010上海世博会园区夜景照明规划”为代表的一系列研究成果，可以说是郝洛西教授及其团队多年探索与耕耘的总结与荟萃。将其集结成册，意义不止于展示世博夜景照明的华美，更重要的是展示一种具有责任感、开拓性的研究过程，以及隐藏于华灯之后坚持不懈、锐意进取的探索精神。

谨以此为序。



教授

同济大学建筑与城市规划学院院长

2010.9.10

Perface

For 159 years Expo has been a showcase of the most innovative achievements from around the world and has proven to be a catalyst for harmonious competition and co-operation. Each Expo has been a temporal snapshot of rapid advancements in technology and of their accrued benefits for the way we live. Shanghai Expo's theme of 'better city, better life' shows the importance of the night: clever lighting allows urban environments to display what is unique, vital and alluring about themselves.

In 2006 Professor Hao Luo Xi took up the lead research role in lighting technology and design at the Light and Vision Research Center at the College of Architecture and Urban Planning of Tongji University. Her team of colleagues and students undertook a number of Expo related research projects including: luminaire development; innovative lighting applications; new energy sources and technology related to lighting; urban master planning and related design. Their research took into account ground-breaking technology and new approaches to design. Their work ideally encompassed considerations of energy efficiency, energy-savings and environmental concerns as well as keeping an eye towards the future of the lighting industry in China. The culmination of their research and development and their contribution to developments in urban lighting were then presented on the world stage at the Shanghai Expo.

Professor Hao and her team engaged in rigorous research combined with attention to practical applications and in doing so developed a unique teaching practice based on experimental design. In this teaching environment students were stimulated to explore new theories and practices. Being exposed to thought-provoking proposals and being able to work in a competitive but also collegial manner resulted in the development of lighting technologies and practices that are useful for society as a whole. They were also able to perceive and explore the research benefits of working mutually with lighting industry.

When 2010 Shanghai Expo was opened it successfully demonstrated how lighting can enhance a landscape. The research that culminated in "Expo 2010 Shanghai, China Lighting Materplan" marked a notable culmination for the work of Professor Hao and her team. Their achievements are set out in this book and mirror the success of Expo itself. The book also sets out their responsible approach to research and reflects a determination to make that research a journey of fruitful exploration.

Professor Wu Changfu

Dean of College of Architecture and Urban Planning, Tongji University

Sep. 10th, 2010

世博会历来都是世界各国展示技术实力、文化形象与美学理念的一个重要窗口，世博会也被看作是人类科技创新的最大盛会。人工电光源的发展正是通过世博会造福于全人类。1873年维也纳世博会的电动机发明、1878年巴黎世博会爱迪生的白炽灯泡、1939年纽约世博会上的第一个实用荧光灯等等。而2010年中国上海世博会恰逢照明技术革命的新浪潮——固态发光。世博场馆的建设和展示设计，通过LED照明技术的集成应用，参观者直接领略到如何用照明科技与灯光艺术诠释“城市，让生活更美好”这一主题，更可领略到对人类科学、技术、文化、艺术、教育等各个领域产生的直接推动。

“光述文化，闪亮世博”。2010中国上海世博会是一个设计创新和科技应用的大舞台，各场馆通过设计的创新以及科技的亮点来展示企业、城市乃至国家的技术实力与文化特色。当夜幕降临之时，各具特色的场馆竞相展示着自己的“光”魅力，其中不乏有构思巧妙的创意，更有各种新技术的应用，恰如其分地演绎了“用技术的手段实现艺术的效果”这一照明科技的真谛。

同济大学建筑与城市规划学院视觉与照明学术研究团队通过国家、省部级等一系列世博重大专项应用课题开展了与世博会相关的科研工作，并先后承担了上海世博园区夜景照明总体规划、世博文化中心的室内外照明设计等工作。团队自2006年开始介入世博会的工作，参与世博工作，无疑对学科发展产生了重要影响，团队所承担的科研课题直接带动了教学内容与方法的更新与拓展。另外也在研究生和博士生的培养方面，形成了特有的学术研究和创新应用的内容和方法。挖掘世博工程设计项目中的研究和学术价值，成为硕士生和博士生论文的重要选题来源，他们的论文工作成果又直接推动了工程设计上的创新。尽管工作中团队面临年年学生入学和毕业人员流动大的困难，但青年学生的创新能力和工作热情，不断带给团队新的思想和活力。

上海世博园区夜景照明总体规划工作以先期开展的一系列世博科研成果为基础，通过对世博园区夜间功能定位的分析与研究，提出了世博园区夜景照明的规划原则。规划中重点解决了世博园区景观光环境实现高效节能的途径和手段、体现上海世博特征的景观艺术照明的原则和方法、制定世博园区光环境建设的相关设计标准和管理准则。规划完成了世博园区夜景照明分区与场馆建筑物照明亮度分级、世博园区色温及色光动态照明控制。为了更好地指导上海世博园区夜景照明设计，除了完成世博园区的总体照明规划之外，还进行了以下各部分的分项规划，并形成了世博园区照明创新技术应用、高效节能照明技术应用、道路系统照明、场馆建筑夜景照明、公共空间照明、绿地景观照明、标识系统照明、城市最佳实践区照明等8项分项规划及导则，用于指导上海世博园区夜景照明设计方案阶段、工程招标阶段和方案深化阶段的工作开展。

世博文化中心作为上海世博会“一轴四馆”永久性场馆之一和开闭幕式的主场馆，其穿梭腾飞、极具未来感的独特外形，展现了城市更新区天际轮廓线的节奏与浪漫，为世界呈现出一个永不落幕的城市舞台。由于该馆所处的区域位置重要、空间功能多样，该馆的照明设计工作不仅要解决常规照明的一般问题，还需突出照明设计中的创新理念。另外，世博文化中心室内外的照明不但要保障世博会期间的各项活动，还要满足世博会后的运营需求。面对世博场馆建设的工期要求和一体化团队的项目操作管理模式，团队力图发挥高校设计团队的专业学术背景优势，该项目的灯光设计创意注重以实验和研究为基础，以教学和科研成果为支撑，探索和尝试了一种全新的实验性照明设计方法。其中位于世博文化中心西、南两个入口大厅的LED数字媒体界面的创新设计，成为最有特点和挑战性的工作。该创意设计与实施直接来源于设计专业的教学基地——建筑光环境实验室，多年来教师秉承实验性教学的发展方向，不仅将该实验室建设成为学术研究的实验基地，也成为技术创新的研发基地。为此通过课堂教学和装置作业，先后共有近70名本科生、研究生参与了该项世博工程的设计与实验工作。凭借他们的聪明才智与创新才华，经过近两年的辛勤工作，设计创意以实验为基础，教学相长，不仅探索出一种新的教学思路，也开拓了一种新的实验性设计方法。

该书是团队参与世博科研与工程设计工作的总结，而我们也非常高兴将上海世博会中未实现的项目通过该书与大家分享。

感谢在我们参与世博工作过程中给予全力支持的国家科技部、上海世博会事务协调局、上海市科学技术委员会、上海市世博科技促进中心、国家半导体照明工程研发及产业联盟、国家低碳照明研究中心、中国照明学会、中国照明电器协会、上海市照明学会、世博文化中心、同济城市规划设计研究院、同济大学建筑设计研究院、现代设计集团华东建筑设计研究院，我们承担的有关世博专项科研课题及工程设计能够顺利完成，充分的信任和鼓励是我们工作的最大动力。

感谢我们工作任教的单位同济大学、科技处、建筑与城市规划学院，校院各级领导的提携和帮助，学校发挥学科优势，积极参与世博、服务世博、奉献世博的倡导，我们感同身受。

感谢在产品研发中，参加课题组试制工作的半导体照明及灯具相关企业单位，产学研仍是我们今后要专注发展的合作模式。

感谢澳大利亚悉尼大学建筑学院的教授Warren Julian、Stephanie夫妇的倾力帮助，他们耐心细致地完成了书中全部英文的校对及润色工作。感谢李勋栋博士的全程中英文翻译及校对工作。最终该书实现中英文双语的版本完全得益于他们的付出和努力。

最后感谢视觉与照明团队的每一位成员，包括目前还在攻读和已经毕业的所有硕士生和博士生们，以及那些热衷于探索光与空间的本科生们。朝花夕拾，为上海世博会工作的日日夜夜，成为我们人生旅途中的一个重要驿站。秉承创新性和实验性的研究与设计方法，将激励我们在专业学习中一路前行。

李海英 教授
2010.9.10

Foreword

Expo is always an opportunity for participating countries to showcase their best in the fields of science and technology, their cultural identity and an aesthetic viewpoint. It is also normally a celebration of innovations in science and technology. The focus of the Vienna Expo in 1873 was the motor car, in Paris in 1878 it was Edison's incandescent bulb, in New York in 1939 it was the fluorescent lamp and Shanghai can claim a new wave of innovative solid state lighting. LED lighting technology was integrated into both the pavilions and into exhibitions and exposed visitors to the nexus between lighting technology and creative lighting. The theme of Expo, towards a better city and a better life, was to reveal how lighting can be a driving force in science, technology, culture, art and education. "Light as a cultural dimension and a means for making Expo shine". Shanghai's Expo was intended to be a stage for innovations in technology and practical, scientific application. Each pavilion had to mount interesting technological displays whilst revealing something of their cultural uniqueness. At night, the pavilions had to don a competitive mantle of aesthetically pleasing light woven from a cloth of technical creativity.

Since 2006, a lighting research team from the College of Architecture and Urban Planning of Tongji University had been engaged in local and nationally based research that related to the forthcoming Expo. Projects such as a lighting master plan and the interior and exterior lighting designs for the Expo Performance Center were undertaken. These years of research had far reaching effects on the college, academia and students alike. For academics the research led to some curriculum and teaching methodology renewal. For students the outcome was a raft of innovative lighting applications and an expansion of possible thesis topics. Conversely it also meant that the achievements of the college were a driving factor in novel lighting designs used at Expo. Whilst the composition of the university team altered slightly each year because of graduations and student intakes, the team remained relatively stable and cohesive. With youthful passion and an innate ability to propound new ideas, the team remained constantly reinvigorated.

The masterplan for the lighting of Expo 2010 was based on outcomes from rigorous research conducted some years prior to Expo. Analysis of the Expo site, its orientation and probable night-time functions, helped the team to establish some planning principles for the site. One of the main considerations for the lit environment was the use of high efficacy and money-saving lamps. Principles and methodology for landscape lighting also had to be established. A schedule of tasks was established and included the identification of lighting zones, a hierarchy for the brightness of buildings, colour temperature control, colour selection and where dynamic lighting was to be used. The master plan for the site was made up of a series of minor plans and they were to account for innovative lighting, energy-saving and efficiency, lighting for roads, pavilions, public spaces, natural spaces and also what was to be identified as unique or suitable for the Best Practice Area of the Expo site. These plans were inextricably linked to all phases of the development of the Expo site: schematic design, project bids, building and running.

The Expo Performance Centre is to remain a permanent building. Its function during Expo was as a venue for the opening and closing ceremonies. With its futuristic spaceship appearance it is a symbol of the rhythm and romance of Shanghai as well as the promise of urban renewal and a place on the world stage. The center is multifunctional and centrally located on the site so the selected lighting design had to be generally pleasing and also reflect the best in creative workmanship. Interior and exterior lighting had to meet the functional needs

for the various activities that would take place there. The college research team had to be mindful of the construction period and time constraints but what they could and did bring to the tasks were expertise from previous research along with experimental ideas and designs. The most challenging part of the lighting scheme for the Performance Center was to design unique LED display screens for the western and southern entrances to the building. In the years leading up to Expo, the architectural lighting laboratory at Tongji University was a crucible of intensive teaching, experimentation, research and development. In all, 70 undergraduate and graduate students worked diligently and collegially for the successful outcomes that were achieved for Expo. The benefit for the college was an injection of some new content and methodology.

This book is the important culmination of the experimental and project research work that was undertaken for Expo 2010. It is our way of sharing the results with everyone. The team is grateful to the following institutions who fully supported our work: the Ministry of Science and Technology of the People's Republic of China, the Coordination Office of Shanghai Expo, the Shanghai Committee of Science and Technology, the Shanghai Expo Technology Development Center, the China Solid State Lighting Alliance, the National Low Carbon Lighting Research Center of China, the China Illuminating Engineering Society (CIES), the Expo Performance Center management, the Tongji Urban Planning and Design Institute in Shanghai, the Architectural Design and Research Institute at Tongji University and the East China Architectural Design and Research Institute Co Ltd. The encouragement and trust shown and the support provided by these institutions was essential for our success.

Thanks are also due to Tongji University Technology Department, the College of Architecture and Urban Planning and all the leaders of the university and colleges. Tongji University was quick to see the advantages for various disciplines to make a positive, sustained and lasting contribution to Expo 2010.

Our thanks also go to those companies that assisted us with trial tests for luminaires, their recognition of the value of joint industrial and educational enterprises and their forward thinking in focusing on future cooperative endeavours.

Emeritus Professor Warren Julian, Faculty of Architecture Design and Planning, University of Sydney and Mrs Julian patiently assisted us with proofreading. Dr Li Xun Dong also worked diligently in providing Mandarin to English translations and proofreading. Together they have made possible this bi-lingual publication.

We must also thank the Editor, Mrs Yang Hong, from China Architecture and Building Press for her sterling efforts.

Finally, thanks to every member of the Vision and Lighting team, including graduates and undergraduates who are passionate about the exploration of spatial lighting. Reminiscing about long hours of work over the past several years has made us understand that Expo has now become an important milestone in our lives. What has been achieved in terms of innovative and experimental research and design will sustain us academically into the future.

Professor Hao Luoxi
Sep. 10th, 2010

1 中国2010上海世博会园区夜景照明规划

1 Lighting Master Plan for Expo 2010 Shanghai China

世博园区照明总体规划

Lighting Master Plan for Expo 2010 Shanghai China

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2 Innovative and Sustainable Development Design

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Lighting Master Plan for Expo 2010 Shanghai China