CANADIAN PRAIRIES GROUP
OF
CHARTERED ENGINEERS

NEWSLETTER

Summer 2015 Edition

Alberta youth take top prizes at international engineering and science competitions

Loads of summer fun to be had in this edition of the CPGCE newsletter. Read on for updates of how our Alberta youth are representing us on the international stage with their research in Engineering and Sciences.

Robert Mayall receiving first place at the Americas PATW Final

The new CPGCE website is just a glimpse of the exciting things that the organization has in store for 2015

The new CPGCE website gives a stunning look on Calgary Engineering, Energy, and Innovation. Not to mention all the great information and links that can be found within. Look inside for the full story.

Just for fun, have a look at the last page for some fascinating scientific breakthroughs of 2014. You might even get to read a joke.

Chairman‘s Notes Summer 2015

Hello everyone.

I hope all of are having a good summer. Yes we did get the odd shower or two here – okay downpours but that was good for the garden and the forest fires. Thankfully the smoke is clearing though it did give us amazing sights of the sun and the moon. I digress. Well there has been a lot of activity since our last Newsletter and here are some of the highlights:

2016 AGM
Saturday January 30th
New Committee members required

Please make a note of the date in whatever device you operate with, paper or otherwise, to be held again at Fort Calgary. The Committee is working to have a keynote speaker but if you have any suggestions, please e-mail any one of the Committee members.

Now there are three Committee members who have stated that they intend to step down then. In addition to that, we have had two resignations in the summer, namely Peter Gibby, the Vice Chair, who has moved to “greener” pastures south of the border and Gobind Khiani who stepped down because of work commitments. We thank both Peter and Gobind for their contributions to the Committee.

So if you can spare just one Wednesday a month and are willing to actively participate in the 2016 Executive Committee, then you are most welcome to contact any one of the Committee Members.

Attendees at the 2015 AGM

New Website

Through the amazing efforts of our indefatigable Secretary, Rick Marshall, we have a new website www.cpgce.org. He worked tremendously hard with our contractor and successfully launched the website earlier this year. He will continue to upload documents to the website e.g. the Newsletters.

If anyone has any documents that you feel may be useful to be archived or copies of old Newsletters which are missing from our list, please contact Rick through the website.

Membership Lists

We now have an updated membership list thanks to Rick Marshall and Niamh Ní Chróinín, who worked with our institution representatives. Our CPGCE membership is as follows:

Institution	Number of members
ICE	154
IET	223
IMechE	31
IStructE	28
Total	480

Technical Presentations

Our Technical Presentations continue to attract increased attendance with excellent speakers. Rick Marshall will continue to post the pdf versions of their presentations on our website.

Visit CPGCE on LinkedIn, Facebook and IET My Community

All those who have LinkedIn and/or Facebook accounts, you will be pleased to know that Niamh Ní Chróinín has created our very own Facebook page, Rick Marshall has set up our LinkedIn account, and David Dean has

highlighted CPGCE activities in the IET "My Community" page. Here are the links:

Facebook:
https://www.facebook.com/pages/Canadian-Prairies-Group-of-Chartered-Engineers/925615957459192

LinkedIn:
https://www.linkedin.com/grp/home?gid=5012924

IET "MyCommunity": Available to members Only
mycommunity.theIET.org/communities/home/392

Western Canadian Group of Chartered Engineers (WCGCE)

I had a very good telephone conversation with Mathew Walton-Knight, the current Chair of the Vancouver based WCGCE, the group from which we evolved more than 20 years ago. We agreed to continue to maintain the link and exchange information of mutual interest.

Newsletter

This wonderful Newsletter is the work of Mia Jovic who has taken over the role of the Editor. It is through her efforts that we have been able to resume our past practice of semi-annual Newsletters.

Finally the Executive Committee hopes to see you not only during the excellent Technical Presentations, but also at the AGM on Saturday January 30th 2016 at Fort Calgary.

The Executive Committee hopes that you will all have a safe, healthy and enjoyable remainder of 2015.

Annual General Meeting 2015

The AGM was held on the 24th of January 2015 at our usual venue Fort Calgary, which has now been extensively renovated. The AGM fairly well attended with 58 members and guests.

The AGM commenced with reports from the Chairman, Treasurer and Secretary. Then on behalf of the Scholarship Committee, Dr. Nigel Shrive, announced the results of the two 2014 CPGCE Scholarship Winners, namely Nicole Barber from the University of Regina studying Civil Engineering and Waheed Zaman from the University of Calgary studying Chemical Engineering.

Mr and Mrs Micallef enjoying the AGM

For Nicole, the judges (Dr. Nigel Shrive, Tom Martin and Mario Micallef) were particularly impressed with her initiative in introducing engineering to young people especially with her presentations to high school students. Her enthusiasm for engineering shone through her writing. Nicole should have a very successful future in her chosen field of Civil Engineering and is a role model for the younger students.

Mr Salt and Mr Enever. Our wonderful doormen, good cop, bad cop?

Nicole, in her acceptance of the Charles Dempsey medal and the Scholarship Award, talked about her work with the high school students. The award would enable her devote more time to her presentations.

For Waheed, the judges were particularly impressed with his eloquence in describing his interests and ideas, especially his belief that engineers should be visible in society to counteract the general perception of the public of engineers being anti-environment rather than pro-development. His active participation in youth programs was noteworthy as he strived to be a role model for them.

Since Waheed was unable to attend the AGM, he was presented with the medal and Scholarship Award at the March Technical Presentation. In his acceptance speech, Waheed reiterated his commitment to increase the awareness of engineers in the general public as well as encouraging the younger engineers to participate more actively in the society as a whole.

Waheed receiving the 2015 scholarship from the CPGCE Executive Committee

The pictures of Nicole and Waheed receiving their awards are posted on our website.

Subsequently the elections for the 2015 Executive Committee were held. One of our longest serving members, Tom Martin retired after serving for 10 years in the Committee, 6 of which were as Deputy Treasurer. His extensive contributions were duly acknowledged. The rest of the 2014 Committee members were re-elected to the 2015 Committee together with 3 new members: Emily Hicks, Niamh Ní Chróinín and Gobind Khiani.

After the AGM, members and their guests were served with a sumptuous buffet dinner, which lived up to the culinary reputation of Fort Calgary.

Following the dinner, our keynote speaker, the renowned Dr. Tom Keenan, educator, author and broadcaster, was introduced. His presentation was *"Technocreep: The Surrender of Privacy and the Capitalization of Intimacy"*.

Attendees at the AGM Connor Scheu, Emily Hicks, and Aymn Ali

Judg

Technocreep: the surrender of Privacy and the Capitalization of Intimacy

Dr. Thomas P. Keenan FCIPS, I.S.P., ITCP

Educator, Author and Public Speaker

Thomas P. Keenan gave a thought provoking if not disturbing presentation on everyday technology that many of us take for granted and how it may have a more sinister application.

Information was presented on the topics detailed below with the following question continually asked throughout the presentation to the audience, 'what is the creepiest use of technology?'

- Intelligence creep
- Camera creep
- Deception creep
- Child creep
- Robot creep

Those who attended the presentation will have noted that many of the topics discussed seemed to centre around or have some connection to pornography. The first topic on

intelligence creep was the advancement in technology called the Kurzweil Reading Machine which was the world's first functional text to speech synthesizer (as shown below).

This contraption was built as an aid to the blind, however as Mr. Keenan explained after discussion with the librarian this machine was mostly used to read pornography! He learned that there are many volunteers willing to read books on the civil war or historic events but very few who are willing to read *Lady Chatterley's Lover* or *The Story of O*.

On April 19, 2013 technology was used to locate the whereabouts of fugitive Dzhokhar Tsarnaev in the aftermath of the Boston bombings (see below).

Thermal imaging is not by any means new and its applications range from use by the fire department to identify trapped humans in a fire or by the police to identify if someone is growing marijauna on their premises. The 'creepy' part of this intelligence is that now these services and applications are too widespread and available to all. According to a report in Forbes there are an estimated 30 million surveillance cameras in the United States which create an estimated 4 billion hours of footage each week.

Mr. Keenan continued to present on examples of advancements in technology designed to assist and the adverse effects of its creation, on many occasions with bouts of laughter from the audience. However there was a very serious point to be made and this seemed to be the answer to the question, 'what is the creepiest use of technology?' which is, what it is doing to the younger generation.

Mr. Keenan focused a lot of time on the advancements and sinister uses of the internet and in particular Facebook. Without fail those of us who use facebook will undoubtedly post pictures of ourselves and others either tagged with names, places and captions. This has changed Facebook from being a site where one can share photos with others (such as dropbox) to 'the world's largest, self-validated, photo database on the planet'. Mr. Keenan previously asked, 'did the CIA create Facebook?' to someone within the agency and the response was 'no' but that it is utilized everyday by the CIA and had it not been created they may have launched something similar.

It cannot be denied that Facebook may bring a lot of people together (those you may have gone to school with 20+ years ago – with no connection to them then, it seems pointless to have a connection to them now..) but it has caused harm. There have been multiple youth suicides due to what is being called cyber bullying and increased privacy laws and increasing the age to hold an account (which is now only 13) may be a way to prevent such issues in the future.

The Internet itself has provided those with an average competency of computers to harass and extort those who may have been a little ignorant to its sinister applications. Cassidy Wolf, Miss Teen USA 2013 who did a huge service to the world by bringing the dangers of having your computer hacked. Miss Wolf's perpetrator had used malicious software and tools in order to turn on her webcam and take compromising photographs of her without her consent. Advanced software is not necessarily needed, applications like snapchat save allow

the recipient to save images which are initially intended to be short lived without the other party's consent

Another story that Mr. Keenan discussed in relation to the creepiness of advancements of technology was that, in the US if you are arrested a mugshot is taken and is published online with the details of the alleged offence. This, through affirmation by the Supreme Court is legal and its use is to inform the public of potential wrong doers in the area. Mr. Keenan's thinking on this is that this is used as publicity shot for the local sheriff who may use this for re-election purposes. However these mug shots are posted of those who have allegedly committed an office prior to any verdict of innocent or guilty. The procedure is that in most cases the information is deleted within 30 days. In one particular case a mugshot was found of a 12 year old boy which included his full name and address. There was no determination of guilt only his mugshot that had been posted in 2010 which further demonstrates that what is posted on the internet stays on the internet – forever.

Present Around The World Competition

This year both Calgary and Edmonton hosted local events for the IET's Present Around the World competition. Held in February, the Calgary event had three strong competitors, while the Edmonton event also hosted 3 competitors. The winner of the Calgary competition was Robert Mayall, a PhD student in Chemistry at the University of Calgary. His talk was entitled: Ending the Guessing Game for Infectious Patients and detailed a nano-engineering approach to more rapidly diagnose infectious diseases. The winner of the Edmonton event was Travis Schoepp, a recent graduate from the University of Alberta. His talk focused on the development of high-powered lasers for nuclear fusion research, work he conducted during his graduate degree.

Alberta's own PATW 2015 winner, Robert Mayall presenting at the Americas Final

Both competitors advanced to the Americas finals of the competition, which were held this past July in Port of Spain, Trinidad. Robert came in first place with Travis as the runner-up. With his win, Robert advances to the global finals of the competition, held in London in November. Overall, fantastic results for Alberta!

Judges and participants of the 2015 Calgary PATW

Technical Presentation Summaries

Fired Heaters Improving Efficiency and Capacity while Reducing Emissions

Roger Newnham, C Eng, FIMechE,

Director Corporate Sales Onquest (previously Born) Canada

Roger Newnham is a long time member of the Institution of Mechanical Engineer. He emigrated to Canada in 1980 and worked for several engineering companies and operators around the world. In 1988 he set up Born Canada.

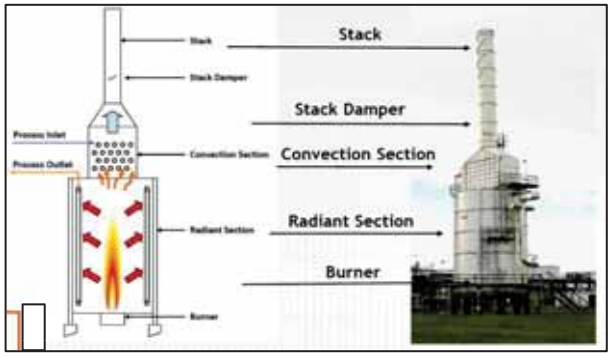
He opened his presentation on the design basics of a fired heater (Fired Heaters 101). This process unit is not dissimilar in concept to the domestic hot water heater except the medium being heated is oil, gas or a mixture of the two. The basic components are identified in the illustration. The first fired heaters were developed in the late 19th century as demand for petroleum products increased. The earliest designs were insulated metal boxes with tubes carrying the fluid and were prone to overheating and coking of the viscous and flammable fluids. The design codes for fired heaters in Canada are based on API (American Petroleum Institute) :

- API 560 – Design of Fired Heaters for Refinery Service
- API 530 – Calculation of Tube Wall Thickness for Fired Heaters

and the CSA (Canadian Standards Association):

- CSA B51 – Canadian Code for Boiler, Pressure Vessels & Pressure Piping.

The fired heater duty is either single phase, a gas or a liquid or multiphase, a combination of gas and liquid. Multiphase fluids complicate both the fluid dynamics and heat transfer designs. There are three basic service categories for fired heaters:



Single phase in/ single phase out (e.g. hot oil or glycol)

Single phase in/ multi phase out (e.g. Hydrocracker)

Multi-phase in/ multi phase out (e.g. Catalytic Reforming**)**

The two forms of heat transfer utilized in fired heaters are

Radiation – heat transmission due to electromagnetic wave propagation.

- Principle of radiant heat is to transfer radiant energy from an emitting heat source to a solid object.
- Radiation is emitted by burners and absorbed by the tubes and fluid.
- In no circumstances should the flames be in direct contact with tubes.

Convection – heat transmission due to temperature difference between a solid body and a moving fluid.

- If there is no fluid motion – heat transfer is purely through conduction.
- All three forms of heat transfer occur in different proportions in both sections.

When designing a heater, the first consideration is to determine the required heat absorption duty of the heater (Q) using the heat flow equation:

$$Q = \dot{m} \times Cp \times \Delta T$$

Where:

ΔT = the temperature increase from inlet to outlet of the process fluid

Cp = the specific heat of the process fluid,
$\dot{m}$ = the mass flow rate of the process fluid

In a fired heater the total heater duty is typically split between radiant (60-70%) and convection (30-40%) sections. The allowable average heat rate must be determined for the fluid(s) to be heated in each section. For hydrocarbons heat flux rates range of 8,000-13,000 Btu/hrft2 are typical.

Having determined the heat duty and the heat rate the mechanical design becomes a key

issue. The optimal design for both heater sections is to have as uniform heat flux rate transfer as possible around each tube. This in practice is difficult to achieve. In the radiation section there is significant difference in heat flux distribution between a single and double fired burner pattern. The latter has a more even distribution and a greater associated manufacturing cost.


Coked tube

The heat flux distribution is a key design issue because the area of the heater tube that has the highest heat flux rate is most prone to coking. Coking is where the fluid being heated deposits carbon on the inside of he tube. The effect is similar burning food while cooking in a frying pan. Coking significantly reduces the heat transfer rate and increases the fluid flow resistance in the heater tube. The impact of a coked tube on heat transfer and fluid flow is obvious from the photograph.

The final design issues for a fired heater is the selection of heater fuel (gas), the optimal design of the burners and associated air management system. The alternatives for combustion air are natural draft, forced draft (inlet air fan), induced draft (exhaust fan) and balanced draft (inlet and exhaust fans). The air management typical requires dampers and an appropriate control system.

Having completed fired heaters 101 Roger Newnham then addressed the challenges in how to improve the efficiency of fired heaters. These are major pieces of process equipment with an installed cost from a fractional million to tens of millions of dollars. The typical lifespan is twenty-five years so it is necessary to improve the thermal efficiency as technology continues to advance. In 1990 oil was less than $30 a barrel and natural gas was half its current price in the US. Design practices that were considered cost efficient in 1990 are no longer valid.

Typical efficiency improvements available for fired heaters are listed.

Change or Upgrade	Efficiency Improvement
Improve operator training	2-10%
Lower excess burner air	1-3%
Install air pre-heater System	5-15%
Upgrade convection section	3-5%
Changing fuels	1-3%

Potential savings total 35%, which will result in a significant decrease in operating costs.

Operator training is always key to both the safety and efficient operation of fired heaters. It is essential that operating guidelines are put in place and that all operators are trained to have an understanding of the operational thermodynamics of the units and the best practices for control system management.

Fired Heaters are operated with an excess of air to ensure there is no unburnt fuel in the emissions. Air contains only 19% oxygen so there are significant heat losses with the excess air. Upgrading the convection section bare tubes with finned tubes lowers the stack temperature. Further heat recovery can be achieved by preheating the combustion air with the exhausted combustion gases.

An example was worked through demonstrated the cost saving and emission reduction which were significant if the excess air is reduced from 40% to 15% and the stack temperature is decreased from 415°C to 250°C. The savings and emission reductions are significant.

Fired Heater Size	Heater duty MW	Original Efficiency	Upgraded Efficiency	Fuel saving $millions/yr	CO_2 emissions reduction mt/yr
Large	80.6	75%	87%	4.4	22,000
Medium	29.3	75%	87%	1.8	8,000
Small	7.3	75%	87%	0.45	2,000

Fired heaters can be oil or gas fired. Gas fired heaters are typically 15% less to purchase, the

fuel demand is approximately 33% less, maintenance costs are halved, excess air can be reduced from 25% to 10%, soot blowing, atomizing steam and preheating the liquid fuel are eliminated. Natural or refinery off gas should always be used where possible.

Roger Newnham delivered the fired heater presentation succinctly and made everyone aware of the design issues and the significant cost and emission reductions available for this major piece of oil processing equipment.

Engineering Innovations in Brain Imaging

Dr.Bruce Pike

Professor of Clinical Neurosciences and Radiology, and CAIP Chair in Healthy Brain Aging, Hotchkiss Brain Institute, Cumming School of Medicine, University of Calgary

Professor Pike introduced the subject by beginning at the beginning! Several Nobel Prize winners were mentioned throughout the talk, with the first being Wilhelm Röntgen. He discovered how to produce and detect X-rays in 1895, and this was the birth of medical imaging. X-rays are good for looking at bones, but not-so-good for imaging the brain: contrast agents can be used to highlight the blood vessels in the brain but the white and gray matter remain difficult to see at any reasonable level of detail. Nevertheless, such images are better for the patient than opening up the skull and having a look inside!

The next step forward came with the revolutionary work of Sir Godfrey Hounsfield (another Nobel Laureate). He worked for EMI and the success of that company in the recording industry allowed the direction of funds to Hounsfield's group. The result was Computed Tomograhy, which would not be possible without the computational capabilities provided by computers. The first CT scanner was built in 1971, and this allowed "slices" of the brain to be imaged and from these, a 3D picture reconstructed. The maths behind the reconstruction is simple for mathematicians and electrical engineers – Hounsfield used an algebraic method, but techniques built on Fourier Transforms are more efficient as demonstrated by the central slice theorem and back projection reconstruction.

Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) developed somewhat in parallel to CT, but these techniques have the capability of functional imaging – allowing the visualization of blood flow, glucose metabolism and the like, so that clinicians and researchers can see what part of the brain is working on the current thought process. Magnetoencephalography (MEG) is the magnetic equivalent of the more well-known EEG. The technique has poor spatial but excellent temporal resolution, so you know when something happened but could not be sure where.

Magnetic Resonance Imaging is really the way to go for looking at the living brain. The technique is based on the fact that nuclei of elements can be made to resonate in a magnetic field. So a strong magnetic field is used to align the nuclei which then respond to pulsed radio waves. As there is no ionizing radiation, the technique is considered safe. The images produced depend on the water present in the tissue and so produce excellent images and contrast in soft tissues. The technology is still seeing rapid developments for making better and better images. The creation of NMR led to four Nobel prizes so far (two in physics and two in chemistry), and a joint one in Medicine for the application of NMR in radiological Imaging (MRI). Bruce thought perhaps there would be another such award for the development of functional MRI. The units in which magnetic fields are measured are Tesla, after the prodigious Serbian inventor, who was a bit acerbic and did not receive the Nobel prize.

The basics of MRI were explained with the help of some excellent diagrams. Again the maths is at a high level as the signal is the sum of contributions from all voxels. The key to getting a signal is the magnetic field gradient: these can be oriented in different directions

through the use of coils around the object being imaged. The magnetic field is made to vary linearly, producing a linear variation in precessional frequency of the hydrogen in water molecules and the resulting resonance can be used to reconstruct the image. Vast amounts of data have to be processed, but meaningful images can be created.

The main magnet in a scanner consists of many windings of a niobium-titanium alloy which is cooled with liquid helium to superconducting levels. This means that large currents can be passed through the coil to create a large magnetic field without producing heat. The big problem is that the large magnetic field attracts anything that is ferromagnetic, so great care has to be taken to keep any such object well away from the scanner. The scanners are left on all the time as starting and stopping consumes more energy.

To get better images faster, you need stronger gradients turned on and off more quickly. A recent advance is Echo Planar Imaging which allows an image to be acquired in 50 ms or less. However, turning the coils on and off is very noisy, so one has to limit the decibels! Circularly polarized coils were introduced in the 1990's, followed by arrays of coils. More recently parallel coils have been introduced, but care has to be taken not to heat the patient with the induced currents!

Dr Pike's personal interest is in functional MRI – trying to determine which bits of the brain do what more precisely than has been known before. The technology is now available to determine dynamically which part of the brain is responding to what stimulus. One way to do this is to look at hemoglobin and oxygenation – blood with oxygen relaxes from the magnetic fields at a different rate to de-oxygenated blood, so one can determine where in the brain that oxygen (and thereby glucose) is being used. Diffusion MRI can also be used since the motion of molecules is constrained in the body. Signals can be generated from the anisotropic diffusion. Fibre pathways can be traced and visualized with a computer technique called tractography, providing some spectacular images of tissue structure.

Areas under development include Ultra High Resolution MRI aimed at revealing and predicting diseases, and seeing the cortex in more detail than before. This can show what small details have been missed in the coarser images of the past. The sub-millimetre accuracy has allowed researchers to begin to unravel the 3D structure of the brain to show what is connected to what and how. Dr Pike showed how a letter is imprinted in the brain when seen by the subject being imaged. Integrating MRI with other technologies such as PET and Ultrasound is also providing new avenues for research and treatment – for example, focussed ultrasound can be used to destroy a malfunctioning part of the brain (limited in where that part can be at the moment) without having to open up the skull.

Professor Pike concluded that engineering innovation had had a tremendous impact on imaging the brain over the last fifty years, and was continuing to do so. Integration of different traditional disciplines will continue to improve imaging and the interpretation of images, leading to better and faster diagnoses and treatments of diseases in the brain. His fascinating talk convinced everyone that the future was bright!

Cracking the Enigma

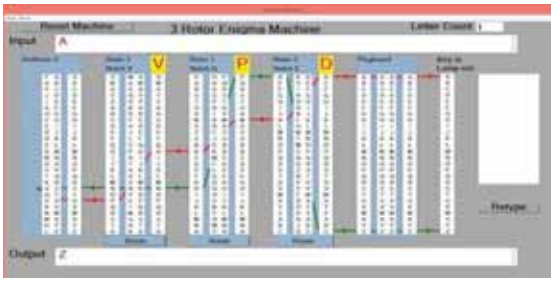
Derrick Harrison C Eng (retired)

Derrick an enthusiast on the history of breaking the German Enigma machine encryption system gave a great presentation on this topic. The background to this subject was following the First World War when military communications had either been by phone, telegraph or typed message, wireless communication had burgeoned and was now the primary technology. There was a massive increase in what is now called radio communication, which was monitored by recipients and the enemy alike. The only way to avoid having your messages read by the opposition was to encrypt them. The one-time-

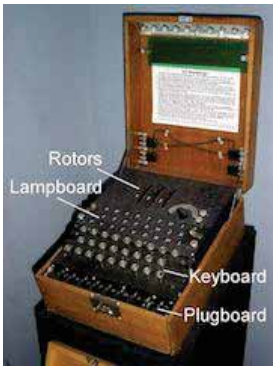
pad was available and worked well but every sheet has to have a random number configuration and both transmitting and receiving parties have to have copies of the sheets. The sheets cannot be reused as it compromises the system. This made the system impractical for the large number of communications required in 20th century warfare.

Germany and other countries developed electro-mechanical encryption machines and by the 1920s the Enigma machine was preeminent. Arthur Scherbius a German engineer had developed the Enigma machine at the end of WW1 and tried to market it to businesses with little success. It was adopted by the German Navy in 1926, and the German Army by 1928. The enigma machine at this time had three rotors and a reflector and a plug board was added. The enigma machine looked like a complicate typewriter and it was calibrated to pre arranged encryption settings by adjusting the rotors and cables to specified positions. When a letter was typed into the machine each rotor, cable and reflector transposed the letter to another letter.

When the next letter key was pressed the rotors moved to new positions. Each mechanical component changed the electrical circuit, which illuminated the lampboard to give the required replacement letter. This is known as a Polyalphabetic cipher. The graphic below illustrates the ciphering process.



Where the letter A is keyed in it is transposed through the rotors V, P, D, the reflector and back through the rotors the to a letter Z. The red line shows the input path to the reflector and the green path back through the rotors to the lampboard. If a second letter A is typed it would not come out as a Z because of the automatic stepping of the rotors for each entry. The plug board could be set to add additional complexity. The machine was designed so that a letter entered could not be generated as the machine output. This was a fundamental flaw in the design.



Three-Rotor Enigma

At this time the three rotor machine had the following machine key combinations:

Reflectors	1	=1
Rotor Positions	3x2x1	=6
Initial Ring Setting	26x26x26	=17,578
Initial Rotor Setting	26x26x26	=17,578
Plugboard	6 cables	=100,391,781,000
Total		=186.075,649,051,516,000,000

Hans Schmidt a German spy sold photographs of the Enigma manuals to the French in 1931. These were passed onto the Poles after the French and British experts decided the photographs were of little use to break the Enigma. In 1932 Marian Rejewski a Polish mathematician and cryptologist worked out the wiring of the Enigma machine. By 1936 by using mathematical permutations (group theory) the Poles built a replica machine named Bombe and developed Zygalski sheets as a manual methodology for cracking the Enigma coding. This was a significant change in code breaking which at this time was dominated by linguists. It was now being

addressed with sophisticated mathematical analysis.

While the Poles were addressing the code breaking of the three-rotor machine, the Germans added two new rotors plus a second reflector in 1938. There were three rotors were chosen from the five available. The Germans overran Poland in 1939 at the start of World War II so the Poles handed over to the French and a British a replica of their reconstructed Enigma, the Bombe and their mathematical techniques.

Britain centralized all their code breaking in Bletchley Park and it was here that the code breaking of all Enigma cyphers was managed. This work was headed up by mathematicians foremost among them was Alan Turing. Turing developed a new Turing Bombe, which was a sophisticated electro-mechanical computer that replicated the Enigma machine and is the forerunner of the modern electronic computer. The standard British bombe contained thirty-six Enigma equivalents, each with three drums wired to produce the same scrambling effect as the Enigma rotors. A bombe could run two or three jobs simultaneously. Each job would have a menu that had to be run against a number of different wheel orders. If the menu contained 12 or fewer letters, three different wheel orders could be run on one bombe; if more than 12 letters, only two.

Bletchley Park, UK

By 1940 the cryptographers were having limited success in breaking the German codes. Each branch of the German military, army, navy and air force used a different variation of Enigma machine. The enemy was continuing to advance the Enigma technology. The British continued to make electromechanical improvements and develop mathematical techniques for Enigma code breaking. In 1940 Enigma rotors and copies of the codebook were recovered from German submarine crew U-33 sunk off Scotland.

By 1942 the four-rotor machine used by the German Navy had been cracked but continuing German Naval improvements later caused a

Replica of Alan Turing Bombe at Bletchley Park,

ten month blackout. By mid 1943 the Allies again cracked the improved cyphers and were able to read most German military transmissions and this supremacy was maintained until war end. This was a consequence of large-scale development of code breaking techniques and technology by 9,000 staff by early 1945 at Bletchley Park. The fifty-eight acre site was covered with temporary wooden huts were the code breaking teams worked in secrecy.

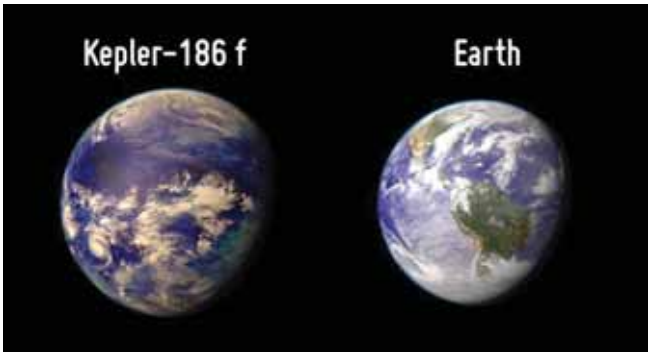
Bletchley Park is now a museum and has both captured models of German Enigma machines and a reconstruction of Alan Turing's Bombe see photographs. By war end the improved Enigma with four rotors, two reflectors, ten cables, and more rotor positions the machine key combinations had been increased to 42,306,743,101,588,200,000,000,000,000 (225 million times more than original) yet the Allies were eventually successful in cracking the code through the development of the Turing Bombe and the associated mathematical techniques. The cracking of the Enigma was a

combination of design flaws, poor implementation and the chance capture of rotors and codebooks.

Derrick Harrison's presentation was well received and he had many questions to respond to.

Three Amazing Scientific Breakthroughs of 2014

1. Scientists discover Kepler, the first Earth sized planet that orbits its star in a designated habitable zone.



2. World largest solar thermal plant starts generating energy by using more than 300,000 mirrors to reflect sunlight in California.

3. Cornell engineering discover a new way to destroy metastasizing cancer cells in the bloodstream by hitchiking cancer killing proteins on life saving white blood cells

Just for fun...

A neutron walks into a bar and asks the bartended how much for a drink.

The bartender says, for you, no charge.

Acknowledgements

The Editor would like to express their gratitude to everyone who submitted a story, wrote an abstract for the newsletter, or just provided a pat on the back. Without you this would not have been possible.

If you have any stories that you would like to have included in the newsletter please contact Mia Jović via editor_newsletter@cpgce.org.

The Current Executive

The following members were proposed and duly elected to the executive committee at the Annual General Meeting held on 24th January, 2015.

From left to right:-

Rick Marshall, David Dean, Bob Salt, Emily Hicks, Peter Gibby (resigned), Mia Jovic, Colin Pollard, Mario Micallef,

Niamh Ní Chróinín, Nigel Shrive, Bob Enever, Mohamed Jaffer

Not present:-

Richard Coldbeck