Digital Technology: the Document Examiner's Friend and Foe

4th Conference of the European Document Experts Working Group

The Hague, The Netherlands, 27-30 September 2006

Organising committee

Marjon Perlot
Wendy Glas
Charles Berger
Arend Thomas
Jan de Koeijer

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Conference Program

Program Wednesday 27th September			
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11:00	Workshop I, part 2.	Aravind Mikkilineni Maria Ortiz	Jeffreys room B2.01
12:00 – 13:00 Lunch Buffet			
13:00	Workshop II, Forensic Image Processing, part 1.	Charles Berger	Jeffreys room B2.01
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15:00	Workshop II, Forensic Image Processing, part 2.	Charles Berger	Jeffreys room B2.01
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Program Thursday 28th September
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12:30	Relative dating of ballpoint inks using SPME/GC/MS: a case report	C. Bird
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14:30	Forensic Imaging Analysis of Laser Printed Documents	W. Mazzella
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Program Friday 29th September
Auditorium

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9:30	A Comparison of the Application of Video Spectral Methods for Forensic Document Examination with Traditional Methods	M. Demirağ
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10:10	Chemical Imaging for Questioned Document Examination	R. Schuler
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	Session V. Analysis Moderator: Williams Mazzella	
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11:30	Toner analysis - Methods for Classification And Identification of Toner-based Printed Material	J. Holzapfel
12:00	Discrimination of document paper by inorganic analysis and multivariate statistical techniques	G. v/d Peijl
12:30	Analysis of Inkjet Inks by PY/GC/MS	C. Murie
13:00	Discussion	
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	16:30 Leave for hotel	
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Program Saturday 30th September Business Meeting*			
Time	**Event**	**Responsible**	**Location**
Business Meeting Joint Session I			
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9:30	Membership SC (vote)	Charles Berger	Auditorium
9:40	Presentation applicant associate members ▪ Special Service for National Security Institute for Expert Services, Budapest, Hungary ▪ Landeskriminalamt Hessisches, Germany ▪ Landeskriminalamt Bayern, Germany ▪ Romanian Border Police	 Judit Hazai Margot Nölke Jürgen Bügler	Auditorium
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	INCID (Ink ageing)	Ursula Hendriks	Jeffreys I room
	Printing	Williams Mazzella	Locard room
	Quality	Hans Gerhard Heuser	Jeffreys II room
Business Meeting Joint Session II			
12:30	Discussion of outcome sub-group sessions	Chairpersons sub-groups	Auditorium
13:20	Closing	New Chairman	
13:30 – 14:30 Lunch			
Continued discussion in sub-groups if needed.			

*The Business Meeting is for EDEWG members (full and associate) and invited guests only.

Workshops

WORKSHOP I

Aravind Mikkilineni
Maria Ortiz
Purdue University School of Electrical & Computer Engineering, 465 Northwestern Avenue, West Lafayette, IN, USA

This workshop will be on *inkjet printing characteristics*. How may we classify certain characteristics: as defects, as printer driver related, as printhead related, etc.? How do we recognize these characteristics and what is their forensic value? In this workshop we will discuss real case examples of inkjet printing in small groups and try to explain what we see. Presenters will then discuss what they believe are the causes of some of the encountered characteristics and what their forensic value is.

WORKSHOP II

Charles Berger
Netherlands Forensic Institute (NFI), PO Box 24044, 2490 AA The Hague, The Netherlands

This workshop will be a more hands-on workshop on *digital image enhancement and analysis.* Adobe Photoshop combined with different purposely developed tools is used for color separation, enhancing weak images, measurements in images, etc. This workshop will be given by Dr. Charles Berger who is a questioned document examiner at the NFI and active in the field of image processing. Bring your portable PCs!

Abstracts Papers

RECENT DOCUMENT DATING: AN APPROACH USING RADIOCARBON TECHNIQUES

D. Zavattaro [(1)], G. Quarta [(2)] , M. D'Elia[(2)], L. Calcagnile[(2)]
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(2) CEDAD, Department of Engineering of Innovation, University of Lecce, Italy

Keywords: Forensics, questioned documents, radiocarbon, paper dating

The absolute dating of paper documents is still now a relevant, unsolved, question for forensics purposes. Standard methods are actually too sensitive with respect to the document storage conditions. Humidity, light exposure and heat strongly affect all the chemical and physical variables which are usually measured for this purpose.
The following question arises: does paper have a feature, age-dependent, which is invariable to storage conditions?
With this goal we investigated the possibility to date paper by analyzing the ^{14}C concentration.
Recent works show that after 1955 the atmospheric concentration of ^{14}C increased until 1964 due to nuclear explosions and it has been decreasing since then. This change in ^{14}C concentration is known as the "bomb peak", and the effect is comparable in the two hemispheres. Because the relative functions are available, we tried to date recent paper documents, i.e. younger than 50 years old.
Because almost all kinds of paper are made of conifer or broad-leaved plants, and this type of trees have a similar biological system for the carbon uptake, an exact knowledge of the pulp composition is not needed.
In our experiment we investigated two documents of known age. These documents are similar, a postal bulletin issued in 1992 and a bulletin issued in 1993, both from the same town. They differ from each other in age by about one year, and we assume that the pulp was produced by the same company.
The samples were treated respectively with acid, alkali and acid solutions in order to remove contaminations (i.e. inks and additives). Following this it was combusted to carbon dioxide in sealed quartz tubes and then reduced at 600°C to graphite by using H_2 as a reducing agent and iron powder as a catalyst. The radiocarbon concentration in the samples was measured using Accelerator Mass Spectrometry by comparing the beam current intensities and the radiocarbon counts acquired for the samples with those obtained for standard materials supplied by the IAEA (International Atomic Energy Agency).
The measured ^{14}C concentration was converted to calendar ages by using the "Northern Hemisphere Tropospheric Bomb ^{14}C Dataset" giving an "apparent" year of production for the two documents of 1981 and 1982, respectively. These "apparent" raw ages are different, as was expected, from the real ones but the method appears, at least, a powerful one to check relative production dates.
In order to obtain a true absolute age for the samples a deeper analysis and interpretation of these raw data is needed by taking into account the number of tree rings and hence the age of the tree(s) used to produce the paper. We propose a mathematical first-order model expressing the ^{14}C concentration (C) in the samples given the number of N rings forming the tree and the shape $f_{^{14}C}(t)$ of the "bomb peak" curve:

$$C = \frac{1}{N^2} \sum_{n=1}^{N} (2n-1) \int_{n}^{n+1} f_{^{14}C}(t)dt$$

By using this equation, assuming that all the tree rings have the same width and neglecting the exponential radioactive decay of ^{14}C from the year of growth to the year of measurement, we found that both the postal-bulletins come from 25-26 years-old trees.
A wide research about the pulp production process would be the next step to be investigated in order to confirm the obtained results and to improve this work. In other words it is important to know if the world factories are producing paper with trees of similar age 'protocol' or not, if not a data-base would need to be created.
In conclusion, the preliminary study on the application of a ^{14}C paper dating method, using our "first-order" model on the analysis of documents of known ages shows consistent results, and has potential in this kind of investigations.

COMPARISON OF NATURAL AND ARTIFICIAL AGEING OF BIRO INKS

Dr. U. Hendriks, Claudia Berger-Karin, Dr. Jochen Geyer-Lippmann
Kompetenzzentrum Kriminaltechnik, KT 43, LKA Berlin

The solvent loss in biro inks of different ink formulas caused by natural and artificial ageing at 45°C was measured by thermodesorption at different temperatures.
The correlation of the graphs representing the loss of phenoxyethanol is discussed considering their utility for case work.
The evaporation of phenoxyethanol from biro ink writings was analysed using two different Thermodesorption/GS-MS-Systems: an Atas injection system combined with a Thermoelectron GC-MS and a Markes injection system combined with an Agilent GC-MS.
Both systems are equipped with a cold trap. The Atas/Thermoelectron system is cooled by liquid nitrogen whereas the Markes injector works with a Peltier element.
The results are compared in the presentation.

GENERAL ASPECTS ON DATING OF QUESTIONED DOCUMENTS

Dr. R.Hofer
Forensic Science Division, Zurich Canton Police

One of the most challenging research areas in forensic document laboratories is the dating of questioned documents. Whilst much effort is invested to determine the age of ink lines (especially those from ballpoint pens), one tends to forget the numerous other possibilities to get direct or indirect information about when a document was written or printed when the paper was produced etc. The goal of this presentation is to remind experts of the large diversity of traces which may lead to an accurate dating. Terms like direct, indirect, relative and absolute dating are discussed with examples without going into details.

AGE DETERMINATION OF BALLPOINT PEN INKS

Dr. J. Buegler
Bavarian State Bureau of Investigation

Ink dating still is a challenging subject in forensic document analysis. Two main concepts are available: indirect dating and direct dating. Indirect dating is based on chemical analysis of the ink composition followed by comparison with samples of an ink collection. In this way the market introduction of the ink under investigation can be determined and an anachronism may be detected. The second concept is based on measuring ink parameters changing with age. The evaporation of ink solvents is a useful parameter for determining the age of ink on paper. In a previous study we have demonstrated that thermal desorption of ink directly from paper followed by chemical analysis using gas chromatography-mass spectroscopy is a promising procedure for characterizing ink binder resins as well as ink solvents. Thermal analysis of ink on paper revealed that fresh ink releases a certain relative amount of ink solvent per unit of time at a certain low temperature. This relative amount decreases as the ink ages. As a consequence, the relative amount of ink solvent outgassing at a certain low temperature and its decrease with time can be taken as a measure for ink age. This age dependent parameter was studied on 85 different ballpoint inks over a time period of 2 years. It was found that some inks do not age with respect to the measured parameter, while other inks show a significant decrease of this parameter up to an age of several months. Based on these results, a general procedure for assessing the age of ballpoint pen inks on paper was developed.

EXPLORATIVE PROJECT TO DETERMINE RESINS AND THEIR AGING PRODUCTS IN BALLPOINT INKS BY MASS SPECTROMETRY

D. Kirsch
University of Giessen, Germany

Forensic analyses of ballpoint pen inks on paper are important to determine the authenticity of questioned documents. Today the analyses are based on the knowledge of aging curves of the dyes and solvents used in ball point inks. Usually the age of ink entries in questioned documents can not be explicitly specified, because the times of monitoring are less than two years using methyl and ethyl violet dyes (1) and typical solvents in blue ball point inks. Additional reasons often are:

- unknown initial composition of the ink and

- unknown storage conditions of the document (2).

Mass spectrometry (MS) is one of the most sensitive techniques in analytical chemistry and is used for forensic investigations of ball point entries on paper, as aging of dyes was investigated by LDI mass spectrometry, whereas solvents were analyzed by GC/MS.

Resins, the third substance class in ballpoint inks are more promising for age determination on a longer time scale. Due to their high molecular character they are less investigated so far. Classical mass spectrometric methods of analysis are based on the release of monomer units by pyrolysis and their detection by GC/MS. A disadvantage of this procedure is the generation of a wide variety of thermal decomposition products from the ink and the paper used. Direct identification and quantification of the molecular components and their aging products by MALDI and/or HPLC-ESI mass spectrometry were found instead to be much more promising than pyrolysis-based analysis.

In principle the project is subdivided into three parts:

1. Investigation of reference resin materials (feasibility study).
2. Artificial aging of reference material and detection of aging products.
3. Studies of ball point entries on paper.

The results show that the compounds of this substance class can be characterized successfully by the chosen MS techniques. All mass spectra show characteristic polymeric distribution patterns. Some compounds additionally demonstrate a dependence on the batch used. This effect might offer the possibility to identify specific batches and dates of production.

MALDI- and ESI-MS were used additionally to characterize the aging products of the resins. Due to the high complexity of resin mass spectra, High-resolution Fourier Transform Ion Cyclotron Resonance (FTICR) mass spectrometry was employed.

Resins of ballpoint inks offer a new parameter in addition to dyes and solvents, for the determination of the authenticity of questioned documents and for age determination of ball point entries.

Literature:

(1) C. Weyermann, D. Kirsch, B. Spengler J Am Soc Mass Spectrom., 17, 297-306 (2006).
(2) C. Weyermann, Dissertation 2005, Justus-Liebig-Universität Gießen, Germany

Financial support by the Federal Criminal Police Office is gratefully acknowledged.

RELATIVE DATING OF BALLPOINT INKS USING SPME/GC/MS: A CASE REPORT

C. Bird, P. Pigou
Forensic Science South Australia, Australia

Our laboratory was recently approached with a request to determine whether a series of 10 handwritten letters, dated 20/6/94 to 25/7/95, could in fact have been written on those dates. Each of the letters was written in blue ballpoint pen ink. The contention was that these documents were actually created in late 2005. Eight known dated documents, putatively written (at least in part) by the same writer as the questioned letters, were received for comparison. These were dated between February 1997 and November 2001.

The volatile components of the ink on each document were sampled by solid-phase micro-extraction, and analysed using gas chromatography / mass spectrometry. 2-Phenoxyethanol is a commonly used solvent in ballpoint inks1, 2 and that solvent was identified in all of the questioned samples, and none of the known dated samples.

Although a long-term study of the ageing of inks has not been conducted at this laboratory and the rate of loss of solvents over an extended period has not been determined, it is reasonable to conclude that the questioned entries are considerably younger than the known dated documents if the inks used are of the same, or similar, formulation.

Comparison of the spectral and thin-layer chromatographic properties of the ink samples indicated that the questioned documents and two of the known dated documents were written in ink of the same formula, or two similar formulas with the same non-volatile components.

Therefore, our findings were inconsistent with the questioned letters having been written on their purported dates.

(1) LaPorte, G. M., et al, “The Identification of 2-Phenoxyethanol in Ballpoint Inks using Gas Chromatography/Mass spectrometry – Relevance to Ink Dating”, J Forensic Sci, 2004, 49, 155-159.
(2) Bugler, J. H., et al, “Characterization of Ballpoint Pen Inks by Thermal Desorption and Gas Chromatography – Mass Spectrometry”, J Forensic Sci, 2005, 50, 1209-1214.

THE PHYSICAL AND CHEMICAL EXAMINATION OF INKJET PRINTED DOCUMENTS

G. LaPorte
United States Secret Service, Washington, DC, United States

This presentation will focus primarily on the physical examination of documents produced with inkjet technolgy. However, like many forensic examinations, the necessity for corroborative testing cannot be undermined. Specifically, a variety of resources available to forensic document examiners can be utilized to non-destructively examine documents. Some examples include the Video Spectral Comparator (VSC), hyperspectral contrast imaging, an Electrostatic Detection Apparatus (ESDA), and a system used to measure print quality (e.g. ImageXpert). The use of chemical examinations such as thin layer chromatography is highly recommended in instances when a forensic document examiner is requested to identify the possible brand of printer, compare multiple questioned specimens, or compare questioned and known documents. This presentation will focus on some of the modern techniques that can be used to forensically examine inkjet documents and their respective limitations.

FORENSIC IMAGING ANALYSIS OF LASER PRINTED DOCUMENTS

W. Mazzella, R. Marquis
IPS, Lausanne, Switzerland

Image analysis provides a means to objectively and quantitatively examine a laser printed document. This paper highlights the complementarities of forensic imaging analysis to classical methods used for the analysis of laser printed documents.
Some practical tests will be presented and discussed. Statistical data processing using discriminant analysis allows to correctly classifying the samples of the tests.
Forensic imaging analysis is realistically applicable in a closed set case, i.e. where the number of potential laser printers can be clearly defined or in page substitution cases.

FINGERPRINT OF INKJET PRINTER DRIVERS

R. Fauser
Regierungspräsidium Tübingen, Kriminaltechnische Untersuchungsstelle, Tübingen, Germany

Based on a counterfeiting investigation in the beginning of 2005, a study of inkjet printer drivers and their effect on the produced graphics was conducted.
The research focused on a Canon printer and a known digital document source.
Testing was undertaken to determine whether changes would occur within the printed document when the positioning of the original image was varied or if the file was converted into a different format. With the support of the manufacturer it was determined that the dot pattern of an inkjet printed image may be linked to the combination of a specific digital document and a printer driver.

FORENSIC ANALYSIS OF DOCUMENTS SEIZED FROM THE TERRORIST GROUP E.T.A.

A. Sánchez Gil
Guardia Civil, Madrid, Spain

The Questioned document Department which belongs to the Guardia Civil Criminalistic Service analyses every document seized from the terrorist group E.T.A.
E.T.A. has a group of people whose aim is to counterfeit documents such as ID’s or passports (mainly French and Spanish). The results from our Questioned Document Experts' analysis is given to our investigators and other Counter-terrorist Units in order to establish whether a document is counterfeit and if it has been printed by the E.T.A.
This presentation will show how the ETA forgery’s have evolved during its history and how digital technolgy has helped the E.T.A. to improve its false documents with inexpensive printers.

EXPERT EXPERIENCES WITH THE FORGERIES OF THE HUNGARIAN PASSPORT

Ágnes Szőkéné Tóth
dr. László Antal, and dr. Judit Hazai
Special Service for National Security Institute for Expert Services, Budapest, Hungary

Following the 1998 Sept. 1. issue of the Hungarian passport currently in use, the first important forgery of the document concerning the laser engraved data page - the photo has been altered - became known in december, 1999. From that time on passports forged by photo manipulation were examined in several cases in our institute. It was established that on many occasions the documents attached to different cases show similarity regarding the characteristics of forgery. A serie of examinations was started to explore the possible relations. In the meantime the Border Guard Directorate of Budapest revealed two forgerer's workshops whose main activity was forging Hungarian passports. The passports seized at the workshops - also forged by altering the photos - were examined, too. The main points of the examinations were as follows:

- method of removing the genuine, laser engraved photo
- technology applied to prepare the "new" photo
- recognition of alterations and damages due to forgery

The documents were examined with a Projectina Docucenter 3000 instrument and a microscope. Identification of the materials used for forgery was performed by infrared spectrometry.

Considering all the examination aspects, most of the documents could be classified into five large groups. The passports seized at the two workshops were compared - on the basis of the above listed points - to all the other passports examined. It could be established, that at least 90% of the passports examined in the different cases could be related to one of the two workshops.

On the basis of these experiences the Institute for Expert Services as an authority put forward a proposal for the modification of the data page in order to protect the photo. As a result of this proposal the security system of the data page has been re-designed, making it more difficult to forge the passport by photo alteration.

SECURITY PRINTING AND FORGERIES ON GERMAN POSTAGE STAMPS

W. Schenk
Central Forensic Science Service (CFSS), Deutsche Post AG, Darmstadt, Germany

Part I: Author Lutz-H. Richter

- General situation in Germany
- Issue and production of postage stamps
- Current security concept: invisible security
- Effectiveness of this concept
- Outlook
- Need to fine-tune the security concept
- Addition: visible security

Part II: Author Winfrid Schenk

- Current counterfeit stamps - Case Study

The Deutsche Post Central Forensic Science Service (CFSS) is part of Service Branch MAIL and is located in Darmstadt. The experts at CFSS investigate in-house forgery claims regarding all postal products, including stamps. They are also a consulting service for security techniques regarding printed products for Deutsche Post AG and are involved in the development and monitoring of anti-forgery devices for German stamps.

Four cases concerning counterfeit German stamps have been taken from the everyday work of CFSS and will be presented here.

MULTI- AND HYPERSPECTRAL IMAGING TECHNIQUE - NEW POSSIBILITIES IN DOCUMENT EXAMINATION

F. Hacizade
Tubitak-Uekae, National Research Institute of Electronics and Cryptology, Gebze-Kocaeli, Turkey

Optical spectroscopy an is important technique that has established itself as a premiere quantitative analytical tool for determining sample composition in forensic document examination. The advantages of optical spectroscopy include minimal sample preparation, non-destructive analysis, high sensitivity, fast acquisition times and the possibility of quantitative measurements of localized areas of a questioned sample. However, for comparing the reflectance, transmittance or luminescence spectra of different areas of the sample, a researcher must repeat the analysis on

another sample region. This type of point mapping investigations are often not fruitful from an optical, spectroscopical point of view due to sample heterogeneity, nonlinear dependence between spectra intensity and density of colorants and complex relations between light reflectance and scattering processes.
Visual inspection of a document is a fast and inexpensive way of examining a questioned document.. Modern technologies like high resolution CCD cameras and electronically tuneable wavelength filters allow researchers to detect some heterogeneity in the field of view (FOV) of that system. Unfortunately, this type chemical imaging systems have only been used successfully for analyzing materials which have strong differences in local optical properties in certain parts of the spectrums. Some differences in the optical spectra provide qualitative output, i.e. via an 8-bit gray scale image format. Visual inspection techniques often fail to solve difficult problems of document investigators because of above reasons and several influences from heterogeneity of the sample: the type of paper used, the characteristics of writing material, the pressure exerted on writing material and the angle of a writing instrument, etc. . Using Multi- and Hyperspectral Imaging Spectroscopy techniques makes it possible to get quantitative spectral information about all pixels of the FOV and merges powerful advantageous of imaging and spectroscopy methods. Thanks to fast microprocessor technology it is possible to detect tiny differences in these spectra and which helps the examiner to make a valid decision.

A COMPARISION OF THE APPLICATION OF VIDEO SPECTRAL METHODS FOR FORENSIC DOCUMENT EXAMINATION WITH TRADITIONAL METHODS

M. Demirağ
Gendarmarie General Command, Kriminal Daire Baskanligi, Ankara, Turkey

Being an indispensable part of forensic science, document examination has been highly regarded all over the world and law enforcement organizations have consulted document examiners to overcome cases they have encountered. Unfortunately, many of those examiners have performed only visual examinations, without using any scientific method or technological device. On the other hand, important developments have been done both on spectral methods and technologies related to document examination. These developments, especially in the period of 1999-2000 as well as methods that are being used in our country and in U.K. have been studied. The purpose of this study is to investigate the applicability of video spectral methods on document examination and to compare these methods with the traditional methods.

400 documents have been examined using the studied methods of infrared absorption, reflection and fluorescence spectroscopy and Raman spectroscopy. As a result of these examinations, it was proved that video spectral methods could be well used with an 83% success rate on document examinations.

Finally it has been argued that video spectral methods exhibit a major superiority to traditional methods, and it has been concluded that forensic document examination should absolutely be performed in laboratories, in which: there are video spectral instruments and systems, databases, scientific methods are being used, research and development activities are being undertaken and there are properly trained examiners.

Keywords: absorption, document examination, infrared spectroscopy, Raman Spectroscopy, video spectral methods.

QUANTITATIVE HYPERSPECTRAL IMAGING MEASUREMENTS – A NEW NON-DESTRUCTIVE TOOL IN FORENSIC DOCUMENT ANALYSIS

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Multispectral imaging devices are well-established non-destructive tools in forensic lab and field applications. Especially in forensic document analysis they are frequently used to obtain valuable image information about features that are invisible or indistinguishable for the naked eye. However, such devices are only suitable for a qualitative assessment and comparison of the spectral images, which means that they use only a small portion of the spectral information that could be retrieved from questioned documents.

We report on the development and initial testing of the prototype of a new generation of hyperspectral measurement instruments that provide quantitative spectral image information on a multitude of wavelength channels. The accurate calibration of the spectral images from this new instrument makes it possible to discover and fully exploit correlations of information contained in several channels.
The hyperspectral imaging instrument developed by Demcon BV measures 70 reflectance and 120 fluorescence/luminescence spectral bands in the wavelength range from 365 to 1100 nm, thus covering the near-UV, visible, and near-infrared parts of the light spectrum. Through accurate calibration to spectral standards, for each of these spectral bands a 4-megapixel greyscale image is generated, which represents the distribution of the reflectance or luminescence of the investigated document area at the corresponding spectral band. The images of all spectral bands of a measurement cover exactly the same document area, so that for any pixel coordinate, the spectral values correspond to exactly the same small region on the document. This is an important prerequisite for applying mathematical algorithms that combine correlated information that is spread over several or many spectral channels. For example, if two inks show only a very small difference in the spectral reflectance that would go unnoticed when looking only at any particular band, they may still be distinguishable easily, if such small differences appear at a number of different channels.
In addition to this considerable improvement of sensitivity, this novel approach to spectral imaging as a quantitative measurement technique offers a number of other important advantages.
Firstly, the calibration of the measurement data makes the results obtained from different samples comparable, even if they cannot be measured simultaneously. It thus becomes possible to compare a sample from a present case with those of earlier cases, or even to build databases with reference measurements that cover certain aspects. Because these measurements are all calibrated to general physical quantities such as the spectral reflectance, the results from different instruments are comparable and can contribute to the same homogeneous database.
The second advantage of quantitative hyperspectral imaging is its possibility to optimize the workflow of a case investigation. The tasks of measuring a document sample and of analyzing the results with respect to particular forensic questions can be distributed over time, location and amongst the personnel. After having measured all available spectral bands of a document in a single, relatively short session, for the subsequent off-line forensic analysis of the data the document itself is no longer required and can further be processed with other, possibly destructive analysis techniques. It is even possible to revisit the measurement data at a much later stage of the document analysis to follow hints that may come from other analysis techniques or new questions that may arise from other circumstances of the case.
In the presentation, we are going to introduce the working principle of the new hyperspectral imaging instrument and discuss some data analysis methods that can be applied to the measurement. We are going to present examples of initial tests on distinguishing inks and enhancing the visibility of faint features on documents.

CHEMICAL IMAGING FOR QUESTIONED DOCUMENT EXAMINATION

R. Schuler[1*], P. Treado[1], C. Gardner[1], G. LaPorte[2], J. Stephens[2]
[1]ChemImage Corporation, Pittsburgh, Pennsylvania, USA.
[2]United States Secret Service, Washington DC, USA.

Improvements in technology and methodology for discrimination testing of inks and questioned documents is important to the forensic science community. Rapid, reagent-less, non-contact and non-invasive examination using hyperspectral UV-visible-NIR absorbance, fluorescence and Raman imaging provides improved discrimination capability. In this presentation we will describe widefield Chemical Imaging, a hyperspectral imaging technique that combines digital imaging technology with molecular spectroscopy for evidence analysis. Widefield Chemical Imaging provides high spatial resolution, high image definition and full spectrum analysis. In operation, digital images of the sample are recorded as a function of wavelength through the use of an electro-optic imaging spectrometer, generating a fully resolved spectrum for each pixel location in the image. The combined spatial and spectral information reveals subtle features of a material often not observable using traditional imaging techniques.

ChemImage has been applying macroscopic and microscopic widefield Chemical Imaging to the examination of forensic evidence. While Chemical Imaging is relatively new to the forensic science community, various validation studies have shown widefield Chemical Imaging as an acceptable method for questioned document examination and ink analysis. In particular, ChemImage will describe the Hyperspectral Contrast Imager (HCI) technology that operates from 350 nm to 1800 nm, and is capable of macroscopic Raman Chemical Imaging. The HCI has been evaluated at the US Secret Service for the non-destructive characterization and identification of different evidence types, including inks and thin-layer chromatography (TLC) plates, and for the ability to differentiate between weakly contrasting features within these samples. It was found that for ink inspection, combined fluorescence and absorbance hyperspectral imaging provided the best results and were superior to either method operating alone.

ANALYSIS OF INK FEATURES STORED IN DIFFERENT CONDITIONS

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An important problem for experts who deal with document examination is determining the changes occurring in writing materials, depending on storing conditions of documents. Research work which has been conducted during the past several years concentrated on searching for such ink components, which degradation would help to determine the relative or absolute age of writing. In this extent the best results were obtained with the use of advanced research techniques, such as HPLC and PY/GC/MS. One however cannot forget that, at the first primary stage of research one usually uses easier and non-destructive methods, first of all optical methods and Raman spectroscopy. Final conclusions or decisions to conduct further research are often based on these initial examinations. It is obvious, that the storage conditions of documents influence both the substrate as well as the inks. That is why the aim of the presented research was to attempt to determine which characteristics of the inks change under various storage conditions and to what extent.Lines written with blue and black ball-pen inks and gelpens on papers differing in class, colour, ultraviolet luminescence and infrared luminescence, etc. were analysed. Samples of paper with ink lines, prepared appropriately, were cut in two after which one part was stored in darkness, and the second was left in daylight for a period of 6 months. Both samples of ink and paper were analysed and compared with optic methods (VSC 2000 HR) and with the Raman spectroscopy (FORAM 684-2).

TONERANALYSIS - METHODS OF CLASSIFICATION AND IDENTIFICATION FOR TONER BASED PRINTED MATTERS

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Landeskriminalamt Nordrhein-Westfalen, Germany

Since toner based documents are frequently used, forensic document examiners are often confronted with forgery of all forms of output devices which use an electrophotografic printing process. This presentation shows possibilities of toner classification and identification by optical, physical and chemical methods and a databased evaluation.

DISCRIMINATION OF DOCUMENT PAPER BY INORGANIC ANALYSIS AND MULTIVARIATE STATISTICAL TECHNIQUES.

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The ability to discriminate between sheets of paper and to determine the origin of pages of paper can provide important forensic evidence, especially in cases involving anonymous letters, the counterfeit manufacture of paper banknotes and document fraud. This field becomes more and more important because of the increase in threatening letters addressed to public figures such as politicians and the relation to terrorist activities. One of the possibilities in these investigations is the chemical or physical analysis of the paper. This may serve to establish a relation between different anonymous letters or to compare with paper that has been seized at a suspect's residence. There are many analytical techniques that can be used for a chemical or physical analysis of paper. However, the question is which methods or combination of methods has the highest discriminating power and which method combinations should be used. Our goal is to assess the discrimination powers of the different techniques whilst also searching for combinations of largely complementary methods so that a fast, efficient, sensitive and reproducible analytical protocol can be established for the forensic identification and comparison of paper samples.
In this work the potential of a selection of inorganic analysis techniques is evaluated. Later it will also be combined with organic and physical characterization results of the paper. The following techniques were applied: LA-ICP-MS (Laser Ablation Inductively Coupled Mass Spectrometry), XRF (X-ray Fluorescence), XRD (X-ray Diffraction) and IRMS (Isotope Ratio Mass Spectrometry). With these techniques both major as well as trace elements present in the paper can be analyzed. A set of 25 different paper types from the European market was used for the comparisons. From two paper types also several paper batches were measured.
Multivariate statistical techniques such as cluster analysis, principal component analysis (PCA) and discriminant analysis (DA) were used to establish the discriminating power of each technique and combination of techniques.
It appeared that LA-ICP-MS had the highest discriminating power. At least 23 out of the total of 25 paper types could be fully discriminated only by this technique. In addition LA-ICP-MS is also a fast and robust technique with easy sample preparation. A small piece of paper was cut out from the sheet and put into the ablation chamber. The paper is subsequently ablated using a 213 nm Nd:YAG laser with a spot size of 140 µm and a line-scan of 5000 µm. The ablated material is swept into an Elan 6100 ICP-MS which measures 45 elements. Subsequently the time dependent

signals resulting from the line scan are integrated. In the comparisons of document papers net element intensities are used that are normalized relative to the intensity of strontium. Despite its lower sensitivity XRF also showed good discriminating power but the correlation with LA-ICP-MS is high and a larger sample area is necessary. The combination of LA-ICP-MS and IRMS provides a powerful, complementary and strongly discriminating set of techniques.
The value of inorganic analysis for document paper discrimination will be illustrated with several casework examples.

ANALYSIS OF INKJET INKS BY PY/GC/MS

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There are a number of applications in which it is useful to compare black inkjet printing inks, for example anonymous letters. Usually, forensic document examiners study these inks using raman spectrometry, thin layer chromatography or high performance liquid chromatography.

Our new protocol uses PY/GC/MS to study the solvents of an inkjet ink on a document. For different inks, we find different solvents. So far we have found 2-pyrrolidinone, glycerin, thiodiglycol, ethriol being used as solvents for these inks. For this study, we have used 16 prints coming from 16 different inkjet cartridges (11 pigment based inks and 5 dye based) and within these we have identified 13 different groups.

RECOGNITION OF PRINTING METHODS

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The last EDWEG proficiency test on the recognition of printing methods showed that there are some senses of uncertainty about how to recognise certain printed matters on the basis of their microscopic features. In this paper some characteristic occurences of various printing processes are given and it is demonstrated how to discriminate between particular methods.

INTRODUCTION OF THE EPR AT SCHIPHOL AMSTERDAM AIRPORT

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The Royal Marechaussee is responsible for the border control in the Netherlands. The officers have to check passports and other identity document for forgeries and fraudulent use. The introduction of the Ducht e-passport, i.e. passport with an RF ID chip, will be a fact as of October 2006. In this e-passport biometrics wll be introduced in the document.

Adding biometrics and other data on a chip in a passport requires the ability to read that data, compare the content with the data elswhere in the document and to the person bearing the document.

The electronic passport reader (EPR) is a device that allows for reading and checking a document. It will detect common forgeries and non-conformities in layout and security features.

In this presentation the introduction of the EPR at Schiphol Airport and the development of the document examining software with its (im)possibilities will be discussed.

Abstracts Posters

COMPREHENSIVE CRIMINALISTIC EXAMINATION OF DOCUMENTS FOR THE PURPOSE OF DATING THEM

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1. The dating of documents is among the main objectives of their forensic examination. Accomplishment of this objective calls for an all-round study of documents - their contents, entries, materials.

2. The basic principles of dating document entries –
   handwritten notes made in ballpoint pen pastes;
   seal impressions applied with endorsing ink;
   inkjet-printed texts by a change in the relative content of volatile components in the ink.

3. The training of experts in the forensic technical examination of documents
(a) the study of document entries and b) the study of document materials) –
one of the basic conditions of such investigations being a success.

4. The accuracy of dating the documents under investigation depends on the quality of the materials used for this purpose.

CONFUSING 'BITMAP' (CASE REPORT)

A. Deringas
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Modern colour laser printers and copiers leave a latent code (also called 'bitmap' according to the decoding software) on their print-outs. It is in the form of a barely visible yellow dot pattern. This feature is very helpful to QD examiners for identification purposes.

The case: law enforcement seized a small manufacturing shop for producing counterfeit documents. A large number of documents (about three hundred) and three printers, among them a hp colour LaserJet 2500, were presented for examination. A part of the documents was printed by colour laser and their latent code corresponded to the code printed by the hp colour LaserJet 2500. However, on one group of documents the code looked rather different: it also consisted of dots, but they were denser and there was no evident pattern repetition. Only after thorough examination of these documents the problem was solved. In some documents the pattern was the same as produced by the seized printer, only in triplicate. This fact showed that these sheets of paper had been reinserted into the printer twice.

Although in the case described above the problem was solved successfully, it may happen that a QD examiner has to compare two documents printed or copied by the same colour laser equipment, when one sheet has been printed once whilst the other has been printed multiple times. Depending on how the sheet was put into printer the comparison of the latent code can be really confusing and a wrong conclusion is possible.

GUIDELINE APPLICABLE IN THE DETERMINE THE STROKE SEQUENCE BY MEANS OF 3D LASER PROFILOMETRY

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The determination of the sequence of crossing strokes can provide important information when investigating fraud. Recently 3D laser profilometry has been introduced as a useful tool for the examination of crossing lines and to determine the stroke sequence used to obtain each word in a document [1-3]. The proposed technique is able to give 3D profiles in a non-invading way. This technique has as output a 3D micro topography of the paper sheet with the strokes of the printing media (inks deposits and/or pen impression). The laser profilometry technique can be used with success when the writing instrument leaves deposits or impression (e.g. ball-point pen, toners from laser printers, etc.). However, the literature does not contain studies on the limits of the technique in the examination of real cases. Besides, at the moment, a standardized protocol on how this type of measurement has to be performed, it is not known.

In this poster, we present the potential of the technique and the encountered problems in the study of the sequence of homogenous and heterogeneous crossing lines performed by means of laser profilometry.
Also, we will introduce a guideline applicable to this type of analysis. With a correct use of the guideline, in absence of a positive identification, the result is "inconclusive" (no false determination did occur).

1. V. Berx, J. De Kinder, A 3D view on the 'crossing lines' problem in document investigation, Proc. SPIE vol. 4709 (2002) 102-110.
2. G. Schirripa Spagnolo, C. Simonetti, L. Cozzella, Superposed strokes analysis by conoscopic holography as an aid for a handwriting expert, J. Opt. A: Pure Appl. Opt., 6 (2004) 869-874.
3. G. Schirripa Spagnolo, Potentiality of 3D laser profilometry to determine the sequence of homogenous crossing lines on questioned documents - in press on Forensic Science International.

3D-IMAGE PROCESSING: ANALYSIS OF BALLPOINT LINES ON PAPER

Eva De Leersnyder, Patrick De Smet (NICC / UGent)
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This research continues earlier work on the 3D-analysis of the writing sequence of crossing lines. At the same time we explore new possibilities to analyse three dimensional profilometer scans of ballpoint lines on paper. The latter is done by following the heights along the lines and by studying cross sections.
The ballpoint lines are extracted semi-automatically using the Steger algorithm, which is an edge detector for curvilinear lines. The localisation of the lines is feasible in most cases. The higher the pressure on the ballpoint pen, the easier it becomes to detect and track the line.
Existing research on writing sequences has concluded that for sufficiently high writing pressures an oval structure or a total intersection was present at some of the crossing points of two lines. The longest axis of the oval structure was always laying in the direction of the second line. In case of an intersection the first line was totally intersected by the second one. In both cases the writing sequence could be determined properly. In the research we present here, we examined various low to medium writing pressures. We conclude that for these situations the determination of the writing sequence does not always give good results. Moreover, some doubts arise about the accuracy of the assumptions that were made in the existing literature.
The impression depths along a line are very sensitive to local changes. No conclusions about the longitudinal variation of pressures could be drawn.
The cross sections are very capricious. After the computation of the average value of twenty-one consecutive cross sections, the observed profile becomes smoother, and the cross sections of the lines written with a slanted pen show asymmetry. Some left-handed lines (pen slanted to the left) and right-handed lines (pen slanted to the right) demonstrate the same asymmetry and some the opposite asymmetry, so the link between the kind of asymmetry and the angle of the pen has not yet been fully determined.
All measurements as well as the characteristics depend heavily on the paper surface, its local changes, its fibres and the (in)consistency of the writer.

CASEWORK ABOUT MONTAGE

Liene Feldamne
State Forensic Science Bureau, Riga, Latvia

No abstract received.

DISCRIMINATION OF DOCUMENT PAPER BY LASER ABLATION INDUCTIVELY COUPLED MASS SPECTROMETRY (LA-ICP-MS)

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The discrimination between sheets of document paper can provide important forensic evidence, especially in cases involving anonymous letters, the counterfeit manufacture of paper banknotes and document fraud. Historically paper characterisation has relied upon the measurement of gross physical properties such as strength, thickness, mass per unit area or the measurement of fibre content, colour and fluorescence. However, the problem with using these methods for the characterisation of paper remains the inability to match two sheets of paper with a high degree of certainty. In this work a detailed evaluation of Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) for

discriminating document paper is presented. Using LA-ICP-MS an elemental profile can be measured of both major and trace elements present in the paper. It will be shown that these elemental profiles are highly characteristic for the origin of the paper.
Inductively coupled plasma mass spectrometry (ICP-MS) has been applied to many types of material that are commonly encountered in forensic investigations, such as plastics, tape, bullet alloys, and glass but until relatively recently it had not been applied to paper. Spence et al[1] have employed solution nebulisation ICP-MS for the characterization of document paper. The discrimination of papers from different sources was attempted by virtue of their elemental compositions. Nine elements were found to be suitable discriminators because of their high concentrations. The results showed that elemental analysis using ICP-MS provides an effective and robust technique for the discrimination of document paper. In this study we will focus on the possibilities of LA-ICP-MS. Compared to solution nebulisation ICP-MS it offers several advantages such as speed and a smaller required sample size. In the same analysis also printed ink can be analyzed. The discriminating power of LA-ICP-MS was evaluated by analyzing 25 different paper types from the European market. From two paper types also several paper batches were measured. A small piece of paper was cut out from the sheet and put into the ablation chamber. The paper is subsequently ablated using a 213 nm Nd:YAG laser with a spot size of 140 µm and a line-scan of 5000 µm. The ablated material is swept into an Elan 6100 ICP-MS which uses an element program of 45 elements. The time dependent signal from the line scan is integrated. In the comparisons of document papers net element intensities are used that are normalized relative to the intensity of strontium. Multivariate statistical techniques such as cluster analysis, principal component analysis (PCA) and discriminant analysis (DA) were used to establish the discriminating power. It could be demonstrated that LA-ICP-MS provided full discrimination of at least 23 out of the 25 paper types. Several casework examples (document paper, banknotes, envelopes) will be discussed to demonstrate the value of LA-ICP-MS in forensic paper analysis.

[1] Spence L.D., Baker A.T. and Byrne J.P. *J. Anal. At. Spectrom*., 2000, **15**, 813-819

TOF-SIMS, A POSSIBLE SOLUTION TO SOME FORENSIC PROBLEMS: DETERMINING THE SEQUENCE OF A HANDWRITTEN ENTRY AND A FINGERPRINT OR OF ENTRIES FROM TWO DIFFERENT BALLPOINT PENS.

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In two recent cases we have had the opportunity to use a relatively new surface analysis technique called Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) to determine the sequence of different types of intersections. TOF-SIMS allows detailed analysis and profiling of the first few monolayers of a surface area by bombarding the surface with a pulsating ion beam. Surface imaging is based on differences is the mass of emitted secondary ions generated by the collision of the ions from the ion beam with the surface molecules.
In the first case the sequence of a ballpoint pen signature and a handwritten entry was questioned. In the second case it was necessary to determine the order in which a fingerprint and handwritten text were placed on a document. Surface imaging of the intersections showed continuous and discontinuous features making it possible to determine the sequence of the different entries.
From a number of reference intersections it was shown that the freshness of the first ink entry is a critical factor in determining the usefulness of this technique for this type of work. A high solvent content and a soft resin allow a mixing of the two layers resulting in ambiguous results. Once the solvents have largely evaporated and the resins have had some time to harden separate layers may be quite easily distinguished making TOF-SIMS a very suitable technique for sequencing problems in forensic science.

FORENSIC ANALYSIS OF DOCUMENTS SEIZED FROM THE TERRORIST GROUP E.T.A.

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Guardia Civil, Madrid, Spain

The Questioned document Department which belongs to the Guardia Civil Criminalistic Service analyses every document seized from the terrorist group E.T.A.
E.T.A. has a group of people whose aim is to counterfeit documents such as ID’s or passports (mainly French and Spanish). The results from our Questioned Document Experts' analysis is given to our investigators and other Counter-terrorist Units in order to establish whether a document is counterfeit and if it has been printed by the E.T.A.
This presentation will show how the ETA forgery’s have evolved during its history and how digital technolgy has helped the E.T.A. to improve its false documents with inexpensive printers.

PAPER DEGRADATION AND INVESTIGATION: A CONSERVATION SCIENTIST'S APPROACH

H. Porck
Koninklijke Bibliotheek, National Library of the Netherlands

Paper research performed in the field of conservation of library and archive materials aims at the understanding of the paper aging mechanisms, and at the evaluation and development of conservation treatment techniques. Conservation science also deals with the characterization and identification of paper in books and archival documents. The results and methods of conservation research can be useful for the forensic scientist. Also, the conservation scientist can learn from the knowledge and experience developed in forensic research. Several practical examples and possibilities will be indicated.

Social Program

During the conference we have the following two social events planned for you:

Welcoming Reception

Date	Wednesday 27th
Transport	Chartered Bus (Company: Beuk)
Departure time	- 16:15 from in front of Delft Train Station - 16:45 from the NFI
Return to Hotel	± 23:00
Dress code	smart casual

The welcoming reception will take place on the cruise ship James Cook, leaving from the world famous Port of Rotterdam. Transport to Rotterdam will be by chartered bus from either Delft train station (for those not attending workshop II) or directly after Workshop II from the NFI. Wining, dining and dancing will take place indoors but there is a possibility to go on deck for fresh air and a better view of the scenery. The ship will depart at 18:00 and return to dock at 22:15. During this time we will tour the port and some of its surroundings, including the famous “Kinderdijk” with a large number of typical Dutch windmills.

Closing Party

Date	Friday 29th
Time	19:30
Transport	tram 1 from Delft station to Scheveningen (stop: Kurhaus, the last but one stop), stamp 5 strips off your card.
Travel time	45-50 minutes
Location	Crazy Pianos is located on the Scheveningen Boulevard, just behind the Kurhaus Hotel
Dress code	informal (casual)

This party will start off with an informal dinner at Crazy Pianos, after which it’s time for some serious dancing and partying. The last tram back to Delft leaves at 24:00, taxis run all night. This is not a closed party so there will also be other guests.

Getting around in the Netherlands

To make sure you won't get lost in the Netherlands we have made the following set of maps:

Map 1	Schiphol airport
Map 2	Trains
Map 3	Delft
Map 4	Delft - NFI, The Hague (Den Haag)

From Schiphol Airport to Delft

Map 1

When you arrive at Schiphol airport, by far the easiest way to get to Delft or the NFI is to go by train. You can buy tickets in the central hall of Schiphol airport and trains depart from underneath.

Map 2

Trains go about 4 times every hour. Trains directly to Delft leave from platform (Spoor) 6 at 24 and 54 minutes past the hour and take about 1 hour to reach Delft (11th stop). A faster (±40 minutes) alternative is to change trains at Leiden Centraal (3rd stop) to Den Haag HS (other side of platform), this train then takes you on to Delft (1st stop after Den Haag HS).

You can also take the train from Schiphol to Den Haag HS from platform 5 at 16 and 46 minutes past the hour. You then have to change trains at Den Haag HS (2nd stop) to Rotterdam Central (other side of platform). The third stop is Delft. For more details check the Dutch railways (NS) website, or check the yellow boards in the hall and stations.
If you intend to go to the NFI directly (not to Delft) then take the train to Den Haag HS (Holland Spoor) or Den Haag Centraal Station and from there take Tram 15 in the direction of Nootdorp, leave tram at stop "Laan van Ypenburg" (see Map 4).

From Delft Station to your Hotel

Map 3

When you get to the station of Delft take a taxi or walk to your hotel. The Train Taxi (Treintaxi) is a typically Dutch means of transport, which involves sharing a taxi with other passengers. The taxi will take you to and from the railway station at a reduced price. You pay a fixed price of Euro 4.20 per person, whatever the distance. Train Taxi tickets can be bought at NS ticket offices or ticket machines. You can buy a ticket from the taxi driver, but it is more expensive, at Euro 5.00. You can also get a normal taxi.

The hotel addresses are:

Museum hotel	Oude Delft 189
Hotel de Ark	Koornmarkt 65
Grand Canal	Breestraat 1
Coen Hotel	Coenderstr 47
Hotel de Kok	Houttuinen 14
Hotel de Plataan	Doelenplein 10
Hotel de Emauspoort	Vrouwenregt 9

On this map you also see the stops where you can get on the Tram or Bus to the NFI.

From Delft to the NFI

Map 4 and 5

To get to the NFI from Delft you can choose either take Bus 62 (one every half hour:) in the direction of Nootdorp Centrum (get out at Laan van Hoornwijck) or Tram 1 (every 10 minutes) in the direction of Scheveningen Noorderstrand and switch at Hoornbrug to tram 15 in the direction of Nootdorp Centrum (get out at Laan van Ypenburg). Both routes will take about 30 min.

tram information

You pay for the fare with a so-called “strippenkaart” that will be handed to you in an envelope on arrival in your hotel. Either you (tram) or the driver (bus) stamps the correct number of strips. Only the last counted strip should be stamped. For this stretch the tram costs 4 strips and the bus 3. So fold the “strippenkaart” and place it with the strip to be stamped facing upwards into the stamping machine.
For directions to the NFI from the bus and tram stops see the aerial photograph, Map 5.
Remember that most people in the Netherlands speak English quite well, so do not hesitate to ask!

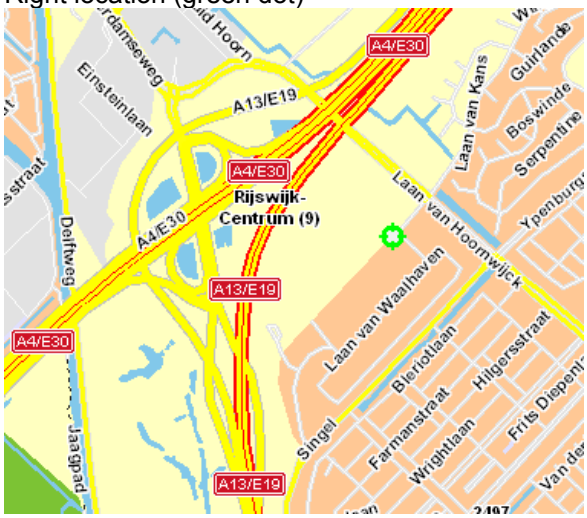
To the NFI by Car

The route to the NFI by car can be downloaded from the NFI website.
English version
Dutch version
Parking space is reserved just next to the NFI, see Map 5. To access this parking drive straight past the entrance to the NFI grounds where you will see signs “Parking NFI” on your left hand side.

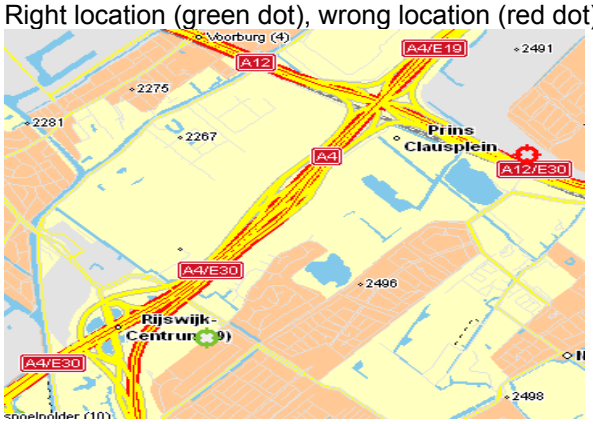
Exhibitors needing to unload equipment need to enter the NFI grounds and go to the rear loading bay, see Map 5. To reach this, drive towards the black gate to the left of the building and announce yourself at the intercom. After passing the gate drive to the last red garage door.

Note! Drivers using a navigation device be aware that some of these direct you to another Laan van Ypenburg with a different postal code (2491 instead of 2497) about 3 km’s away from the NFI building.

Right location (green dot)



Right location (green dot), wrong location (red dot)



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