IEEE Information Theory Society Newsletter

President's Column

Andrea Goldsmith

I write this article on the first warm day of spring in the Bay Area, with my kids outside making a small fortune from their lemonade stand. As the natural world begins its cycle of renewal for the year, I thought I would reflect briefly on the cycles of renewal our field and society has experienced over the years, and the current one in progress.

The roots of our field and society began with Shannon's "A Mathematical Theory of Communication" at the dawn of the Information Age. This Age, which began in the 1950s, dictated a shift from the Industrial Revolution economy to one based around the manipulation of information. Shannon's work provided a mathematical framework for quantifying this information and for determining the fundamental limits on its compression and reliable communication. Yet technology was so far behind what Shannon theory predicted in 1948 that its initial relevance to the Information Age was far from clear.

Our society was formed shortly after publication of Shannon's work as the Information Theory Group of the Institute for Radio Engineers (IRE). The first Information Theory Symposium took place in London in 1950 with about 20 papers. These papers and commentary on them comprised the first Information Theory Transactions, which appeared in 1953 (I guess our publication delays have long historical roots). The dynamic growth of Information Theory during its first decade was coupled with a dramatic technology shift in 1958, instigated by the invention of the integrated circuit. Over the next two decades, as circuits improved exponentially in performance and complexity, the coding and communication techniques developed by information theorists began to find their way into information technology, including data storage, deep space communications, satellite systems, military radios, and data modems. The field of Information Theory also grew beyond compression, coding, and communication to encompass new areas, including networks, stochastic processes, and signal processing. The society evolved over this period as well, dropping its status as a "Group" to become an IEEE Society, increasing the Transac-

tions from quarterly to bimonthly publication, instituting Shannon lectures at the annual symposia, and expanding the disciplines, number, and countries of its members.

The 1980s and 1990s saw tremendous growth in information technology, particularly in mobile communications and Internet usage. These systems capitalized on information-theoretic ideas for multiuser wireless communication, coding, and data storage, which were easily and cheaply implemented with the technology of the day. Commercial success of these systems brought growth and visibility to our society, including new generations of information theorists, growing membership throughout the world, and new areas of investigation including cryptography, quantum information theory, pattern classification, learning, and automata. The Information Theory Symposium also expanded globally, taking place in Asia for the first time in 1988. As the 1990s came to a close, we celebrated the 50th anniversary of Shannon's landmark paper with a special anniversary symposium and issue of the Transactions, conversion of the Shannon lecture to a Shannon award, and recognition of information-theoretic discoveries, advances and inventions with a profound impact on information technology through the Golden Jubilee Awards.

Which brings us to the current decade and beyond. Although some believe the "golden era" of Information Theory is behind us (which, incidentally, was predicted as far back as 1955), I find these predictions to be premature. In fact, the dawn of the twenty-first century finds our social and professional activities more dependent than ever on communication networks and devices as well as easy access to and manipulation of information. As the information we access and the networks over which we access it become more complex and unpredictable, defining and solving relevant problems in Information Theory becomes more challenging, which means there is much more work for us to do. Information Theory also continues to forge connections with new areas such as security, biology, neuroscience, and sensing. There are great challenges in defining a common language and

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From the Editor

Tracey Ho

Dear IT Society members,

I'm glad to have the opportunity to serve the IT Society as the new newsletter editor, and I thank the Board of Governors for entrusting me with this role. Please join me in thanking the outgoing newsletter editor Daniela Tuninetti for all her work, and congratulating her on doing an outstanding job. I am also personally very grateful to her for all her help and advice in getting me up to speed, and to the present and former society presidents Andrea Goldsmith and Dave Forney, for their advice in editing my first issue.

Sadly, this issue comes with the news of Ralf Koetter's passing. Ralf was a wonderful and brilliant mentor and dear friend to me, as he must have been to many. I was very fortunate to spend a grad student summer and a short postdoc with him in Illinois. Typical of his kindness, when my summer housing fell through, he insisted that I should simply stay with his family. In this issue he is remembered by his friend and former postdoc adviser Alexander Vardy.

On a happier note, the many activities and initiatives described in this issue show that the IT Society is thriving and headed in exciting new directions. News items include the commemoration of the 30th anniversary of the CD with the IEEE Milestone Award, and Thomas Kailath receiving the Padma Bhushan award from the President of India — congratulations! Venturing into more unusual territory, a fun article on information theory and wine, forwarded by Ezio Biglieri, is reproduced in this issue.

Please help to make the newsletter as interesting and informative as possible by offering suggestions and contributing news. The deadlines for the next few issues are:

Issue	Deadline
September 2009	July 10, 2009
December 2009	October 10, 2009
March 2010	January 10, 2010

Announcements, news and events intended for both the printed newsletter and the website, such as award announcements, calls for nominations and upcoming conferences, can now be submitted jointly at the IT Society website http://www.itsoc.org/, using the quick links "Share News" and "Announce an Event". For more details please see the article on the new website in this issue.

Articles and columns intended only for the printed newsletter should be e-mailed to me at tho@caltech.edu.

Please submit ASCII, LaTeX or Word source files; do not worry about fonts or layout as this will be taken care of by IEEE layout specialists. Electronic photos and graphics should be in high resolution and sent as separate files.

I look forward to your contributions and suggestions for future issues of the newsletter.

Tracey Ho

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framework within which our mathematical tools and insights can impact these disparate fields. The current era also denotes a shift in our society, with many of its founding fathers no longer active, and a new generation of society leaders taking the helm. I joined the society BoG in 2003 and, since then, I have seen many important changes in the society put in place to maintain our relevance and vibrancy through the next decade and beyond. My goal as president has been to nurture these changes and instigate new ones with the same goals. In the next few paragraphs I will report on these new and ongoing initiatives as well as the current state of the society.

As I reported in my March column, the state of our society is strong with respect to our Transactions quality, conference attendance and quality, prestige and recognition of our members, student engagement, and chapter activity. A new and unwelcome development this year has been with respect to our finances. The IEEE investments have declined by approximately one third, and hence our reserves have dropped from about $300K to under $200K. Despite these heavy losses, our finances are still in good shape for this year, and even support some new initiatives. However, there are some long-term risks looming due to changes in the formula for our Xplore income from conference proceedings, which will reduce our annual income by about $110K within the next two years. While the society budget can weather this change and remain (barely) in the black, long-term planning is required to mitigate financial risks and continue to fund our current initiatives as well as new ones.

In order for us to remain vibrant, relevant, and at the forefront of research in our field, I believe it is imperative that we reduce the publication delays of our Transactions. This submission-to-publication (sub-to-pub) time currently stands at just under two years, the largest for any of the IEEE Transactions. The Publications Committee has taken substantial action in this regard, as reported at the March BoG meeting. In particular, our editor-in-chief (EiC) Ezio Biglieri has recommended setting stringent deadlines on each stage of the editorial process, in particular for reviews, editorial decisions, and author revisions. Has has also recommended to reduce AE load by increasing the number of AEs from 36 to 50. This raised some concerns about AE quality, which will be alleviated by doing away with our informal policy of precluding people that have served as AEs any time in their career from serving again. Better training of AEs was also recommended, along with a clarion call to our members (in their roles as authors, reviewers, and editors) of our shared responsibility to do this job well. The ad-hoc committee of the Publications committee, chaired by Alex Grant, also reported on their investigation of upgrades to Pareja that would help AEs and the EiC do their jobs better. In the end, the committee recommended that we migrate from our home-grown Pareja system where we are the sole user to Manuscript Central (MC), a professional web-based paper processing service used by 280 professional societies and over 2800 books and journals. The BoG unanimously supported the EiC's recommendations as well as the MC migration recommendation, which is now before the Publications Committee. These recommendations are not without controversy or risk. However, significant change is needed to address the core cultural, structural, and technology problems contributing to our severe publication delays. While these changes won't reduce our sub-to-pub time overnight, they seem to hold much promise for making significant gains over time, and will be closely monitored to determine their impact and value.

Another set of changes approved in the March BoG meeting related to society governance. Our society has always been governed congenially by the BoG with very limited bureaucracy or hierarchy, which is one of our greatest strengths. However, as our activities have grown and diversified, some of decisions and oversight have shifted to committees. In order to ensure more oversight of the discussions leading to these decisions, it was proposed to make one or more officers ex-officio members of all committees where not already in place. In particular, the BoG voted to make the President and 1st VP ex-officio members of the Conference and Online Committees, and the 2nd VP an ex-officio member of the Student and Outreach Committees.

In terms of new initiatives, the Distinguished Lecture program will launch this year, our website launched in February and recently surpassed 10,000 hits, the outreach committee has begun a mentoring program matching young researchers with more senior colleagues, and the Second Annual North American School of Information Theory for graduate students and postdocs will take place this fall with the inaugural Padovani Lecture given by Abbas El Gamal. More details can be found elsewhere in the newsletter. Our society members have been frequently honored with prestigious awards, and there are some recent developments on this front as well. A new award has been established, the BBVA Foundation Frontiers of Knowledge Award in Information and Communication Technologies, to honor outstanding research work and practical breakthroughs in this area. We are fortunate to have one of our best-known members, Jacob Ziv, as the inaugural winner of this award. In addition, we have received a key approval from the IEEE on reinstituting the Baker Prize. This prize, co-sponsored by societies across the IEEE, will go to outstanding papers on fundamentals of electrical engineering published over a five-year window. For new award developments within the society, the first solicitation of outside nominations for the Shannon Award was a success, with six nominations received including several names that had not been considered before. The Shannon committee is in the midst of deliberations based on these external as well as internal nominations, and the winner will be announced, as usual, at the ISIT banquet.

This article will appear in June, a busy month for our society, with a workshop on networking and Information Theory in Volos, Greece and our International Symposium in Seoul, Korea a few weeks later. In the fall we host another workshop in Taormina, Sicily, perhaps the first time that all three of our society meetings take place outside the United States. You can hear much more about the state of our society and progress on initiatives at the society's annual BoG meeting, which will be held the afternoon of June 28 at ISIT. The last BoG meeting of 2009 will take place the afternoon of October 11 in Taormina. Meeting agendas and locations will be posted to the society website about two weeks before each meeting. The meetings are open to all, and BoG meeting attendance is a great way to meet society leaders, learn how the society is governed, and get more involved in society activities. Alternatively, you can contact me (at andrea@ee.stanford.edu) or the other officers and BoG members with your ideas, concerns, or interest in volunteering. The future vibrancy and relevance of our society and research rests in the hands of our current and future members. It is your ideas, participation, and hard work that will sustain the golden age of Information Theory and our society for many decades to come.

The Historian's Column

Anthony Ephremides

Whether we work in academia or industry or government labs and whether we are consultants or private investigators, an important part of what we do is performing on stage! Yes, strange as it sounds if we put it this way, we are indeed required to make presentations, give lectures, conduct discussions, run short courses and talk to all manner of audiences. Of course, there is a difference between giving a scientific talk and performing in a play or a musical show. But there are subtle similarities too. As I look back along almost half a century, I find delightful moments of "stage experiences" for myself as well as for others.

To begin with what we share with actors and art performers is stage fright. That feeling of cold sweat, the grip in the stomach, the shaking of the knees. Today I see it mostly in inexperienced students but also in accomplished professionals. In the past I experienced it myself. In retrospect I think it is a rite of passage that helps us cement our self-confidence and overcome self-doubt. Eventually most of us outgrow it but not everyone. In fact, some of the most famous and well-known people in our community, whom I shall not name, suffer from it but in a "reverse" fashion. That is, the more established you are the higher the pressure to perform superbly. People expected that every time Domingo or Pavarotti (substitute your favorite researchers from our community for their names) appeared on stage, they should surpass their past accomplishments. Setting the bar high sets in motion a phenomenon of "positive feedback" that leads to the bar being raised by a little every time you make an appearance. Of course, there are exceptions to this fear. There are some who either because of ignorance or supreme confidence get on stage and enjoy every moment of it. Oblivious of the audience's reaction they execute their routines with ease and dexterity whether they improvise or not. The same is true for stage actors. You need of course to know "your lines" so to speak. But beyond that, achieving a transcendental delivery of the presentation is a supreme accomplishment that remains the envy and "holy grail" for most of us.

Then there is the element of communicative skills. This is something akin to what we call voice projection in singing; some of us manage to "reach" our audiences better than others. Making eye-contact with the audience as opposed to talking to the board or the screen is an important component of communication talent. Often this skill is combined with the ability to entertain. It is an unfortunate fact, however, that audiences demand from the speaker continuously increased level of ability to capture their attention. Not unlike the case of drug addiction, they need a higher and higher dosage of entertainment value to stay tuned. This is especially true of students. One of the most disappointing experiences of an instructor is the sight of students (or audiences) falling asleep during the lecture. To keep them engaged it is necessary to invent unusual and innovative stimuli and to exaggerate in order to catch their attention. As an example, consider the case of a high school teacher of mine (he was teaching us Physics) who would present us with striking scenaria like "we let a stone weighing one kilo fall for fifty hours" or "in Rome there are at least two million nuns riding mopeds" or "in Hungary they have horses that are seven meters long; you don't see them here because our streets are too narrow". The ability to inject comedy into a lecture without converting it to a farce is the uncanny prerogative of exceptional individuals. If you think a little I am sure you will be able to name a few.

The third ingredient of "performing" in our profession is, of course, preparation. Designing and rehearsing a presentation is a necessity. I remember a nightmare I had once when I dreamed that I was about to sing the title role of Boris Godunov on the stage of the Metropolitan Opera and as the curtain went up I realized with horror that I did not know the lyrics. Again there are those exceptional individuals who, through a mix of experience and sheer internal talent, seem to not require much preparation. The best way to experiment with your ability to do that is to walk into your class without notes and without memorizing anything. Learning to talk around a subject when you cannot discuss it directly is a rare and very valuable talent.

Finally, there is the indefinable aura that some amongst us seem to possess. This is akin to what we refer to as charisma in public figures and politicians. There are people whose work is highly respected but their presentations are dreaded. And there are, at the other extreme, lightweight researchers who "dance" with ease and skillfully on the stage and manage to capture audience affection.

It is strange that what we fail to do at schools and universities is to train students in this sort of performing. As actors go through drama school and singers through classes of musical training, we must introduce and maintain programs for training our students in public speaking and oral discourse in general. All too many of them are not only "green" in this respect, when they enter the profession, but also become rigidly resistant to "on the job" training.

Ultimately, to be a good expositor one needs the following ingredients: a "big mouth", a "big ego", and a "big heart" as my colleague Curtis Manyuk suggested. Indeed, you need to like to talk. If you don't you are dead on arrival. There will be no hope for redemption. Then you need to be a "ham" and hug center stage. You must embrace the conviction that you are the greatest. If you are timid and modest you tend to undercut your potential. And last, but not least, you need to like reaching out and offering the invaluable service of educating. If you don't like to reach out to other people you are condemned to stay confined to solitary irrelevance, even if you do first-rate research.

Thinking of ourselves as actors is not only adding flare to what we do. It is actually adding value, and effectiveness and confirms the purpose of our professing which is, above all, service to human kind. And it does not take extraordinary arguments to establish that the podium or the blackboard is also a stage for the performing arts. After all, it has been said that "the whole world is a stage".

In Memoriam, Ralf Kötter

This winter, the information theory community lost one of its giants: Ralf Kötter passed away in Munich, Germany, in the early morning hours of February 2, 2009. During the past 15 years, his seminal contributions have transformed our field, and his work will surely remain a source of inspiration for years to come. Those of us who have had the privilege to know Ralf personally will cherish the memory of a towering intellect, with a big heart and a gentle soul.

Ralf Kötter was born in Königstein im Taunus, Germany, on October 10, 1963. He received his Diploma in Electrical Engineering from the Technische Universität Darmstadt, and earned a Ph.D. in Electrical Engineering from Linköping University, Sweden, under the supervision of Thomas Ericson. After a brief sojourn at the IBM Almaden Research Center, Ralf joined the University of Illinois Urbana-Champaign, where he remained for the major part of his career, from July 1997 until December 2006. During the last two years of his life, Ralf was at the helm of research in information theory and communications in Germany, as Head of the Institute for Communications Engineering at the Technische Universität München (TUM).

Ralf received numerous awards for his work, including the Information Theory Society Paper Award (2004), the Vodafone Innovations Award (2008), the Best Paper Award from the Signal Processing Society (2008), and the ComSoc & IT Joint Paper Award (2009). He served as Associate Editor for the IEEE Transactions on Information Theory and the IEEE Transactions on Communications. He was Technical Program Co-Chair for the 2008 International Symposium on Information Theory, and twice Co-Editor-in-Chief for special issues of the IEEE Transactions on Information Theory (one on factor graphs and iterative decoding, and the other on networking and information theory). During 2003-2008, he served on the Board of Governors of the IEEE Information Theory Society, taking active part in several key committees and initiatives.

Goethe once said: what is demanded of genius, first and foremost, is love of truth. Ralf's love of truth was limitless. He had the ardent will and the innate ability to address every research problem he encountered at its most fundamental level. He always strove to understand the very heart of the problem, wherein he often found the truth and the beauty he was seeking. It is no coincidence that so many of Ralf's results are now counted among the most "beautiful" theorems in our field.

A good example is Ralf's work in network coding. He started on this track in earnest at the Information Theory Workshop in Metsovo, Greece, in June 1999. At the workshop, Raymond Yeung presented his paper on linear codes for network multicast, which later won the Information Theory Society Paper Award. It was a great result, and everyone in the audience was happy

to accept it at face value. Everyone, that is, except Ralf. He went on musing, thinking, seeking the beauty and the truth... These musings eventually led to his paper with Muriel Médard which not only established the algebraic foundations of the field, but also brought the ideas of network coding much closer to practice. Indeed, the principle of *randomized network coding*, first developed in a series of papers by Ralf and his colleagues, critically relies on the underlying algebraic structure. The end result is an ingenious, completely decentralized, network-coding protocol, which bridges a fundamental gap between the theory of network coding and the practice of communication networks. The impact of network coding in general, and of Ralf's contributions to this field in particular, on the design, optimization, and operation of future high-performance networks is one of the most exciting areas of research in information theory today.

Ralf's early work, dating back to his student days at Linköping, was already a treasure-trove of wonders. One of the algorithms sketched out in his Ph.D. thesis is now known as the Kötter algorithm and universally recognized as the best approach to multivariate interpolation over finite fields. Much later, Ralf and I, in collaboration with several others, developed VLSI for this algorithm running at over 3.0 Gbps. According to Dick Blahut, Ralf's thesis also "made the well-known Forney formula obsolete," by showing how to compute error values on the fly during Berlekamp-Massey decoding. His 1995 paper with Wiberg and Loeliger developed the foundations for the theory of *factor graphs*. This paper still underlies much of the current research into the behavior of message-passing algorithms, and is one of the most cited references in this area. Ralf's short stint at the IBM Almaden Research Center led to key patents in the area of magnetic recording: the results of his work during that period are now implemented in IBM products. During the year and a half we spent working together at the University of Illinois, we produced half a dozen papers on a broad array of subjects, ranging from the theory of tail-biting trellises to signal-space characterization of iterative decoding. The papers I wrote with Ralf are among the best papers I ever wrote.

It would be futile to attempt recounting *all* of Ralf's contributions in the confines of this brief eulogy; a comprehensive tribute to his work is planned for a later date. Thus let me now fast-forward to the last few years of his life, a life that was cut so woefully short by cancer. Many have described Ralf's fight with cancer as brave and heroic. It was. It was also unyielding. While his body was giving up on him, the disease never got the upper hand in the battle with his spirit. The last major conference that Ralf attended was the Oberwolfach Kodierungstheorie Workshop in December 2007. He arrived there after a heavy dose of chemotherapy and confided to me, in private, that he felt really

Ralf Kötter, 1963–2009

Award Announcement

Prof. Thomas Kailath, Professor Emeritus, Stanford University, and winner of a number of IEEE medals including the 2007 Medal of Honor, has been awarded the prestigious Padma Bhusan Award by the Govt. of India. Padma Bhushan is a national award (mid level in a three tiered system) and is given for the most eminent contributions in the sciences, business, arts and social welfare. About a dozen Padma Bhushan awards are given each year.

Prof. Kailath received the award from the President of India on April 14, 2009 at the Presidential Palace, New Delhi, India.

Padovani Lecture at the 2009 School of Information Theory

Gerhard Kramer

The IEEE Information Theory Society has recently endowed a Padovani Lecture to be held at the annual School of Information Theory. The lecture is sponsored by a generous gift by Dr. Roberto Padovani and will provide a stipend and travel support for an out-standing lecturer at the School. We are pleased to announce that the first Padovani Lecturer is Prof. Abbas El Gamal of Stanford University. Prof. El Gamal has made profound contributions to both academic and industrial research, contributing to the development of digital imaging, network information theory, and integrated circuit design, and cofounding Silicon Architects which is now part of Synopsys. The 2009 School of Information Theory will be held Aug 10–13, 2009, at Northwestern University. For more information, please visit the School website at http://www.itsoc.org/people/committees/student/2009-school-of-it/

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sick. While most people knew, nobody could tell. Ralf was his usual self: happily soaking up every bit of new research, going for long walks to discuss his latest ideas, eagerly taking part in lively conversations that often lasted into the morning hours. In fact, those few attendees that were blissfully unaware of his condition left Oberwolfach in the same state of blissful ignorance (I recall one of them asking Ralf on the last day why he decided to shave his head, a question that Ralf simply shrugged off).

I also recall visiting Ralf at the Freising hospital near Munich in January 2009. He could no longer walk. He had just undergone a terrible operation. His blood counts were dangerously low. Yet, what concerned Ralf the most that wintry day was that, for the first time ever, someone else was teaching his lectures at TUM. He spent most of the day on the phone with his assistant, making sure that the latter was well-prepared for the lecture. During that week in January 2009, we talked about so much… Ralf was eager to catch up on the latest news in research. Which papers at the ISIT in Toronto turned out to be the most interesting? What was I working on? What was everyone else doing? There, at the hospital in Freising, Ralf and I started a new research project going: list-decoding of the Kötter-Kschischang codes on the operator channel. It was fun again!

I believe that information theory has inherent intellectual beauty that has always attracted the best and the brightest people. We have been particularly fortunate to have Ralf Kötter join our research community. His passion for information theory knew no bounds, his mighty intellect and his wondrous spirit etched an everlasting stamp on our field. He has been a shining light, a light that was extinguished much too soon. We will miss you, Ralf.

Alexander Vardy

Philips Honored with IEEE Milestone Award for Development of CD

Martin Bastiaans and Frans Willems

On March 6th 2009, Royal Philips Electronics received the prestigious IEEE Milestone Award for its contribution to the development of the compact disc (CD). John Vig, President of the IEEE, presented the award to Rick Harwig, Chief Technology Officer of Philips Electronics, at a Ceremony that was hosted by Eindhoven's University of Technology. The Award Ceremony, which ended with the unveiling of a bronze plaque, coincided with the 30th anniversary of the historic demonstration of the first CD prototype, codenamed "Pinkeltje", on March 8th 1979, to an audience of about 300 journalists in Eindhoven. This compact disc had a diameter of 11.5 cm. To come to a worldwide standard Philips teamed up with Sony, which had developed a 30 cm digital optical disc audio system in the late seventies. The CD-audio system became a worldwide success and had several successors, of which the Blu-ray Disc is the most recent one. The demonstration of the CD in 1979 marks the beginning of the digital entertainment era, and the CD, whose performance strongly relies on error correction and digital modulation, is the first successful consumer product based on Shannon's ideas. Since its introduction in 1982, an astonishing amount of 240 billion CDs have been sold, which results in an average of 40 discs per person on Earth.

The Award Ceremony was attended by more than 300 persons. Among them were many that had contributed to the development of the CD in the early days. Highlight at the Ceremony was the presentation of Joop Sinjou, the project leader at the Philips industry group "Audio" in the seventies responsible for the development of the CD, in which he discussed the technical progress within Philips that eventually resulted in the demonstration in 1979. Sinjou also played a major role in the cooperation with Sony. This cooperation resulted in a joint standard in 1980. Hiroshi Ogawa, who was a member of the Sony team at that time, gave a presentation of Sony's developments related to the compact disc.

During the Award Ceremony, Hans Peek presented the first copy of the Milestone Book with the title "Origins and Successors of the Compact Disc" to Joop Sinjou. The book, edited by J.B.H. Peek, J.W.M. Bergmans, J.A.M.M. van Haaren, F.J.C.M. Toolenaar, and S.G. Stan, retraces the origins of the CD system and the subsequent evolution of digital optical storage, with a focus on the contributions of Philips to this field. The book is published by Springer, Philips Research Book Series, Vol. 11, ISBN 978-1-4020-9552-8.

More information on the Compact Disc Milestone Event can be found on http://www.ieee.nl/milestone.html.

John Vig, President of the IEEE.
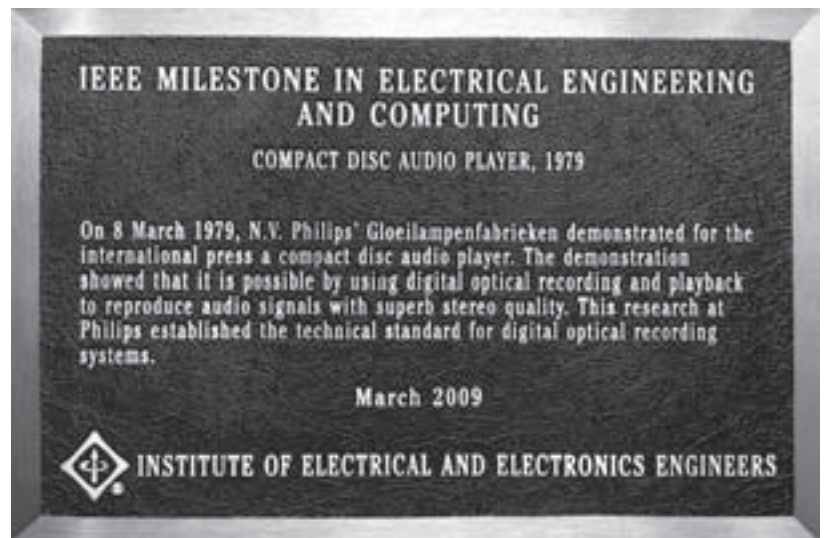
Bronze plaque with the IEEE Milestone citation.

GOLOMB'S PUZZLE COLUMN™

Some Partition Problems

Solomon W. Golomb

Let $p(n)$ denote the number of *partitions* of the positive integer n (that is, the number of ways to write n as a sum of positive integers without regard to order) and let $P(n)$ be the number of *ordered* partitions of n (that is, the number of ways to write n as a sum of positive integers where the order of the summands matters). For example, since $3 = 2 + 1 = 1 + 1 + 1$, $p(3) = 3$, but $P(3) = 4$ since $2 + 1$ and $1 + 2$ are counted separately.

Let $p_k(n)$ denote the number of (unordered) partitions of n into exactly k (positive) parts, and $p_{\bar{k}}(n)$ be the number of (unordered) partitions of n into at most k parts. Let $P_k(n)$ denote the number of ordered partitions of n into exactly k (positive) parts, and $P_{\bar{k}}(n)$ be the number of ordered partitions of n into k non-negative parts.

A. 1. Give an expression for $P_{\bar{k}}(n)$, in terms of n and k.

   2. Give an expression for $P_k(n)$, in terms of n and k.

Let $p'_k(n)$ be the number of (unordered) partitions of n into exactly k parts where there is no common divisor $d > 1$ of all the parts. (Note that such a divisor d would also divide n.) Let $P'_k(n)$ be the number of ordered partitions of n into exactly k parts where there is no common divisor $d > 1$ of all the parts.

B. 1. Give an exact expression for $p_2(n), n \geq 1$.

   2. Give an exact expression for $P_2(n), n \geq 1$.

   3. Give an exact expression for $p'_2(n), n \geq 1$.

   4. Give an exact expression for $P'_2(n), n \geq 1$.

   5. Show that $p_3(n)$ is a monotone increasing function of n for $n > 3$.

   6. Prove that for prime $n > 5, p'_3(n)$ exceeds $p'_3(m)$ by at least 2 for every $m < n$.

   7. Can you prove that $p'_3(n)$ is even for all $n > 4$?

   8. Find an expression for $p_3(n)$, for all $n \geq 1$.

   9. Find an expression for $p'_3(n)$, for all $n \geq 4$.

Equivalence Relations Solutions

Solomon W. Golomb

1. Here is one representative example for each of the eight subsets of the three conditions (Reflexive, Symmetric, and Transitive) on binary relations $B(x, y)$ on the set Z^+ of the positive integers.

	R	S	T	B(x,y)
1.	×	×	×	$x = y + 3$
2.	×	×	✓	$x < y$
3.	×	✓	×	$x \neq y$
4.	×	✓	✓	$\max(x,y) < 100$
5.	✓	×	×	$x > y - 5$
6.	✓	×	✓	$x \leq y$
7.	✓	✓	×	$|x - y| < 10$
8.	✓	✓	✓	$x \equiv y \pmod 7$

2. Each of (*a*) through (*f*) is obviously true when $x = y$ (and hence Reflexive), and these statements make the same assertions when x and y are interchanged (hence Symmetric). We will quickly verify that each is also Transitive.

   (a) "$x + y$ is even": If $x + y$ is even (say $2s$) and $y + z$ is even (say $2t$) then $x + z = (x + y) - y + (y + z) - y = 2s + 2t - 2y = 2(s + t - y)$, an even number.

   (b) "xy is a perfect square": If $xy = s^2$ and $yz = t^2$ then $xz = \left(\dfrac{st}{y}\right)^2$, and it is well known that if r is rational (e.g. $\dfrac{st}{y}$) and r^2 is an integer (e.g. xz), then r must be an integer.

   (c) If, as binary numbers, x and y end in the same number of zeroes (say t zeroes), and y and z end in the same number of zeroes (again t, because of y), then all three of x, y, and z end in this same number of zeroes (e.g. t zeroes), from which, in particular, x and z end in this same number of zeroes.

   (d) If x and y have the same smallest prime factor (say p), and if y and z have the same smallest prime factor (it must be this same p), then x and z have the same smallest prime factor (namely p). In the case of "or no prime factors at all", this is only satisfied by $x = y = z = 1$.

   (e) The relation $x^y = y^x$ is the same as $x^{\frac{1}{x}} = y^{\frac{1}{y}}$, so that if $x^{\frac{1}{x}} = y^{\frac{1}{y}}$ and $y^{\frac{1}{y}} = z^{\frac{1}{z}}$, then $x^{\frac{1}{x}} = z^{\frac{1}{z}}$ and $x^z = z^x$.

   (f) If x and y have the same largest perfect square factor (say t^2), and if y and z have the same largest perfect-square factor, it must be the same t^2, which will be the common largest square factor of all three of x, y, and z, so that in particular x and z have the same largest perfect-square factor (this same t^2).

3. Here are the equivalence classes for the equivlence relations (*a*) through (*f*).

   (a) "$x + y$ is even" is really the same as $x \equiv y (\bmod 2)$. There are two equivalence classes: the even numbers and the odd numbers.

   (b) "xy is a perfect square" puts each square-free number r (those numbers not divisible by the square of any prime number) in a separate equivalence class. Every number of the form $r \cdot t^2$ is in the same equivalence class with r, for each positive t, since $(rt_1^2)(rt_2^2) = (rt_1t_2)^2$.

(c) "As binary numbers, x and y end in the same number of 0's" puts each power of 2, 2^r for each $r \geq 0$, in a separate equivalence class. The class containing 2^r also contains $2^r t$ for each odd number t.

(d) "x and y have the same smallest prime factor (or no prime factor at all)" has the number 1 in an equivalence class all by itself, and then puts each prime number p in a separate equivalence class. The class containing p also contains pt for every positive integer t that has no prime factor less then p.

(e) "$x^y = y^x$" has one equivalence class consisting of $\{2, 4\}$, since $2^4 = 4^2$, but every other positive integer is in an equivalence class by itself. (To prove this, rewrite $x^y = y^x$ as $\dfrac{\log x}{x} = \dfrac{\log y}{y}$, and consider the function $f(x) = \dfrac{\log x}{x}$ for all *real* $x > 0$. Since $f'(x) = \dfrac{1 - \log x}{x^2} = 0$ at $x \equiv e$, and $f''(e) < 0$, $f(x)$ has a unique maximum at $x = e = 2.71828\ldots$, where $f(e) = \dfrac{1}{e}$ and $f(x)$ descends monotonically in both directions away from $x = e$. For x with $0 < x < 1$, $f(x)$ is negative, while $f(x) > 0$ for all $x > 1$. Thus for each x with $1 < x < e$ then is a unique x' with $e < x' < \infty$ such that $\dfrac{\log x}{x} = \dfrac{\log x'}{x'}$. The only *integer* x with $1 < x < e$ is $x = 2$, for which the x' is $x' = 4$: so no other positive integer shares its value of $\dfrac{\log x}{x}$ with another positive integer.

(f) "x and y have the same largest perfect-square factor" puts each perfect square in a separate equivalence class. The class which contains t^2 also contains $t^2 \cdot r$ for each square-free number r. (Note that this equivalence relation is, in a particular sense, a *dual* equivalence relation to case (b): "xy is a (perfect) square".) Finally, it is relations (b), (c), (d), and (f) that have infinitely many E-classes each containing infinitely many positive integers.

Some Partition Problems

Let $p^k(n)$ denote the number of (unordered) partitions of n where the largest part is exactly k ($k \leq n$), and let $p^{\bar{k}}(n)$ be the number of (unordered) partitions of n where the largest part is at most k. Let $p_{odd}(n)$ be the number of (unordered) partitions of n where all the parts are odd numbers, and let $p_{dist}(n)$ be the number of (unordered) partitions of n where the parts are all distinct (i.e. no two parts are equal). Prove each of the following.

C. 1. $p_k(n) = p^k(n)$ for all $n \geq 1$ and all $k \leq n$.

2. $p_{\bar{k}}(n) = p^{\bar{k}}(n)$ for all $n \geq 1$ and all $k \leq n$.

3. $p_{odd}(n) = p_{dist}(n)$ for all $n \geq 1$.

Update from the Outreach Committee

The IT Society outreach program has identified mentoring as being an important component of success and a particular challenge for some of our members. We are therefore setting up a mentor/mentee network, *open to all*. A typical mentor/mentee pairing would a faculty member or professional in industry mentoring a graduate student or postdoc; a senior faculty or industry researcher mentoring a junior faculty or researcher. We would strongly encourage mentees to become also mentors currently or in the future. A mentor/mentee relationship will be a priori a three year one. A mentor will agree to communicating with his/her mentee roughly every month or two to provide professional advice and feedback. We also plan to have a yearly mentor/mentee breakfast at ISIT. The mentor/mentee list will be posted on our new Society web site. A mentee should be part of the IEEE IT Society for the duration of the mentoring period.

If you are interested in becoming a mentee, please tell us about your interests. Note that we cannot guarantee you a particular mentor and so we do not take requests for specific mentors. If you are interested in becoming a mentor, please tell us about your interests and tell us how may mentees you are willing to take. To become a mentor or mentee, please mail the Mentoring Coordinator at itsocmentorshipcmte@ listserv.illinois.edu. You may find a partial list of current mentoring pairs and resources on mentoring on our web site http://www.itsoc. org/people/committees/outreach/mentoring. We hope you join us in making this mentoring program a success.

Muriel Medard (chair)
Todd Coleman
Christina Fragouli
Bob Gray
Sid Jaggi
Tara Javidi

IT Society Student Committee Update

Krish Eswaran, Aylin Yener, Matthieu Bloch, and Ivana Maric

Greetings from the Student Committee! This promises to be an exciting year for students in the information theory community:

We are currently in the midst of preparing for the 2nd Annual School of Information Theory, which will be held at Northwestern University Aug 10–13. This year, we are lucky to have Dan Costello of University of Notre Dame, Abbas El Gamal of Stanford University, and Bruce Hajek of University of Illinois at Urbana Champaign, as our instructors, and Robert Gallager of Massachusetts Institute of Technology as our keynote speaker. Like last year, the School will feature student presentations as well to foster interaction among the students, as well as with the more senior attendees. We are grateful for the support from the Information Theory Society as well as our other sponsors including DARPA, Northwestern University and University of Southern California. Another exciting event is that this year, the School will feature the inaugural Padovani Lecture. The Padovani Lecture is made possible by a generous gift from Roberto Padovani. The 2009 Padovani Lecturer is Abbas El Gamal. The organizers of the school this year are Randy Berry and Dongning Guo of Northwestern University coordinating the local organization, Daniela Tuninetti and Natasha Devroye of University of Illiois at Chicago coordinating the applications, Matthieu Bloch of University of Notre Dame and Yalin Sagduyu of Northwestern University coordinating the School web and publicity, and Aylin Yener of Penn State and Gerhard Kramer of University of Southern California serving as general chairs. We are all looking forward to another successful school and seeing you in Evanston in August!

We also have a new student committee website accessible at http:// www.itsoc.org/people/committees/student/. Anand Sarwate and Matthieu Bloch were instrumental in this effort, and we owe them a debt of gratitude. The website is now fully integrated with the new Information Theory Society site, which makes it easier to upload dissertations, to archive media resources of past events, and to maintain a lively website. Among several updates, we have created a "Job opportunities" section that lists open positions for Post-doc and fellowships. We welcome all suggestions and ideas for new content that would benefit the student IT community.

Plans are underway for our ISIT 2009 events. As in previous years, we will have a student roundtable event and a panel. The roundtable will feature exciting and timely discussion topics including Compressed Sensing, Information Theoretic Security, Network Coding, Relaying, Feedback, Source Coding, Information Theory and Biology, Information Theory and Stochastic Flows (Please see the Student Committee Web for reading lists). As is custom by now, we hope you bring your appetite for lively research discussions and great food.

For the panel, the topic will be collaboration. The title is "When does conversation become collaboration?" Once again, we will distribute gifts for our members, with a new twist: a raffle with a memorable prize. Come to the event, more importantly volunteer, and you shall be rewarded!

As always, the Student Committee is looking for volunteers to get involved. This year many of our student leaders are graduating and we have quite a few openings for leadership positions in the committee. If you are midway in your PhD, the committee is a great way to get involved, meet and get to know fellow students, as well as senior members of our community. The student committee, much like our Information Theory Society, is collegial and tight knit, and getting involved, we certainly hope will be as rewarding and fun for you as it is for us. If you are interested in getting involved, feel free to e-mail Aylin Yener (yener@ee.psu.edu), Krish Eswaran (keswaran@EECS.Berkeley.EDU) or Ivana Maric (ivanam@wsl.stanford.edu).

Through the Web

Updates on the Society's website project.

J. Nicholas Laneman

You may have noticed some dramatic changes to the Society website http://www.itsoc.org/. The new website is the result of a substantial investment of Society resources and volunteer time to provide state-of-the-art tools, allowing everyone in the IT community to contribute content and interact through the web. It is quickly becoming a primary place to share community news, events, and so forth. Since the site went live a few months ago, it has received over 200 visits per day, 7 days a week, from all over the world!

The purpose of this article is to highlight these changes, summarize new ways in which the website can be leveraged, and seek your contributions and feedback.

Ch-Ch-Changes

Since its formation at CISS 2007, the Online Committee has been leading the creation of a new website based upon a Content Management System (CMS). A web CMS allows multiple content creators to submit content without requiring technical knowledge of HTML/CSS or the uploading of such files, and allows online editors to review submitted content before publishing. Put more simply, a CMS allows more people to contribute and manage content more easily than with traditional "static" HTML/CSS websites.

Through careful evaluation of software platforms and developers, the Online Committee selected Plone, a leading open-source CMS, and partnered with SixFeetUp, Inc. for professional graphic design, software customizations, and web hosting. Basing the project on open-source software technology has enabled over a 3-to-1 leverage of funds invested, based upon the estimated value of Plone software out of the box. Customizations include content types such as individual profiles, papers and awards, committees and chapters, and meetings. A dynamic homepage provides quick links to content throughout the site. As needs develop and funding allows, additional rounds of software development can be pursued.

Shortly after the first major round of development came to a close in late 2008, the Society Officers approved launching the site at ITA 2009. The former site remains available at http://legacy.itsoc.org/ as we continue to migrate content to the new site. To encourage and gauge use of the new site by the community, the Online Committee has been working with a number of individuals, Committees, and Chapters and also collecting web usage statistics using Google Analytics. These usage statistics can be made available to interested parties for content and membership development.

Another change worth mentioning is a cultural one. At CISS 2009 the Board of Governors approved the formation of a standing Online Committee to continue managing the Society's web operations. Designated members of the Online Committee will serve as Associate Online Editors with specific focus areas within the website, e.g., news and events, committees and chapters, surveys and tutorials, blogs and mailing lists, and so forth. The Online Committee maintains a web area at http://www.itsoc.org/people/ committees/online to archive its discussions and plans. All Society members are welcome to provide input and suggestions, and those interested in participating as members of the Online Committee should send an email to oe@itsoc.org.

Getting Started

The new website provides a powerful foundation for content creation and interaction among community members. Members of the Online Committee are available to help get you started, and we are always open to suggestions on how to make the site more useful for the community. The remainder of this article will provide quick instructions for getting started using the site.

Check or Register for an Account

Contributing basic content like biographical and contact information, news items, events, and dissertations requires that you have an account. In some cases, an account has already been created because of membership on committees or recognition for awards.

You can check for an existing account by pointing your web browser to the main homepage http://www.itsoc.org/ and entering your last name in the "Search" box. If a search result with a person icon comes up, you already have an account. If you have trouble inferring your username, send an email to oe@itsoc.org for help.

To register for a new account, point your web browser to the main homepage http://www.itsoc.org/and click on the quick link for "New user?". Enter your contact information, upload a picture, and click the "Register" button at the bottom of the page when you are done. It will take a day or two for your account to be approved by one of the Online Editor(s).

Don't be shy. Upload your favorite photo of yourself and allow it to be displayed on the main homepage. The software randomly selects a profile for each page view, so the more people that allow display of their profiles, the more dynamic the main page becomes.

Feel free to share your main email address, because the software provides automatic email obfuscation to prevent SPAM. If you are skeptical, view the source of a page containing an email address.

If you forgot your password, you can visit the quick link for "Forgot your password?" to reset it via email.

Share News and Events

News items and events are some of the most important bits of information to share with the community in a timely fashion. The new website allows these to be posted directly by community members with lightweight review by Online Editors. The Newsletter and Online Editors are using the new website for a joint submission process for such content.

To post a news item, point your web browser to the main homepage http://www.itsoc.org/ and look for the quick link to "Share News". Try to include an image and caption, if you have them. Also try to include links to related information on the website, if applicable.

To announce an event, point your web browser to the main homepage http://www.itsoc.org/ and look for the quick link to "Announce an Event". Try to include as much detail about the event as possible, particularly dates, times, locations, and contact information.

After filling in the relevant information in either case, click on the "Save" button at the bottom of the page. Click on the "State: Private" tab and select "Submit"; Online Editor(s) will review and publish the content within a few days. The Newsletter Editor will also consider the content for publication in the print newsletter.

Upload Your Dissertation

Many important results are buried in unpublished chapters of Ph.D. theses. The new website allows us to make sure the community can track them all down.

To post a link or a PDF to your dissertation, point your web browser to the main homepage http://www.itsoc.org/ and click on the quick link to "Post Your Dissertation". A permanent link to a PDF at your institution is preferable, but if there is no permanent PDF of your thesis on the web and you have copyright permissions, feel free to upload the PDF directly.

After filling in the relevant information, click on the "Save" button at the bottom of the page.

Click on the "State: Private" tab and select "Submit"; Online Editor(s) will review and publish the content within a few days.

Interact in a Committee or Chapter

A number of Committees (e.g., Board of Governors, Students, Outreach, and Membership and Chapters) and Chapters (e.g., Benelux, Korea, Russia, and Israel) have started or are starting to use the new website for their operations.

If you are looking for a Committee or Chapter in which to participate, you can browse the directories by pointing your web browser to http://www.itsoc.org/people/committees or http://www.itsoc.org/people/chapters, respectively.

If you are the Chair or Co-Chair of a Committee or Chapter who is interested in using the website, please contact the Online Committee for further assistance by sending an email to oe@itsoc.org.

Acknowledgments

Quite unexpectedly, the website project became a 3 year journey of experimenting, developing specifications, identifying the right technology and developer partner, managing software development, migrating content from the old to the new site, and bringing the community up to speed. All of our progress has been the result of cautiously optimistic support from the Officers and Board of Governors, invaluable service provided by volunteer members of the Online Committee, and stellar execution by SixFeetUp, our software development partner. Although everyone's input has been tremendously helpful, the Society owes special appreciation to Bixio Rimoldi for his input on the project during his year as President, to Anant Sahai for his assistance in managing contracts and finances, and to Matthieu Bloch, Jean-Francois Chamberland, and Anand Sarwate for their tremendous volunteer service during the major software development and content migration that led to the launch of the new site.

IT Society Board of Governors Meeting Minutes

Champaign, IL, September 23, 2008

João Barros

Attendees: Alexander Barg, João Barros, Giuseppe Caire, Daniel J. Costello Jr., Michelle Effros, Hesham El Gamal, Elza Erkip, Dave Forney, Andrea Goldsmith, Alex Grant, Tor Helleseth, Frank Kschischang, J. Nicholas Laneman, Muriel Médard, Fred Mintzer, Prakash Narayan, David L. Neuhoff, Alon Orlitsky, Anant Sahai, Amin Shokrollahi, Aylin Yener. Ken Zeger.

The meeting was called to order at 15:03 by Society President Dave Forney, who welcomed the members of the Board and their guests.

1. The agenda was approved by consent.

2. By consent, the Board approved the minutes of the previous meeting (Toronto, Canada, July 6, 2008).

3. The President reported that the Society continues to be in good financial shape, with a considerable surplus.

   The President congratulated Giuseppe Caire on his election to Second Vice-President of the Society.

   The President thanked Rob Calderbank, Ralf Koetter, Shlomo Shamai and David Tse for their service as members of the Board.

4. Division IX Director, Fred Mintzer, gave a presentation entitled "An Introduction to Division IX", which included information about the Societies that belong to Division IX and the duties of a Division Director. IEEE Membership has been increasing, whereas Society Membership has been decreasing. The Director also showed some concern with the cost of membership and the distance between practicing engineers and the IEEE, after they leave university.

5. The President and the Treasurer mentioned that there has been some consideration of transferring funds from the Society to the IEEE Foundation to endow the Shannon Award. If the officers decide that this is a good idea, the Treasurer will provide further details.

   The President asked the Division IX Director about the solidity of the IEEE Foundation. The Director answered that everything has been under very close scrutiny.

6. The President noted that the Society has been a technical co-sponsor of the IEEE Transactions on Mobile Computing (TMC) since its inception, although its actual involvement has been negligible. He has been in touch with the TMC Steering Committee to ask whether there is any good reason for the Society to remain a technical co-sponsor. The TMC Board would like the Society to stay involved in order to encourage Society members to be involved in TMC and to offer member subscription rates to Society subscribers.

   The President mentioned that the Society also technically co-sponsors the IEEE Transactions on Information Forensics and Security. Muriel Médard mentioned that the involvement of the Society in that publication is very active. As an example, Pierre Moulin is the Editor-in-Chief and Muriel Médard has been a Guest Editor-in-Chief for the last special issue.

   The President moved that the Society withdraw from technical co-sponsorship of the IEEE Transactions on Mobile Computing. The motion passed unanimously.

7. Alex Grant presented the conference committee report. All workshops and conferences are on track.

   Elza Erkip gave an update on the proposal for ISIT 2013 in Istanbul. Erdal Arikan and Elza Erkip would be the general co-chairs. Amos Lapidoth would join Emre Telatar and Jossy Sayir as co-chair of the Technical Program Committee. The organization committee is currently being completed. The proponents recommend delaying the signing of a contract due to the variations in currency exchange rates.

Michelle Effros raised the concern that the current economic situation justifies keeping the registration fees as low as possible. David Neuhoff mentioned the possibility of requesting the help of IEEE in negotiating with the conference venue. The Board discussed the effects of the current financial crisis on the budgeting and attendance of ISIT. It was the sense of the Board that the ISIT organizers should proceed to firm up their contractual commitments despite current economic uncertainties.

Hesham El Gamal presented a preliminary version of a proposal to hold an ITW 2010 in Cairo, Egypt, tentatively during the Winter. General Co-Chairs would be Hesham El Gamal and Andrea Goldsmith. The Technical Committee Co-Chairs would be Abbas El Gamal (Stanford) and Pramod Viswanath (UIUC). The proposed theme would be "Information Theoretic Foundations for the Wireless Revolution". The venue would be the Mena House Oberoi, located very close to the Great Pyramid. One of the motivations is to support the Egyptian efforts in building an education and science infrastructure. The program would be 50% invited and 50% contributed.

On behalf of the organizers, Alex Grant presented a sketch proposal for an ITW in Dublin, Ireland, in August 2010. The focus would be on Mathematical Methods in Information Theory. Workshop co-chairs would be Marcus Greferath and Joachim Rosenthal.

8. Andrea Goldsmith reported on the activities of the Awards Committee. The official name of the joint award is IEEE Communications Society—Information Theory Society (Comsoc/ITSoc) Joint Paper Award. The eligibility window for this award in the future will be 3 years as defined in the IEEE awards document.

The Board discussed whether a paper should be precluded from receiving both awards. Amin Shokrolahi argued that if a paper is very good it should be allowed to win both awards. Alon Orlitsky stated that finding rules for preclusion is not an easy task. Daniel Costello expressed some concern that the situation of a paper winning both awards is likely to happen a lot. Michelle Effros suggested that the character of this award should be different from the IT paper award to avoid a ranking of awards.

Andrea Goldsmith presented the proposed amendments to the Society Bylaws, which correct some of the formulations related to awards. In particular, the Bylaws need to be updated with respect to the joint award and the procedures related to the ISIT Student Paper Award.

Alexander Barg raised the concern that the procedure is too complex and consequently subjective. In particular, he believes presentations should not be part of the evaluation. Muriel Médard defended that presentation skills are important, which justifies their inclusion in the set of criteria. Michelle Effros added that the presentation helps separate the contributions of student and advisor.

In response to a question by Prakash Narayan, Andrea Goldsmith clarified that the weight of the presentation component is lower than that of the other criteria. Alexander Barg asked what is meant by "dominant" author. Andrea Goldsmith explained this is left to the advisor.

The President pointed out that these amendments are work in progress.

Andrea Goldsmith reported on the status of the Baker Prize Paper Award, which will be reviewed by the IEEE Awards Board shortly.

The President announced that this year there will be a more formal nominating process for the Shannon Award including an open call, because of the increasing breadth of candidates who may be considered.

9. Muriel Médard presented the status on the Information Theory Society Outreach Effort. The first event at ISIT was very well intended. The next event will be led by Todd Coleman and will take place at the Allerton Conference. Muriel Médard compared the numbers of women participating in the IT, Signal Processing and Communications Societies. The President mentioned that the Society should be aware of these numbers, for example when forming technical program committees. Current efforts include a mailing list called withits@mit.edu for women in the Information Theory Society.

10. Frank Kschischang reported on the work of the Membership and Chapters Committee. The membership numbers rose by more than 200 members, mainly due to an initiative at ISIT, where IEEE members who were not IT members received a free half-year IT membership.

    Frank Kschischang presented a detailed analysis of the current Distinguished Speakers Program, which was found not to be working well. The travel expense amount of 500 USD seems low, the criterion for distinguished speakers is not particularly compelling and the program is rarely taken advantage of. Based on the practices of other Societies, such as the Signal Processing Society, a proposal has been elaborated, in which 10 geographically and technically dispersed individuals would be appointed as distinguished lecturers, each with a nominal two-year term, extendable to 3 years provided that no more than one lecture has been given in the first two years. The budget would probably come to 20k USD per year.

    Anant Sahai proposed recording lectures by Distinguished Speakers and making them available on-line.

    Frank Kschischang made a motion that the proposal for a new IT Society Distinguished Speakers Program be accepted. The Board approved the motion unanimously.

    The President discussed the officers' intention to increase the responsibilities of the Membership and Chapters Committee to cover various outreach efforts such as the Distinguished Speakers Program and the IT Schools, and to flesh out the membership of this committee. New members will be appointed by the incoming chair, Giuseppe Caire.

11. João Barros presented a proposal on behalf of Ralf Müller for the 2009 IEEE Winter School on Coding and Information Theory, to be held in Trondheim, Norway, from March 29 to April 3. The President stated that the European Winter School has been working well for a long time and deserves the Society's support. Ken Zeger asked about the high costs. João Barros answered that these are reasonable costs for Norway and a lot of effort has been put into cutting them down. Tor Helleseth vouched for the location.

    João Barros presented a motion for the Society to grant 12k for the organization of this Winter School. The Board approved the motion unanimously.

12. Aylin Yener presented the report of the Student Committee. The last event at ISIT was very successful. The next Summer School will take place on August 2 to 6, 2009 at the Northwestern University Campus, Evanston, Chicago, IL.

    Dave Neuhoff asked how the participants would be selected if the number of participants is limited to 100. The Board discussed several possible criteria, including student seniority and geographic proximity to the venue.

    Aylin Yener presented a motion for the Board to approve a 10k grant to help support this Summer School. The Board approved the motion unanimously.

    The President addressed the necessity of defining general criteria for awarding grants to IT schools. This task will be undertaken by the reconstituted Membership and Chapters Committee.

13. The Board expressed its appreciation for David Neuhoff's contributions as a Society officer.

14. Dave Neuhoff mentioned the need to nominate new members for the Nomination and Appointments Committee. Jim Massey and Ralf Koetter were nominated by Daniel J. Costello and Michelle Effros, respectively, for the Nomination and Appointments Committee. The Board shall vote on this issue via email.

15. Dave Neuhoff presented the recommendations of the Constitution and By-Laws Committee. This included a few amendments to Article V (Standing Committees), the details of which can be found on the Society's file server.

    The Board approved the proposed amendments unanimously.

16. Nick Laneman reported on the status of the new IT Website, which is currently at 90% of completion. Society members are now able to introduce their profile information onto the website independently. Chapters, Conferences and Committees will be able to create and maintain websites and file servers in a convenient way.

Frank Kschischang asked about a tentative release date. Nicholas Laneman explained that a timeline will be defined in the next few weeks. Release should occur before the end of the year.

The Treasurer asked whether there will be any additional requests for funds. Nicholas Laneman replied that none is planned, but more expenditures could be possible.

The President presented a motion that the Online Editor be allowed to expend an extra 10 k USD on the web site development. The Board approved the motion unanimously.

17. Elza Erkip reported on new business pertaining Sirin Tekinay's position as program manager at NSF. Sirin Tekinay is currently working as a volunteer. Future program managers are also expected to be working on a volunteering basis. Several members of the Board expressed concern for this situation and its likely consequences for programs funding information theory research in the United States.

18. The Board thanked David Forney for his service as President.

19. Incoming President Andrea Goldsmith announced that the next Board meeting will be held on March 18 in Baltimore in conjunction with CISS. The other two 2009 Board meetings are likely to be on Sunday, June 28 in Seoul in conjunction with ISIT 2009, and on Sunday, October 11 in Taormina, Sicily in conjunction with an ITW.

20. The meeting was adjourned at 18:44.

Report on 10th Winterschool on Coding and Information Theory

Ralf Müller

The 10th Winterschool on Coding and Information Theory was held from Mar 29 to Apr 3, 2009 at Hotel Alexandra in Loen, Norway. The Winterschool on Coding and Information Theory was established by Han Vinck of Univ. Essen. It has a long tradition in Europe and was first held in Essen, Germany in 1991. With an accuracy that needs some minor error correction, the event takes place every second year. This year, the winterschool was, for the first time, sponsored by the IEEE Information Theory Society, reflecting the increased effort the IT society puts into student education after already sponsoring the first Annual School of Information Theory in North America in June 2008 (see IT Newsletter, Sep. 2008).

The winterschool was planned to have 5 tutorials, given by Johannes Huber of FAU Erlangen, Helmut Bölcskei of ETH Zurich, Holger Boche of TU Berlin, Rüdiger Urbanke of EPF Lausanne, and Ralf Kötter of TU Munich. The program was overshadowed by the tragic death of Ralf Kötter on Feb 2, 2009. Ralf had been very enthusiastic about participating in the winterschool and, as late as Jan 6, 2009, had sent me the abstract of his tutorial on *Network Coding, Separation and Equivalence of Networks*. Nevertheless, the students enjoyed the wonderful tutorials on *Information Combining, Communication over Noncoherent Underspread Fading Channels, Recent Advances in Shannon Sampling Theory — Fundamental Limits for Digital Signal Processing, and Channel and Source Coding via Polar Coding* by the remaining 4 speakers, respectively, where Rüdiger Urbanke was supported by his student Eren Şaşoğlu.

The winterschool was attended by 49 students and 15 senior staff. 30 of the students gave presentations about their ongoing work, and faced critical and constructive questions by the audience. Discussions continued during the lunches, dinners, and the free time. Though the students came from 15 different schools in 8 different countries, the students began interacting with each other very fast on both scientific and personal matters. Already on the 3rd day, they spontaneously organized a trip to the nearby Jostedalsbreen (with 480 km^2 the largest glacier in continental Europe) during the free time in the afternoon.

The school was co-organized with Geir Øien of NTNU in Trondheim with much support from my students Vesna Gardašević and Rodrigo de Miguel. I am also grateful to João Barros of Univ. Porto and Dave Forney who helped me to secure financial support from the IT society. Furthermore, I am grateful to the Research Council of Norway and the Department of Electronics and Telecommunications at NTNU for further financial support.

For the first time, students had the opportunity to acquire credits for their participation at the Winterschool on Coding and Information Theory to be recognized via the European Credit Transfer System (ECTS) at their home institutions.

The 11th Winterschool on Coding and Information Theory organized by Xavier Mestre, Angel Lozano, and Ezio Biglieri will be held in Catalonia, Spain in 2011.

Call for Nominations

IEEE Information Theory Society Distinguished Lecturers

In 2009, the Membership & Chapters (M&C) Committee of the IEEE ITSoc was created. One of the M&C Committee's missions for the year 2009 is to re-establish and revamp the society's Distinguished Lecturer Program.

Through this program, ITSoc Chapters will have an opportunity to organize lectures given by the appointed DLs, and receive financial aid to offset the costs related to the DLs' travel. DLs will be appointed for a period of two years.

We envisage to have a total of 10–12 active DLs, with 5–6 newly appointed DLs each year. DLs shall be appointed by the M&C Committee, following internal and external nominations.

We invite all society members to submit DLs nominations for the year 2009–2010 to the M&C Committee by the deadline of June 15th, 2009 [please submit your nomination statement by e-mail to Giuseppe Caire <caire@usc.edu>]. DL nominees should be an outstanding researcher in Information Theory and related areas, with a distinguished track record of research. Furthermore, he/she should be an outstanding speaker, able to engage a broad public and raise interest on Information Theory and "Information Theoretic Thinking". Finally, the ideal nominees should be personally available and motivated to deliver 2–3 distinguished lectures per year, during his/her appointment.

The M&C Committee will serve as the liaison to the Chapters, matching Chapters invitations with traveling schedules of the appointed DLs.

We envisage to use the ITSoc Website as the main tool to organize distinguished lectures, post the DL program schedule, and eventually post multi-media material of some distinguished lectures.

Giuseppe Caire (M&C Committee Chair)

IT and Wine

This feature first appeared in the World of Fine Wine magazine, www.finewinemag.com

SPIRITS OF PLACE
AN INFORMATION-THEORETIC ACCOUNT OF
TERROIR AND TYPICITY

Many of us accept that fine wine
expresses a sense of place, but what does that really mean?
Douglass Smith attempts to clarify some crucial issues

An early seismologist, Frank A Perret, listens to the rumblings of the Solfatara volcano; Italy, 1917

Photography © Bettmann / Corbis

We expect a fine wine to tell us where it is from. Sometimes this is described as the wine having a "sense of place." What we are looking for in this "sense of place" are certain clues of smell or taste that lead us to a particular part of the globe—even to a particular plot and vintage.

This article is an attempt to clarify and explicate what one might mean by saying that a wine expresses sense of place, using some ideas from information theory. A wine's sense of place may come from its soil, aspect, and microclimate, or it may come from the typical way in which that wine is made in a particular local area. But terroir and typicity are nevertheless different criteria and should not be confused.

Terroir

Terry Theise has written eloquently about wanting wine to "*signify* something," in particular, to express a "spirit of place":

> When a vine is at home, it settles in and starts to transmit. We "hear" those transmissions as flavors. A naturally articulate grape like Riesling sends clear messages of the soil—flavors that are consistent, specific, and repeated year after year, varied only by the weather in which that year's grapes are ripened.[1]

This is an admirably clear place to begin. Theise is looking for the grape to show a particular character year after year, depending on where it is planted. Statistically, this sort of relation is called a "covariance" relation. In this case, the character of the terroir varies together with the character of what's in the bottle.[2]

We are looking for the grapes from one plot, vintage after vintage, to give similar gustatory qualities when in bottle, while the grapes from a different plot yield suitably different qualities. It is these differences in the final characters of the wines in question that allow the taster to distinguish what is from where. Indeed, such covariance relations between terroir and wine allow the wine to *communicate* something about the terroir in which it was crafted.

Covariance relationships have been much studied in information theory—the mathematical study of signal versus noise in a communication system.[3] Claude Shannon, arguably the father of this mathematical study, put it this way: "The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point."[4]

Most of information theory has no particular bearing on wine, and we must content ourselves with only the barest outline of a program in this paper. Nevertheless, an information-theoretic approach may help clarify and elucidate certain issues that have remained somewhat obscure in recent wine debates.
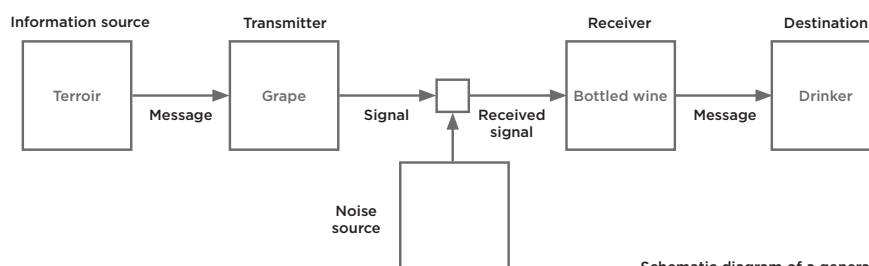
To begin, let us focus on the diagram (*see below*) adapted from Shannon.[5] To clarify, let us make the "information source" the place or particular terroir. The "transmitter" is the grape, the "receiver" is the bottled wine, and the "destination" is the person who drinks the wine.

Theise and others claim that some kind of signal or message is transmitted from the place via the grape to the drinker. This message is available to the astute aficionado assuming that the "noise source" has not overwhelmed the signal—about which, more later.

For a message to have any content at all, Shannon tells us that it must be "*selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen."[6] The information content of any given message is determined by the number of possible messages that that system can produce. A system that can only produce one message provides no information. A system that can produce a handful is, we might say, information-poor. A system that can produce many is information-rich.

This approach maps directly on to certain debates about wine. Those grapes that are most transparent to a message of place, that are most "articulate" in Theise's sense, are precisely those grapes capable of producing the largest variety of messages under different local circumstances. One might say that properly cultivated Riesling and Pinot Noir grapes are intrinsically information-rich sources. The character of their output is highly variable depending on fine differences of local terroir. A grape that is only capable of a limited repertoire of flavors, or that is vini- and viticulturally processed so as to be capable of only such a limited repertoire is, in contrast, information-poor.

This approach may also provide some additional purchase on the much-debated issue of whether fruit flavors can reveal terroir. David Schildknecht has been very clear in denying the supposed dichotomy between flavors of fruit and flavors of terroir.[7] As Schildknecht clearly shows, one can indeed distinguish a sense of place based on fruit flavors alone. Randall Grahm, however, has made the point more specifically about overripe fruit: that there is a dichotomy between flavors of overripe fruit and flavors of terroir.[8] Perhaps both of them are right. An information-rich grape and winemaking system may indeed provide its message in flavors of fruit. However, Grahm's point may be rather distinct. If fruit were cultivated in a manner that would tend to reduce its range of expression—that is, in a

Diagram adapted from Claude E Shannon, "A Mathematical Theory of Communication"

Information source | Transmitter | Receiver | Destination

Terroir → Message → Grape → Signal → Received signal → Bottled wine → Message → Drinker

Noise source

Schematic diagram of a general communication system

way that reduced the number of possible messages it could carry—its information content would thereby be reduced as well. This follows by the simple logic of information theory. Clearly, Grahm and others believe fruit that is allowed to become overripe has lost some of this range of expression. If this is so, then an overripe sort of flavor in a wine may be an indicator that information has been lost from the system.[9]

A problem arises. How do we gauge the content of the "message" or "signal" being sent by the grape? In a standard digital signal, of course, the message is a string of ones and zeroes, perhaps realized in the magnetic surface of a hard disk. In an analogue signal, the message is contained in some sort of complex waveform, perhaps etched into the surface of a wax cylinder. The signal reproduces this message in electromagnetic radiation, which is then captured by a receiver and reprocessed into a message identical to the transmission, plus whatever noise accompanied the signal.

In the case of wine, however, things are trickier. It would be simplest if the signal were some clear aspect of soil chemistry—for example, if limestone soil produced wine that tasted of limestone. However, although many wine writers continue to claim that terroir is, in this sense, literally in the glass, there is in fact no evidence for it.[10] Vines grown on limestone don't make wine that tastes of limestone; vines grown on slate don't make wine that tastes of slate; and the Rhine is not a superior place to drill for petrol. So the message is not so simple.

Perhaps the message is simply one of place: A wine doesn't tell us what sort of soil it is grown on. It tells us, quite literally, where it's from. "I'm from the Mosel," it says. Or even, "I'm from the Wehlener Sonnenuhr." However, if so, would that really be so very interesting? We knew that from the label, after all. Why get so worked up by a simple redundancy? *Redundant information is no information at all*. Presumably any such message must be more meaningful to us than the simple (re-) assertion of a wine's AOC.

Further (let us assume that the message is, in some sense, telling us about terroir), in what way is it "expressed" or *encoded* by the flavor of grape and wine? What characteristics of the wine's flavor and aroma lead us to take the wine as telling us something? As we have already said, this is a more difficult matter than a simple one-to-one correspondence of terroir and aroma chemistry. As we have also seen, Schildknecht gives us plenty of reasons for rejecting the approach that says the taste of terroir is some sort of earthy, stony, or other flavor defined by not being fruit. Indeed, flavor of fruit may be precisely the thing that gives a fine Riesling its sense of place.

Perhaps we can change things around. The wrong fruit in the wrong place, it is claimed, sometimes masks the terroir. So what are these "wrong" flavors, then? This is the *via negativa*: get at the "message" flavors, the flavors of terroir, by discovering what they are not. If, indeed, overripe fruit is less expressive and more "anonymous" than ripe, flavors of overripeness will tend to indicate information loss and hence make a wine that expresses much less of whatever it is that wine expresses. Is there anything more, however, that remains to be said on this issue? Or are we simply left with the claim that we should avoid overripeness?

Of course, there are other flavors in wine—such as vanilla, clove, cinnamon, wood, or smoke—that are not normally derived from grape or yeast at all but are, rather, barrel-imparted flavors. Clearly they cannot be part of the "message" of the terroir. We will deal with them in the next section.

Let us return to first principles. The flavor of the grape has to be evocative of something. Its message must elicit, in some sense, a remembrance of the location in question. Perhaps it does this by a kind of poetry, metaphor, or even direct association. It is not entirely clear. If one has already learned, however, to associate flavor X with place Y, the Pavlovian mental arithmetic will occur when we are in the presence of X, whatever that flavor actually happens to be. It is the poetry that remains to be understood and explained, for even the basest rotgut can elicit a remembrance (if not abhorrence!) of place or occasion.

The taste of terroir might not be that of any particular flavor or set of flavors. It might, perhaps, be any flavor that allows one to locate a wine geographically. But it cannot merely be that, because of the issues we will consider when we address typicity. Let us at least postulate that terroir flavors have to be—in some sense—grape-derived. As Theise defines it, the flavor of terroir is "a particular flavor from a particular place, based first on soil."[11] But further, this flavor must have a certain aesthetic or poetic quality that is evocative of time and place.

Of course, such flavors are not *merely* grape-derived. Making grapes into wine is an inherently artificial, human-mediated process. As, indeed, are the selection of clones, the planting, pruning, and other care regimes in the field. This process, however, must be transparent to the signal. That is, the same human-mediated viti- and vinicultural regime should be such as to produce different signals in different sorts of terroir. They should be information-rich processes, allowing the grape its fullest range of expression.

Another question concerns the aging of wine. It is not clear that aging a wine should enhance its signal. The extra time in bottle simply takes us farther from the information source and is more likely to amplify extraneous noise. Insofar as we are looking for purity of signal, we should be looking for purity of fruit—that is, young wine. By aging a wine, are we simply cherry-picking the signal we want when we decide it is best to drink wine at an advanced age? Does an aged wine make itself more available to poetic speculation by human wine enthusiasts? Or is there some other way that aging relates to the signal of place?

Typicity

It is also possible for a wine to express Theise's "spirit of place" not by transmitting any information about its *soil*, but instead by displaying other sorts of regularity that generally go under the name "typicity." Retsina, after all, has "spirit of place," and this has nothing to do with the local terroir. Indeed, there are many sorts of wines with long pedigrees and universally recognized "spirits of place," like Bordeaux, Burgundy, Champagne, traditional Rioja, Port and Sherry, where the reliable "signal" of year-in, year-out flavor depends, at least in part, on features extraneous to grape and soil. Instead, it is

determined by the oak treatments given, by particular human manipulations of yeast, additions of alcohol, and complex aging and blending regimes, among many other things.

Are these not also "wines with place"? Are we to say that the only (or truest) wines with place are those that are tank fermented and bottle aged? If one were looking for purity of signal from the terroir and the minimization of extraneous noise, then simplicity and stainless steel would appear the most obvious way to go.

In information-theoretic terms, we may define two sorts of extraneous influence on the signal, referred to as "noise" in the above diagram. One sort is so-called Gaussian, or purely random, in character; we might analogize this as the luck of weather, pest infestations, or other random variables that may affect a wine in any given year. Another sort of noise is non-random, where "the received signal is a definite function of the transmitted signal."[12] Typical, year-in, year-out manipulations of grape, must, and wine with traditional processing regimes introduce a sort of noise but, nonetheless, produce an end product that is a predictable function of its input. This sort of signal perturbation is called distortion, and in some forms of artistic communication—the electric guitar, for example—it is intentionally produced and appreciated. Non-terroir-driven typicity is a sort of distortion of signal in this way. It may also be that if the distortion is of a certain character, we will be able to recover the signal entirely or even hear aspects of it more clearly. This sort of typicity may also allow us to situate the wine in its place; but in that case, the song we are attuned to is really the distortion of the human hand: its oak aging treatment, yeast, blending regimes, etc.

But is that such a bad thing? Are we always looking to decrease any extraneous noise that gets between us and the terroir? Or instead, is this human-mediated distortion really part of the delight of the drink? If so, then wine is less a device to communicate the message of terroir than it is a human concoction, a stew or brew cobbled together from a recipe, by a chef, for a particular gustatory end. It may not be the bearer of any particular "message," or at least no particular message outside of that produced by any other beverage or imparted by any other human creation.

Conclusion

I hope to have provided a model that can be of use in clarifying issues about a wine's sense of place. It is an information-theoretic model, stemming from work done by Claude Shannon in the 1940s. We have left aside the precise mathematics he and others derived, instead using its general outline to clarify issues that have at times seemed somewhat obscure in wine aesthetics.

In this model, a wine can be said to yield its "spirit of place" in the same manner as any receiver may capture a signal. Of course, just as every vine is planted in some terroir or other, every grape may be said to transmit its own signal. One question is how information-dense this signal really is. How many potential signals can it transmit? Insofar as a grape is truly transparent to its message, it will be able to transmit a much richer repertoire of aromas and flavors than a grape that is

capable of only a limited range. It is in that way that we may (partially) discern quality grapes and quality wine.

Further, much that goes by the name "typicity" is, at least on this picture, a kind of human-generated distortion. So long as a particular distortion occurs in certain limited regions of the world, it may also be used to locate a wine and provide it with a sense of place.

Various problems remain. In particular, we still lack a good sense of what precise message is being transmitted from the soil and in what ways it yields poetic or metaphoric insights. Until we have a good understanding of what that message might be, we are open to the claim that in fact there isn't any message, and the whole notion of transmitting a "spirit of place" is fatally broken. In that case, it would not be clear that there were any such thing as "terroir," at least as an element of the aroma or flavor of a wine. Of course, even in such a case we would all agree that there are some soils on which certain grapes grow exceptionally well and others not; but this is a quite different and much weaker claim than that the soil is sending us some *message* in the glass that we may distinguish by nose and palate. ∎

Notes

1. Terry Theise, "To See the Universe in a Grape: Specificity, and Why Wines Should Taste of the Places in Which They Grew," *The World of Fine Wine* 16 (2007), pp.112–15, at p.115.
2. By "terroir" we will mean the physical environment of the grape vine—its soil, subsoil, climate, elevation, aspect, wild yeasts, etc.
3. Claude E Shannon, "A Mathematical Theory of Communication," *The Bell System Technical Journal* 27 (July, October, 1948), pp.379–423, 623–56. Also available at: http://cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf; my page numbers are from this later edition.
4. Ibid., p.1.
5. Ibid., p.2.
6. Ibid., p.1 (his emphasis).
7. For example, David Schildknecht, "Rose on the Rocks: What Terroir's Not," *The World of Fine Wine* 9 (2005), pp.27–30. David Schildknecht, "Terroir Is Where the Hearth Is," *The World of Fine Wine* 14 (2006), p.73.
8. "Overripe grapes, overextraction, and reliance upon 100 percent—nay, even worse, 200 percent—new oak, impart a strong stylistic imprint [...] but may greatly detract from the expression of terroir." See Randall Grahm, "*A la Récherche des Grands Crus Perdus*: In Search of a Great Growth in the New World," *The World of Fine Wine* 13 (2006), p.46.
9. David Schildknecht tells me that Jean-Michel Deiss believes a blend of grape varietals is an inherently richer medium for communicating terroir than is a *monocépage* (personal communication). One can find similar statements from Deiss in Andrew Jefford's *The New France* (Mitchell Beazley, London; 2002), pp.60–62. This is an interesting claim that requires further investigation.
10. See, for example, Jamie Goode, *The Science of Wine* (University of California Press, Berkeley, CA; 2006), pp.29–34; Harold McGee and Daniel Patterson, "Talk Dirt to Me," *New York Times*, May 6, 2007.
11. Theise, "To See the Universe in a Grape," p.113.
12. Shannon, "Mathematical Theory of Communication," p.19.

Letters

Comments on "Shannon, Beethoven and the Compact Disc" by K. A. S. Immink

Léon M. H. E. Driessen

Introduction

In his article "Shannon, Beethoven, and the Compact Disc" [1], published in the Information Theory Society Newsletter, December 2007, Kees Schouhamer Immink makes incorrect statements about the development of CIRC, the Compact Disc (CD) error correction and concealment format. He thereby fails to credit his and my former (now deceased) colleague Lodewijk Barend Vries, myself (Léon M. H. E. Driessen), and the company that we all worked for at that time, Philips Electronics.

In the late '70s and early '80s, Immink was involved in discussions about the CD, mainly regarding the channel code. He was a member of the team of engineers from Sony and Philips whose task was to determine a joint system standard for the CD, which eventually was established in 1980. During that time, I was assisting Vries with making and studying proposals for the Error Correction Code (ECC) to be used in the CD system. Like Immink, Vries was also involved in the negotiations with Sony. Though I never attended the Sony-Philips meetings myself, I was well informed about the ECC discussions. Consequently, I am sure that some statements by Immink are inaccurate.

More than two months after I sent my comments to Immink, his only response was that he wrote the IT Newsletter article in good faith and candor. However, although an author has some latitude in writing his personal reflections of important events of thirty years ago, good faith and candor are not enough; he should restrain himself from making incorrect statements about developments that he was not involved in himself.

The incorrect statements

The following two statements by K. Immink, quoted from [1], are definitely wrong:

1. "There were two competing ECC proposals to be studied… Sony proposed a byte-oriented, rate-3/4, Cross Interleaved Reed-Solomon Code (CIRC). Vries of Philips designed an interleaved convolutional rate-2/3 code having a basic unit of information of 3-bit characters."

2. "CIRC, the Reed-Solomon ECC format, was completely engineered and developed by Sony engineers."

Immink compares CIRC [2] with the original rate-2/3 convolutional code of Vries [3]. That is not appropriate, as CIRC emerged only after in-depth discussions between Philips (mainly Vries) and Sony (mainly K. Odaka and T. Doi). Various error-correcting coding schemes were proposed and discussed during the six Philips-Sony meetings that were held between August 1979 and June 1980.

The original code proposed by Sony was a rate-2/3 code too, namely a simple cross-interleaved (16-bit audio sample oriented, since Sony opted for 16-bit signal quantization) code, named ICIC.

After the first meeting, both Sony and Philips carried out measurements and theoretical performance calculations in order to compare both codes. Then, based on the information exchanged between Sony and Philips, Doi et al. modified their original code in January 1980 into a rate-3/4 cross b-adjacent code (CBAC). This CBAC was a combination of two $d = 3$ (single-error, double-erasure correcting) codes with a particular interleaving between them, still applying 16-bit-wide symbols. Vries analyzed this code, assisted by me because of my algebraic coding theory knowledge. The analysis of the performance of this code resulted in an internal Philips Research Technical Note [7], which was sent to Sony as a discussion paper for the next Philips-Sony meeting.

During the meeting of March 1980, we (Philips) agreed with Sony that CBAC outperformed both the original rate-2/3 codes. But we also proposed a number of important improvements. Further analysis of Sony's CBAC made clear to us that there were possibilities for improving the error correction and detection capabilities of the code by opting for byte-oriented codes, without having to change the information rate. We suggested to Sony to split up the samples into two 8-bit-wide symbols (bytes), and to do arithmetic in the Galois Field GF(256). As a result, codewords doubled in length (counted in symbols), and the minimum Hamming distance d increased from 3 to 5. This modification offered better protection against random errors and short burst errors, while not diminishing the protection against long burst errors. Another attractive feature of the proposed modified code was that it allowed several decoding strategies. Despite the disadvantage of increased encoding and decoding complexity, Sony was convinced by the described advantages and accepted the modifications as proposed by Philips.

The minutes of the March 1980 meeting [4] state that one of the results of the meeting was a new joint proposal for the error-correcting code. After agreeing on the various code parameters and the interleaving scheme, the improved CBAC code with rate 3/4 eventually was renamed CIRC, and became the ECC standard for the Compact Disc system [2], [6], [8].

The fact that CIRC evolved from CBAC which evolved from ICIC is confirmed by Doi in [5, pp. 169–170]; see also his acknowledgment on page 174. For further information about CIRC, Doi refers to the paper by Vries and Odaka [6]. At the end of this paper, Odaka states in his biography: "Mr. Odaka jointly proposed the CIRC system with L. B. Vries of Philips." Odaka does not mention the other three Sony inventors [2], but he clearly recognizes Vries as one of the inventors.

Without the contributions of Vries and Driessen (both from Philips), Sony would have opted for their rate-2/3 cross-interleaved code, and without Sony's input Philips would have chosen its original rate-2/3 convolutional code.

CIRC is really the result of a fruitful collaboration between Philips and Sony. This is also corroborated in Section 3.1 of a book that describes the origins of the Compact Disc [9].

Concluding remarks

Though CBAC, from which CIRC evolved, was proposed by Sony, the final ECC standard for the CD system was the result of a fruitful collaboration between technical employees from Sony and Philips. Indeed, two of the Sony inventors of CIRC, Odaka and Doi, have credited Vries as a co-inventor. Lodewijk Barend Vries, who is not among us any more, deserves to be credited properly by Immink, particularly on the 30th anniversary of the CD [9].

References

[1] K. A. Schouhamer Immink, "Shannon, Beethoven, and the Compact Disc," IEEE Information Theory Society Newsletter, Vol. 57, No. 4, pp. 42–46, Dec. 2007.

[2] K. Odaka, Y. Sako, I. Iwamoto, T. Doi, and L. B. Vries, "Error correctable data transmission method (CIRC)," U. S. Patent 4,413,340, Nov. 1983.

[3] L. B. Vries, "The Error Control System of the Philips Compact Disc," AES Preprint 1548, New York, Nov. 2–5, 1979.

[4] Sony-Philips digital audio disc memorandum (confidential), Tokyo, March 19, 1980.

[5] T. T. Doi, "Error correction for digital audio recordings," The AES Premiere Conference—The New World of Digital Audio, New York, June 3–6, 1982, pp. 147–177.

[6] L. B. Vries and K. Odaka, "CIRC—The error correcting code for the Compact Disc digital audio system," The AES Premiere Conference—The New World of Digital Audio, New York, June 3-6, 1982, pp. 178–186.

[7] L. M. H. E. Driessen and L. B. Vries, "The performance of Sony's cross b-adjacent code on a memoryless channel," Philips Research Technical Note No. 54, March 1980.

[8] L. M. H. E. Driessen and L. B. Vries, "Performance calculations of the Compact Disc error correcting code on a memoryless channel," 4th Intl. Conf. on Video and Data Recording, Southampton, 1982 (IERE Conf. Proc. No. 54), pp. 385–395.

[9] J. B. H. Peek, J. W. M. Bergmans, J. A. M. M. van Haaren, F. J. C. M. Toolenaar and S. G. Stan, "Origins and successors of the Compact Disc—Contributions of Philips to optical storage," Philips Research Book Series, vol. 11. Springer, 2009.

Letters

Reply to Comments on "Shannon, Beethoven, and the Compact Disc" by L. Driessen

I thank Driessen for sharing his personal views on the history of the Compact Disc (CD). He points out that the error correcting code (ECC) tested in March 1980 was not the same as the one that could be purchased in the shops in 1983. I refer to [1] and later for details. His second point, whether Philips significantly contributed to CD's ECC, is a matter of debate. Can, for example, a theoretical error performance computation be seen as a material contribution to the engineering of CD's ECC? I don't think so, since the taskforce relied on simulations and real-time experiments. Driessen refers to undisclosed documents, and I could refer to even more confidential documents, but this is grossly unscientific. This concludes my reply, but let me add some tangible background so that his comments can be put into perspective.

The Sony/Philips teams responsible for the ECC format differed significantly in size and experience. Driessen joined the Philips Research group Magnetic Recording in 1979 very fresh from Mathematics school [2]. He was not allowed to attend the meetings [4], and his claim on being "well informed" should therefore be taken with a pinch of salt. Vries and Driessen were within Philips Research responsible for the ECC of the Compact Disc [4]. In 1979, Vries filed US patent 4,354,269, a rate 2/3, convolutional code, which he strongly defended during the first meetings. Two of Vries' total of four CD ECC patents carry my name as first inventor, US4,477,903 and 4,593,395. Driessen's name is not on any CD related patent.

Doi, an energetic leader and gifted engineer, was responsible for Sony's first digital audio projects. He filed Sony's first digital audio patent US4,206,440 in 1976. Doi's digital team designed, among others, the PCM digital audio adaptor and the DASH 24-track digital pro-audio recorder, the workhorses that made the digital audio revolution possible. Both devices use cross-interleaved codes similar to CIRC (see e.g. US4,306,305 and others). There are around a dozen US patents granted to Doi and over forty US patents to his team filed prior to 1982.

In March 1980, we conducted experiments in Tokyo for appraising the codes using soiled and scratched discs [3] since theoretical 'white-noise-based' performance calculations are a far cry from the 'scratchy' real thing. I stayed in Tokyo for around a month to conduct the experiments, and had a splendid look into Sony's kitchen during the time the Sony engineers conceived the ICBA/CIRC code. The Sony cross-interleaved code was implemented with the same rate, 2/3, as the Philips convolutional code to obtain a bit rate of 2.35 Mbit/sec [1] so that both codes were compared at the same information density. There was a mounting pressure on us to increase the playing time to 74 minutes and 33 seconds (see [3] for the alleged Beethoven connection), and both the code rate and the disc diameter are obvious candidates for increasing the storage capacity. The Sony rate-2/3 code we tested in March 1980 was performing very well, and was changed into the rate-3/4 code, gaining 7 minutes and 43 seconds playing time. Major conceptual changes were not made, as the time between the March 20 meeting and the CIRC patent filing date, May 21, was only 4–5 weeks (subtracting time for drafting the application). Driessen's statement [4] that 'without the contribution by Vries and Driessen, Sony would have opted for their rate-2/3 cross-interleaved code', is speculation. One could as well speculate that Ludwig von Beethoven posthumously determined Sony's rate-3/4 code.

Driessen, by reporting on 'in-depth ECC discussions' between the two parties, shows that he never attended the meetings. Sony's ECC code, equipped with a 16 kB RAM [6], met with violent "Are they crazy" [5] opposition from Philips. Not exactly a typical in-depth discussion, I think, but eventually —it must have been during another 'in-depth ECC discussion'—Philips accepted CIRC.

Driessen supports his claims by mentioning Sony's acknowledgements to Philips' contributions. Note that all articles, authors, acknowledgements, and conferences where the CD format was disclosed, were explicitly approved by the management, and follow the 'our contributions are equal' doctrine [3]. The Philips Research book mentioned by Driessen written by five writers—none of whom attended the meetings—is mainly a compilation of old articles written by (former) Philips workers, and reiterates the Philips' website with the 'official' Philips history including the Beethoven myth.

References

[1] T. T. Doi, 'Error correction for digital audio recordings', The AES Premiere Conference—The New World of Digital Audio, New York, June 3–6, pp. 147–177, 1982.

[2] L. M. H. E. Driessen, *et al.*, 'An Experimental Digital Video Recording System', IEEE Trans. on Consumer Electronics, CE-32, Aug. 1986.

[3] K. A. S. Immink, "Shannon, Beethoven, and the Compact Disc", IEEE IT Society Newsletter, Vol. 57, No. 4, 2007, pp. 42–46.

[4] L. M. H. E. Driessen, "Comments on Shannon, Beethoven, and the Compact Disc by K.A.S. Immink", IEEE IT Society Newsletter, Vol. 59, 2009.

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Call for Papers

8th International ITG Conference on Source and Channel Coding (SCC'10)
Siegen, Germany - January 18 - 21, 2010

SCC'10 is organized by the ITG (Information Technology Society) expert group 5.1 (Information and Systems Theory) in technical co-sponsorship of IEEE.

Topics of interest include but are not limited to:

- **Classical Information Theory**
- **Network Information Theory**
- **Multi-user Information Theory**
- **Source Coding and Compression**
- **Speech, Audio, Image and Video Coding**
- **Channel Coding and Coded Modulation**
- **Joint Source and Channel Coding, Error Concealment**

- **Multiple Access (e.g. CDMA, OFDMA)**
- **MIMO Systems and Space-Time Coding**
- **Synchronization**
- **Aspects of Cognitive Radio**
- **Cryptography**
- **Quantum Information Theory**
- **Applications**

Program Chair:
Prof. Dr.-Ing. R. Mathar, RWTH Aachen

General Chair:
Prof. Dr. Christoph Ruland, University of Siegen

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For information regarding program, registration, accommodation and transport, please, check the conference website:
www.scc2010.net

Tutorials (1,5 h or 3 h) will be organized on the afternoon of January 18, 2010. The program committee invites proposals for tutorials.
Invited key note speeches will be given on recent developments in communication theory.

There will be oral presentations of 25 minutes and plenum presentations of posters.

Submission
Authors are invited to submit a full 6-page paper. Lecturers of potential tutorials are encouraged to submit a summary and the contents of the tutorial until **September 8, 2009**.

Papers should be submitted electronically by **http://edas.info**
Proposals of tutorials should be sent by e-mail to the General Chair. Presentations and papers should be in English. Further details see:
www.scc2010.net

At least one author of accepted papers must be registered for the conference by **November 15, 2009** in order to include the contribution in the proceedings.

Deadlines:
Submissions due: September 8, 2009
Notification of acceptance: Oct. 8, 2009
Camera-ready papers due: Nov. 15, 2009

Call for Papers

2010 International Zurich Seminar on Communications
March 3 - 5, 2010

The 2010 International Zurich Seminar on Communications will be held at the Hotel Zürichberg in Zurich, Switzerland from Wednesday March 3 through Friday March 5, 2010.

High-quality original contributions of both applied and theoretical nature are solicited in the areas of:

Wireless Communications	UWB Communications
Information Theory	Fundamental Hardware Issues
Coding Theory and its Applications	Network Algorithms and Protocols
Detection and Estimation	Network Information Theory and Coding
MIMO Communications	Cryptography and Data Security

Invited speakers will account for roughly half the talks. In order to afford the opportunity to learn from and communicate with leading experts in areas beyond one's own specialty, no parallel sessions are anticipated. All papers should be presented with a wide audience in mind.

Papers will be reviewed on the basis of a manuscript (not exceeding 4 pages) of sufficient detail to permit reasonable evaluation. Authors of accepted papers will be asked to produce a manuscript not exceeding 4 pages that will be published in the Proceedings. Authors will be allowed twenty minutes for presentation.

The deadline for submission is **September 27, 2009**.

Additional information will be posted at

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http://www.izs.ethz.ch/
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We look forward to seeing you at IZS.

Helmut Bölcskei and Amos Lapidoth, Co-Chairs.

Conference Calendar

DATE	CONFERENCE	LOCATION	WEB PAGE	DUE DATE
June 23–27, 2009	**International Symposium on Modeling and Optimization in Mobile, Ad-Ho, and Wireless Networks (WiOpt'09)**	Seoul, Korea	http://www.wiopt.org	passed
June 28–July 3, 2009	**2009 IEEE International Symposium on Information Theory (ISIT 2009)**	Seoul, Korea	http://www.isit2009.info	passed
July 15–20, 2009	**Dobrushin International Conference**	Moscow, Russia		passed
Aug. 10–13, 2009	**School of Information Theory**	Northwestern University, USA	http://www.itsoc.org/people/committees/student/2009-school-of-it/	passed
Oct. 11–16, 2009	**2009 IEEE Information Theory Workshop (ITW 2009)**	Taormina, Italy	http://www.deis.unical.it/itw2009	passed
July 13–17, 2009	**10th International Symposium on Communication Theory and Applications (ISCTA '09)**	Ambleside, Lake District, UK	http://www.hwcomms.co.uk/ISCTA09.html	passed
Sept. 20–23 2009	**2009 IEEE 70th Vehicular Technology Conference (VTC 2009-Fall)**	Anchorage, Alaska, USA	http://www.ieeevtc.org/vtc2009fall/index.php	passed
Sept. 30–Oct 2, 2009	**47th Annual Allerton Conference on Communication, Control and Computing (Allerton 2009)**	Monticello, IL, USA	http://www.csl.uiuc.edu/allerton/	July 1, 2009
Nov. 30–Dec. 4, 2009	**2009 IEEE Global Communications Conference (GLOBECOM 2009)**	Honolulu, Hawaii, USA	http://www.ieee-globecom.org/	passed
Nov. 1–4, 2009	**The Asilomar Conference on Signals, Systems, and Computers (Asilomar 2009)**	Monterey, CA, USA	http://www.asilomarssc.org/	June 1, 2009
Dec. 14–17, 2009	**Twelfth IMA International Conference on Cryptography and Coding**	Cirencester, UK	http://www.ii.uib.no/~matthew/Cirencester09/Cirencester09.html	June 12, 2009
Jan. 18–21, 2010	**8th International ITG Conference on Source and Channel Coding (SCC'10)**	Siegen, Germany	http://www.scc2010.net	Sep. 8, 2009
March 3–5, 2010	**2010 International Zurich Seminar on Communications**	Zurich, Switzerland	http://www.izs.ethz.ch/	Sep. 27, 2009

Major COMSOC conferences: http://www.comsoc.org/confs/index.html