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## Aims of the International Graphonomics Society (IGS)

During the second international graphonomics conference in 1985, the decision was made to establish the International Graphonomics Society (IGS). The general aims of the IGS are the advancement of research in the field of graphonomics. These aims include an exchange of views and expertise, joint-project research, and the dissemination and application of knowledge wherever appropriate. Some means to achieve these goals are: the organization of conferences and workshops and the publication of their proceedings, the stimulation of communication and research contacts by any other means, the transmission of information through a regular bulletin (BIGS), an electronic list (Scrib-L) and the maintenance of a graphonomics research directory. The IGS has the status of a legal non-profit organization. It was established as a foundation ('stichting') under the law of the Netherlands on January 30th, 1987.

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## From the Editors



This is the 30th Bulletin of the International Graphonomics Society, BIGS 15, 2. We would like to announce that with this issue, we launch the on-line version of BIGS (eBIGS)! Just before each issue of eBIGS we will send you an email message to keep you updated; thus it is very important that all members keep their email addresses up to date. We also take the opportunity to invite our readers to participate in a series of regional reviews on graphonomic research. One of the aims of this series of reviews is to foster international research collaborations among IGS members, and to facilitate the exchange of recent research. Readers are also invited to submit letters, regular or occasional columns, book reviews, or news. Consider submitting brief tutorial papers or research notes. Remember, all contributions to eBIGS can be cited or referenced. For more information, please email us at [pepeum@wam.umd.edu](mailto:pepeum@wam.umd.edu) or [asgleedham@ntu.edu.sg](mailto:asgleedham@ntu.edu.sg).

This issue of BIGS contains a synopsis of IGS 2001 by Diana Romero, and contributions from Drs. Daniel Bullock and Brad Rhodes, and Dr. Ruud Meulenbroek on “Computational Handwriting Models: Issues and Trends” presented at the the International Workshop on Computational Handwriting Models, IWCHM 2000, University of Nijmegen, 28-30 June 2000. In addition, a list of news and recent publications relevant to IGS membership are compiled in this issue. As usual, BIGS is completed with an update of the Conference Agenda, workshops and other special events.

José L. Contreras-Vidal  
Graham Leedham

### IGS Board

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## ***Message from the President***



Montreal, November 1, 2001.

Dear Fellow members,

The last IGS conference, in Nijmegen, has been a great success! Ruud Meulenbroek and his team worked very hard to make this event an excellent meeting and I thank them all!

As you know there are some board members that will complete their term in 2002 and 2003 and we will have to replace them. If someone would like to help our organization in this context, please send me a short curriculum vitae by email ([rejean.plamondon@polymtl.ca](mailto:rejean.plamondon@polymtl.ca)) . I will contact the board with regard to the choice of the new members in the forthcoming weeks.

An important issue has been raised about the future of IGS during our panel session on August 8. The challenge is to find a way to attract researchers from the different fields of IGS even when a conference focuses on a specific theme. Hans-Leo Teulings (the Chairman of the next IGS conference in Arizona (USA) in 2003) and I will be glad to receive any suggestion from our members concerning this key issue. Please again feel free to exchange email with Hans-Leo ([NeuroScript@uswest.net](mailto:NeuroScript@uswest.net)) if you have any suggestion.

Réjean Plamondon  
President of IGS



## **IGS Feature**

**Report on the 10<sup>th</sup> Biennial Conference of the International Graphonomics Society.** By Diana Romero, Motor Control Laboratory, Department of Exercise Science and Physical Education, Arizona State University, PEBE, Room 107B Tempe, AZ 85287-0404, USA  
[dromero@asu.edu](mailto:dromero@asu.edu),  
<http://www.public.asu.edu/~dromero>



The 10<sup>th</sup> biennial IGS conference was held August 6<sup>th</sup> - 8<sup>th</sup> 2001 at the site of its origin: the University of Nijmegen, The Netherlands. The international scope of the society was reflected in the 71 attendees, who represented Europe, Australia, Asia, and North America. The special theme of the conference was Motor Disorders, and was organized as a single-track event spread over three days with 27 slide presentations in addition to a poster session. Dr. Andrew Schwartz from the Neuroscience Institute in San Diego, California and Dr. Mark Latash of Pennsylvania State University were the keynote speakers.

Dr. Schwartz started off the presentations by discussing his work concerning cortical neuronal activity in monkeys while drawing, and demonstrated that the activity patterns contain information pertaining to psychophysical invariants that may be used to predict movement. The subsequent three sessions that day involved populations with a variety of motor disorders, including patients with cerebellar ataxia, Parkinson's disease, schizophrenia, attention deficit hyperactivity disorder, and depression. The poster session followed, with the majority of presentations concerning pattern recognition and handwriting production.

Dr. Latash kicked off Day Two with a discussion that Bernstein's motor redundancy problem may not be a problem after all, but rather when viewed with new theoretical approaches, may be an example of the abundance of the system and an inherent part of a solution for natural motor tasks. Two sessions on motor control followed, with presentations concerning neuromotor noise, cyclic and discrete aiming, movement analysis and prediction, inter-joint coordination, and a model of movement generation. Day Three continued on with the focus on motor control with a variety of presentations on movement control, development, and disorders.

The diversity of attendee backgrounds and the single-track format provided the opportunity for interesting discussions and analysis of the research presented. Although the society is comprised of members in the areas of motor control, pattern recognition, forensic document examination, motor development, and computer simulation, the majority of the presentations were motor control oriented. Many of the projects presented, however, did utilize drawing or writing tasks, thus conforming to the "graphonomics" characterization of the society. A special issue of Human Movement Science is planned on the basis of a selection of the papers presented at IGS 2001 and is anticipated to be published late 2002.



The interesting and educational professional aspects of the conference were well balanced with fun and entertaining social and cultural events. Conference participants were kept well provisioned with coffee and snacks throughout the day, including an appetizing lunch. Tuesday afternoon attendees got treated to an outing to the Kroller-Müller museum, which houses a significant collection of works from famous artists and is located within a beautiful park. I personally was very impressed by the park: bicycles were available for the public's use and we had a great time riding in the countryside working up an appetite for the banquet to follow. The banquet was held at the Doddendael Manor House, a historic castle that was recently renovated. Entertainment was provided by a duet of a singer accompanied by a lute player, performing medieval songs that fit the ambiance of the manor. The superb food, wine, and entertainment made for a wonderful social evening enjoyed by all and was a definite highlight of the conference!

Having never attended an IGS conference, or any other conference with less than 300 participants, I really appreciated the organizing committee's attention to detail for making the conference welcoming and fun for the participants. The single-track format, the shuttle buses to and from the site, the nice meals, the great banquet and outing, were all well-planned and really provided the opportunity for socializing on both a professional and personal levels. I thoroughly enjoyed the conference and look forward to IGS 2003!

*Diana Romero is a doctoral candidate in the Motor Control Lab, Department of Exercise Science & Physical Education, Arizona State University, under the direction of Professor George Stelmach.*

## **IWCHM 2000**

International Workshop on Computational Handwriting Models  
University of Nijmegen, The Netherlands, 28-30 June 2000

As stated in the following welcome address, the goal of the international workshop was two-fold: First, to review the state of the art in the computational aspects of handwriting production, and second, but not least, to recognize the outstanding trajectory of Prof. Arnold Thomassen who officially retired as head of the Department of Experimental Psychology of the University of Nijmegen in 2000. Two extended abstracts from this workshop are included in this issue of eBIGS.



## IWCHM 2000

International Workshop on Computational Handwriting Models  
University of Nijmegen, The Netherlands, 28-30 June 2000

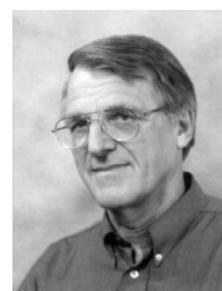
### Welcome address

The organizing committee of the International Workshop on Computational Handwriting Models 2000 is very pleased to welcome you to this workshop at the University of Nijmegen, 28-30 June 2000. In the preliminary communications the background and aims of the workshop were described as follows:

"In the 1960s a number of scientists, including Denier van der Gon, Thuring, Vredenburg and Koster, developed the first cybernetic models of handwriting. Since then, several neurocognitive and biophysical models of handwriting have been developed that have built upon and in turn extended the insights of these pioneers. The International Workshop on Computational Models of Handwriting will be aimed at discussing these advances. It will do so by bringing together researchers from a variety of disciplines who have recently taken up the challenge to apply their theories to the complex skill of handwriting."

It is the committee's view that recent advances in the area of computational handwriting models reflect important developments in the field of human motor control. The workshop's programme confirms this view and holds promises for interesting discussions. Your cooperation and the generous support by the Nijmegen Institute for Cognition and Information (NICI), the Faculty of Social Sciences and the Board of the University of Nijmegen (KUN), the Netherlands Organization for Scientific Research (NWO), and the International Graphonomics Society (IGS) have made it possible to organize IWCHM 2000.

IWCHM 2000 is also organized to honour Professor Arnold Thomassen who will officially retire as head of the Department of Experimental Psychology of the University of Nijmegen in 2000. Between 1985 and 1995 Professor Thomassen was President of the International Graphonomics Society (IGS) which is one of the ways in which he made significant contributions to our field. The workshop will be concluded by the official valedictory speech of Professor Thomassen.



On behalf of the IWCHM 2000 organizing committee,

Ruud Meulenbroek<sup>1</sup> - Workshop Organizer



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Organizing committee:

Prof. dr. Gerard P. van Galen<sup>1</sup>, Prof. dr. Stan C.A.M. Gielen<sup>1</sup>, Prof. David A. Rosenbaum<sup>2</sup>, Dr. Wouter Hulstijn<sup>1</sup>, Dr. ir. Frans J. Maarse<sup>1</sup>

<sup>1</sup> University of Nijmegen, Nijmegen, The Netherlands

<sup>2</sup> Pennsylvania State University, University Park, PA, USA

## ***Computational Handwriting Models: Issues and Trends \****

*Ruud Meulenbroek*

Nijmegen Institute for Cognition and Information  
University of Nijmegen, The Netherlands

An overview of computational handwriting models that have been developed since the 1960s demonstrates several interesting developments in the field of motor control. In the 60s and 70s central and peripheral information-processing models of handwriting were developed in relative isolation. Whereas the central-neurocognitive models emphasized hierarchical top-down information processes, the peripheral-biophysical models addressed heterarchical, bottom-up processes. Examples of these pioneering analyses of the control of handwriting movements are a neural model of variations in cerebral organization as a function of handedness and writing posture [1], the neurocognitive models of memory and motor processes involved in spoken and written language [2,3,4] and the cybernetic models of handwriting movements which, among other aspects, identified the minimum number of independent peripheral mechanisms that are responsible for the quasi-continuous pen-tip displacements that people generate during cursive handwriting production [5,6]. In the 80s and 90s the neurocognitive and biophysical models converged in various ways. Whereas neurocognitive accounts of handwriting yielded computational (neural network) models capable of automatically parsing and recognizing the peripheral stream of digitized pen-tip displacements (e.g., [7,9]), biophysical models gradually increased in complexity by describing control mechanisms at more central levels of the neuromotor system [9-17]. Researchers from many disciplines contributed to these developments. As a result a variety of important motor control issues are addressed by computational handwriting models. Examples of these issues are: motor equivalence, inverse kinematics, inverse dynamics, optimization principles, output variability control and perception-action relationships. In the presentation, the overview of computational handwriting models and the issues and trends in the study of human motor control that can be distinguished in this area, will be illustrated by discussing empirical evaluations of some claims that were made in various stages of model development.



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*\* Abstract prepared for opening lecture at the International Workshop on Computational Handwriting Models, IWCHM 2000, University of Nijmegen, 28-30 June 2000.*



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# ***An Adaptive Network Model of Cortico-Cerebellar Contributions to Practice Effects in Serial Movement Timing\****

**Brad Rhodes<sup>1,2</sup> & Daniel Bullock<sup>1</sup>**

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Learning and production of serial movements have recently received much attention from psychological and neuroscience experimentalists as well as modelers. We here reprise a new neural network theory (Rhodes, 2000) that specifies interactions among several distinct bases for serial movement learning and performance. For the classical keypress data of Sternberg, Monsell, Knoll, & Wright, Klapp, and Verwey, the model accounts for temporal characteristics of serial behavior performance both early and late in learning, and provides a unified treatment of changes that occur along the learning continuum. Key data properties that the model exhibits are: 1) a list length effect on latency early in practice that disappears with extended practice; 2) a pattern of long latency followed by markedly shorter inter-response intervals (IRIs) for non-initial sequence elements under two conditions: either with foreknowledge of a novel sequence to be produced and adequate opportunity to prepare for its execution, or without preparation but after significant amounts of practice; 3) a slowing of mean production rate for longer sequences that does not disappear with practice; and 4) a serial position dependence of IRIs that disappears after extended practice. The model is consistent with patterns of errors that are apparent during serial performance, as well as with the working memory dynamics implicated by recent word-length effects from immediate serial recall tasks.

The major elements of the model are: a fronto-cortical gradient-based representation of serial-order that provides a sequence production buffer and competitive queuing; and a cerebellar-based learning module that learns both serial chunks and individual responses. In the gradient representation, the relative activation level of primed items serves as implicit code of serial order. Through practice, the cerebellar learning mechanism learns to anticipate and preempt slower cortical loading of the appropriate gradient into the frontal production buffer as well as to speed up the execution of individual responses within the sequence. These major components, along with others included within the model, are compatible with neuroanatomical constraints and with the major trends emerging from neurophysiological, clinical, and brain imaging investigations of learning and performance of serial movements. The model in particular highlights the functional significance of projections from the deep cerebellar nuclei to the frontal cortex via the motor thalamus.



Production of novel, preloaded sequences is accomplished by the 'execution module' of the model. Although sharing gradient-based representation and competitive queuing selection of individual items with a major class of earlier models of serial movement production, this module resolves many problems not immediately evident within these earlier models given their algorithmic or difference equation specification. Only when implemented within a differential equation framework do many of these problems become obvious – and thus require resolution. Examples of such problems include complete deletion of selected items from the gradient buffer and prevention of premature selection of a subsequent item (before execution of the item currently being performed). This module also incorporates an automatic, but competitive, gain control system that governs overall function during the performance of a sequence. Gain must be switched between the gradient buffer and the components of the module responsible for actual execution of the selected item. This competition for gain assists in solving the problem of completely deleting items from the buffer once they have been selected for performance. It also embodies the type of working memory dynamics that Cowan has proposed to explain the word length effect, for example. The proposal is that the working memory representation (the gradient in the present model) decays during actual performance of an item and is then refreshed by searching that representation for the subsequent item. This execution module exhibits the human operating characteristics evident from the Sternberg and colleagues data related to performance of novel sequences.

A working memory submodule is incorporated to enable the model to construct a gradient representation as the model is presented with a series of input items – as would be the case in any task requiring performance of a novel sequence, such as a phone number. Once established, this gradient can be voluntarily transferred to the buffer of the execution module. This transfer process, a key constituent of voluntary preparation, triggers learning of the sequence in two other parts of the model. The first is a cortical chunking component capable of learning a compressive representation of the loaded sequence. This form of learning could (at least in part) constitute a form of explicit learning. It allows subsequent recognition, and recall of the sequence into the working memory subsystem, when initial items of the same sequence are presented at a later time. This chunk recognition operation provides an important contextual signal to the second learning component within the model: the cerebellar side-loop.

The transfer of the sequence from working memory to the production buffer within the execution module also provides a teaching signal to the cerebellar module. This teaching signal causes the latter to learn its own gradient representation of the sequence. After sufficient practice, presentation of the initial item(s) of a learned sequence causes the recognition component to provide the cerebellar module with a specific contextual input. Appearance of this input triggers the cerebellar module to rapidly instate its learned gradient for the sequence into the production buffer. This trans-cerebellar buffer loading occurs much more quickly than loading that utilizes the working memory. Such speeded loading has important implications for learning-dependent changes in the latency of first item production within a sequence.



Intra-sequence transitions, from earlier to later items, are also learned by the cerebellar module. This marks a second role within the overall model for the cerebellar sideloop. The differentiation between roles is solely based upon the input and output connections to and from the cerebellar circuits – as is the case *in vivo*. With extensive practice of a sequence, cerebellar learning reduces the latency between items and speeds up production of the entire sequence. Doing so relies upon the adaptive timing competence that is known to be provided by the cerebellar cortex. The necessity of embedding this competence within the context of sequence performance emphasized the issue of scalability and the importance of the recurrent nature of the cerebellar circuitry, and resulted in the development of a new model of cerebellar adaptive timing and sequencing. This Recurrent Slide and Latch (RSL) model is introduced and documented in Rhodes and Bullock (in press). There it is noted that timing and sequencing operations requiring entire cell populations in alternative models require only a few cells in the RSL module. The learning that occurs within this cerebellar module is a form of procedural learning.

A key feature of the dynamical model is stable, self-regulated interaction, from initial to late stages of practice, among the various components of the model. The theory explains how each component contributes different competencies, all of which appear necessary when attempting to explain the brain system responsible for serial learning and production. The involvement of multiple substrates is now well established. Of special interest is the model's incorporation of parallel and serial representations within a consistent and unified framework, because it allows a reconciliation of mechanisms previously treated as exclusive alternatives. The gradient buffer, chunking apparatus, and the first of the cerebellar module roles are fundamentally parallel; the second cerebellar role, with its exploitation of recurrence, is fundamentally a serial mechanism. The latter is typical of sequence learning and production models in which the sequence is not explicitly represented, but instead is recovered only when the system runs. Thus, the current model hypothesizes a distinct role for each of two major classes of mechanisms previously proposed to explain serial organization in learning and performance.

Although the model has not yet been applied beyond the domain of button pressing tasks, it is extensible to cover many types of performance in which subjects learn stable sequences defined over finite sets of items. Included here are linguistic performances, such as typing, handwriting and speech production. The structure of the model makes it compatible with prior cognitive proposals that emphasize how chunking maximizes effective use of working memory and output buffers that have a severely limited (e.g., 4-7 item) capacity. For handwriting, the most compatible treatments are dynamic neural network models that generate cursive forms via overlapped readout of a small number of discrete linear strokes represented in a motor buffer (e.g., Bullock, Grossberg & Mannes, 1993; Contreras-Vidal, Poluha, Teulings & Stelmach, 1998).

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Rhodes B, Bullock D (in press) A scalable model of cerebellar adaptive timing and sequencing: The recurrent slide and latch (RSL) model. *Applied Intelligence*, in press. (Also in technical report CAS/CNS-TR-2000-021)

\* *Abstract prepared for the International Workshop on Computational Handwriting Models, IWCHM 2000, University of Nijmegen, 28-30 June 2000. This work was supported in part by the Office of Naval Research (ONR N00014-92-J-1309, ONR N00014-93-1-1364, and ONR N00014-95-1-0409) and The University of Ballarat.*

### **IGS News**

- With this issue, the Bulletin of the International Graphonomics Society becomes on-line and the printed version is discontinued. To make sure you receive the IGS Bulletin, Society information, and other valuable information please update your email address by sending an email to the Secretary/Treasurer at [gemmert@asu.edu](mailto:gemmert@asu.edu).
- The IGS office has been transferred from Nijmegen to the new Secretary/Treasurer, Arend van Gemmert at Arizona State University in Tempe (USA). His email address is [VanGemmert@asu.edu](mailto:VanGemmert@asu.edu). A new membership payment procedure is still being explored but will probably be 'electronic only'.
- A limited number of the proceedings of the tenth biennial conference of the IGS is still available. The volume contains 41 four to seven page extended abstracts (228 pages). A list of the titles and the names of the authors of the abstracts can be found at the IGS 2001 conference Website at <http://www.socsci.kun.nl/psy/igs/>. To order a copy you can contact Ruud Meulenbroek at [meulenbroek@nici.kun.nl](mailto:meulenbroek@nici.kun.nl). Price: USD 25.
- A photograph of IGS 2001 participants can be downloaded from the conference Website ([www.socsci.kun.nl/psy/igs/igs\\_2001/](http://www.socsci.kun.nl/psy/igs/igs_2001/)); when this site is inactivated (i.e. as soon as the Website IGS 2003 is made accessible), the photograph will be made accessible through the IGS Website.
- A special issue of Human Movement Science on the basis of a selected number of IGS 2001 contributions is being prepared



## **Recent Publications**

In this section of BIGS the bibliographical details of recent publications relevant to the IGS are reported. In addition to publications by IGS members that were reported to the IGS office, the results of searches in Medline are given that were directed at papers on handwriting and related graphic skills, which were published during the six months prior to the distribution of BIGS. IGS members are invited to report the bibliographic details of their recent publications to the IGS office.

Siebner HR, Limmer C, Peinemann A, Bartenstein P, Drzezga A, Conrad B. (2001) Brain correlates of fast and slow handwriting in humans: a PET-performance correlation analysis. *Eur J Neurosci.* Aug;14(4):726-36.

Matsuo K, Kato C, Tanaka S, Sugio T, Matsuzawa M, Inui T, Moriya T, Glover GH, Nakai T. (2001) Visual language and handwriting movement: functional magnetic resonance imaging at 3 tesla during generation of ideographic characters. *Brain Res Bull.* Jul 1;55(4):549-54

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Smits-Engelsman BC, Niemeijer AS, van Galen GP. (2001) Fine motor deficiencies in children diagnosed as DCD based on poor grapho-motor ability. *Hum Mov Sci.* ;20(1-2):161-82.

Kam M, Gummadidala K, Fielding G, Conn R. (2001) Signature authentication by forensic document examiners. *J Forensic Sci.* 46(4):884-8.

Katanoda K, Yoshikawa K, Sugishita M. A functional MRI study on the neural substrates for writing. *Hum Brain Mapp.* ;13(1):34-42.

Bergeron BP. (2000) Pen-based computing: applications in clinical medicine. *J Med Pract Manage;* 16(3):148-50

## **Forthcoming Conferences**

### **16th INTERNATIONAL CONFERENCE ON PATTERN RECOGNITION ( ICPR 2002)**

ICPR 2002 is the sixteenth conference of the International Association for Pattern Recognition (IAPR) and is organized in cooperation with the IEEE Computer Society and supported by the Canadian Image Processing and Pattern Recognition Society (CIPPRS). The ICPR 2002 Theme will be



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“Pattern Recognition for Mankind and the Environment” and the conference will be an international forum for discussions on recent advances in the fields covered by the four conference tracks:

Track 1: Computer Vision and Robotics

Track 2: Pattern Recognition, Neural Networks, and Document Analysis

Track 3: Image and Signal Processing

Track 4: Biomedical and Multimedia Applications

**Organizing Committee:**

General Chair: Ching Suen, Concordia University, Canada

Technical Program: Rangachar Kasturi, Penn State University, USA

Sponsorship and Publicity: Réjean Plamondon, École Polytechnique, Canada

Tutorials and Demos: Denis Poussart, Université Laval, Canada

Local Arrangements: Denis Laurendeau, Université Laval, Canada

Finance Committee: Jean-Guy Deschênes, École Polytechnique, Canada

Xavier Maldague, Université Laval, Canada

**Paper Submission:**

Authors are invited to submit their latest unpublished research work to IAPR's highly attended conference. Information on manuscript format and instructions on paper submission is available at the conference web site.

**Tutorial Submission:**

The Organizing Committee invites interested researchers to send proposals for the Tutorial Program. Instructions for submitting tutorials are available at the conference web site (<http://www.icpr2002.gel.ulaval.ca>).

**Important Dates:**

-Deadline for paper submission: 1 December 2001

-Deadline for tutorial submission: 15 January 2002

-Notification of acceptance: 1 March 2002

-Camera ready papers and author registration: 15 April 2002

-End of early bird registration period: 15 April 2002

**Conference Location:**

ICPR 2002 will be held at the Quebec City Convention Center. Quebec City is known for its French culture and European tradition, its beautiful scenery along the St-Lawrence River, excellent food, and exceptional quality of living.

**Conference Secretariat:**

ICPR 2002 - Quebec City

c/o Agora Communication

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