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The Caribbean Academy of Sciences

NEWSLETTER

UPDATES:

⇒ 22nd Conference Announcement— August 9-14, 2021

⇒ A call for abstracts for the CAS 22nd Virtual Conference is now open until April 30, 2021.

Conference Theme:

Science, Technology and Innovation for Sustainable Development in a Greener Caribbean

Contributing Authors to this Newsletter:

- Professor Emeritus Ronald Young
- Dr. Arnoldo Ventura
- Professor Neela Badrie
- Professor Kit Fai Pun
- Donna Ramkissoon

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Call for Abstracts

CARIBBEAN ACADEMY OF SCIENCES
VIRTUAL 22ND BIENNIAL CONFERENCE
AND GENERAL MEETING
AUGUST 9 - 14, 2021

THEME

Science, Technology, and Innovation for Sustainable Development in a Greener Caribbean

Deadline: April 30, 2021

Visit http://cas-gychapter.org/ for submission guidelines

Submit to: casgychapter@gmail.com

Keynote Speakers

Prof. Maya Trotz
University of South Florida

Dr. Patrick Chesney
The Guiana Shield Facility

Dr. Devon Dublin
Hokkaido University of Education

Prof. Percy Hintzen
University of California Berkeley

Guyana hosts the Caribbean Academy of Sciences Virtual 22nd Biennial Conference

The CAS Guyana Chapter

The establishment of the Caribbean Academy of Sciences (CAS) was informally proposed at the General Assembly Meeting of the International Council of Scientific Unions [ICSU] in Bern, Switzerland in September 1986. Because of the relatively small size of the region and the need for scientists for the Academy to be an effective regional force for science, it was necessary to embrace all the sciences, including social science. The inauguration of the CAS took place at an international seminar on "Science, Development and Society" at the Central Bank Auditorium in Port of Spain, Trinidad on 16th and 17th May 1988. CAS is incorporated in Trinidad & Tobago.

The resuscitation of the Guyana Chapter of the Caribbean Academy of Sciences (CAS) commenced following a decision made by the CAS Executive at its 21st General Meeting held in October 2018 in Kingston Jamaica. This decision was made since the current life of the previously elected Guyana Chapter Executive expired. This left the Chapter inactive for an extended period of time.

The University of Guyana, through the support of former Vice Chancellor – Professor Ivelaw Griffith hosted an orientation meeting on March 29, 2019. Professor Emeritus Winston Mellowes, President of CAS Executive provided an overview on the role of the Caribbean Academy of Sciences within the region.

A voluntary working group, comprising of staff members and students from several faculties was established as an immediate action from this meeting. Ms. Petal Punalall Jetoo was assigned Principal Coordinator for this working group. Several sub-committees and focal points were established which led to elections of the Guyana Chapter Executive in February 2020. The CAS Guyana Chapter will host the Virtual 22nd Biennial Conference of the Caribbean Academy of Sciences on August 9-14, 2021

The new Executive includes:

1. Ms. Elena Trim - President
2. Dr. Anna Perreira—Vice President
3. Dr. Jacqueline Murray— Programme Officer
4. Ms. Heetasmin Singh—Treasurer
5. Dr. Dawn Fox - Asst. Secretary Treasure

Ms. Elena Trim

President

Dr. Anna Perreira

Vice President

Inclusiveness to Cope with the Caribbean Covid-19 Pandemic

Dr. Arnoldo Ventura

CONTEXT

The ongoing Coronavirus pandemic has revealed deep flaws in the economic, social, environmental and governmental affairs of many countries, including the small territories of the Caribbean. One issue of immense importance to the Caribbean, that has been highlighted by the pandemic, is poverty.

This afternoon, I shall therefore denote what Covid-19 has disclosed about Caribbean poverty and what efforts it has prompted to focus on and start its eradication.

To contain the pandemic, perplexing decisions are being made to close or open schools and businesses, or how much to curtail other normal social and economic activities, through testing, tracing and isolation. Since the situation is closely similar across the region, an integrated approach to manage this crisis is warranted. Small countries with limited human, health and financial resources have no option but to become more self-reliant, collaborative and knowledge oriented. Nevertheless, individual countries have to know themselves better and acknowledge their shortcomings in order to react timely and responsibly to unique challenges.

In this context, they are being forced to collaboratively strengthen and use scientific and technological knowledge to achieve critical masses of capabilities to diversify their economies and become more resilient and innovative. Adoption of emerging technologies such as artificial intelligence, to make better decisions, biotechnologies to become more productive in food production and medical care and virtual classrooms are becoming increasingly crucial to our survival.

PANDEMIC REALITIES

A prominent feature of the pandemic is that many have no choice but to violate lock downs and curfews, because this is the only way they can survive each day. This unfortunately has served to make the lot of the poor and disadvantaged much more precarious. Another discouraging feature is that poor children depending on attending school to have a daily meal have been left without what, for many, is the only meal as with schools closing this lifeline has been severed.

COVID -19 AND POVERTY

A disturbing revelation of the effects of the pandemic is that popular approaches to tackling poverty are being shown to be unsustainable. As an example, it is now clear that safety nets, at best, can help to ameliorate, but it does not actually reduce poverty. No surprise then, that within a few months into the pandemic, millions have been thrown back into misery.

Caribbean poverty not only excludes over 30% of the young talent from fully participating in development, but it also has created loss of trust between government and the governed. The result is defiance of Covid protocols and will surely dampen the acceptance of recently devised Covid vaccines.

Also, since many of the frontline workers in the pandemic, such as garbage collectors, hospital cleaners and orderlies are among the working poor, it must be acknowledged that the pandemic cannot be controlled if they, their families and communities, are not adequately protected. Since the absolute poor, and those in the informal sector, form the largest segment of Caribbean populations, it is imperative that poverty eradication be tackled aggressively to increase resilience to pandemics and other phenomena that are likely to increase in frequency and severity across the region. Furthermore, poverty reduction strategies have the potential to elevate informal producers into the formal sector and so contribute to rebuilding dislocated economies by providing jobs, keeping people from criminality and building bridges between communities.

Covid-19 restrictions have already shown that heavily polluted environments can be rescued, if rampant profit seeking fossil fuel dominated manufacturing and distribution are curtailed. Since the lockdown, pollution of air, waterways and harbours have improved globally. Wildlife including birds, have returned to major cities. If the physical space can be cleansed, why can the gross social inequalities and mounting discordance not be similarly curbed?

CHINA'S POVERTY REDUCTION SUCCESS

Despite many programmes and billions spent globally to reduce poverty, it still stubbornly remains. Over the last many decades, there have been pronouncements about gains in poverty reduction, but what has to be recognized, is that 70% of this was due to the diligent efforts of China, which has been able to remove 850 million of its citizens out of poverty. Moreover, President Xi recently announced that China will dislodge extreme poverty by the end of the year.

With such achievements, it makes good sense to see how China was able to accomplish this objective. One of the lessons learnt, is that their poverty eradication programme was led from the very top, armed with the required resources and seriousness of purpose. But of even greater importance was that the head of state was personally involved, visiting those in poverty to ensure that remedial measures were being diligently applied. Poverty was not simply measured in aggregated terms, but was personalized to families, and taken not as an irritating side issue, but instead accepted as pivotal to the nation's prosperity.

EDUCATION UPHEAVAL

Education is one of the few ways to empower the poor to break the cycles of poverty. Unfortunately, Covid -19 has upended educational systems, forcing remote learning to become the accepted norm. This means digital infrastructure, hardware, broadband connectivity, agile and trained teachers in the new formats and creative administrators, must be available to all, rich and poor alike. Although in the main cities of the Caribbean are reasonably digitally connected, this is not true of many rural areas and poor inner-city communities.

As the Covid restrictions take hold, an unequal education system is about to get even worse. It is estimated that already poor children have lost over four months of school because of inadequate connectivity. If some are lucky, they may have one cell phone at home to share among adults and other school age siblings. It is now obvious that if poor children are not to be left further behind, broadband and internet connectivity have to be made universal, tablets and laptops provided by the state to poor students, as is now the case with books in many schools.

Covid has ushered in a new era of teaching and learning but not all students can easily adapt, while many teachers have to be specially trained to handle the varying demands and learning styles. Also, assessing students and catering to the special needs of some, become more challenging for both teachers and parents. New methodologies geared at addressing problems unique to remote learning, such as assessment mechanisms are urgent matters for programme managers to collaborate and seek to develop common solutions that will capture the children further disadvantaged by the changing circumstances that have added layers of difficulty to their already stretched circumstances.

THE NEED FOR ACCURATE INFORMATION

The situation on each island is unique and will require accurate up to date information to make effective use of limited human and material resources. This is best obtained by collaborative scientific research.

It is interesting to note that whereas information about economic growth and businesses flood print, voice and video media daily, information about poverty improvement or lack of it, is aggregated and released maybe once a year, in arcane publications. This level of disinterest given to poverty has to change if effective measures are to be developed, implemented and built on to reduce poverty until it is eliminated.

CONCLUSION

To conclude, Covid -19 has confirmed quite unambiguously that science is indispensable to solve ineluctable modern problems. In the Covid case, first to control the pandemic, and secondly, to help with socio-economic recovery. The scientific community must make use of this opportunity to demonstrate its relevance to equitable socio-economic progress for all.

Thank you for your attention.

Exhibition - Third Virtual Panel
Situation of Covid-19 Pandemic in the Americas
Interciencia Association
24 November 2020

CAS Celebration of the United Nations International Day of Women and Girls in Science

Submitted by:

Professor Neela Badrie

Contributions of Professor Laura Roberts-Nkrumah to Science and Agriculture

The date February 11th is established as an annual international day of women and girls in science by the General Assembly of the United Nations to recognise the critical role women and girls play in science and technology. Science and gender equality are both vital for the achievement of the internationally agreed developmental goals, including the 2030 agenda of United Nations Sustainable Development Goals. This Day is an opportunity to promote full and equal access to and participation in science for women and girls.

According to the United Nations Educational, Scientific and Cultural Organisation (UNESCO)Institute for Statistics (UIS) data, less than 30% of the world's researchers are women and only around 30% of all female students select STEM-related fields in higher education. A comparative distribution of The University of the West Indies (UWI) St. Augustine on-campus enrolment shows female domination with a slight increase from 60% to 63.1% for 2001/2 and 2017/2018 respectively. When the statistics is compared by the Faculties which offer STEM by gender, it revealed a slight decrease in enrolment of females from 53.8% in 2001/2002 (Faculties of Engineering, Medical Sciences and Science and Technology) to 51.6% in 2018-2019 (Engineering, Food and Agriculture, Medical Sciences and Science and Technology.

According to UNESCO, Gender Equality in Science, Technology and Innovation (STI), it has been demonstrated that when women contribute, with their particular perspectives, priorities and approaches to Research and Development, the questions asked, and the solutions created are more diverse and more societally relevant. One of the goals of the Caribbean Academy of Sciences (CAS) is to raise the level of scientific consciousness in the region, and increase the public understanding and appreciation of the importance and potential of Science and Technology in human progress;

We are pleased to profile the scientist Professor Laura Roberts –Nkrumah, lecturer and researcher in agriculture from the University of

The West Indies.

Profile of Professor Laura Roberts-Nkrumah

The sub-urban area in which Professor Roberts-Nkrumah grew up was a plant-rich environment, with many fruit trees. This fostered an early attraction to plants and to fruits. At secondary school, she was an interdisciplinary student and pursued English Literature, Geography and Botany. Botany was her preferred science because it sustained her fascination with plants.

Her earliest inspiration for science and agriculture

The earliest inspiration for a career in agriculture came from her grandmother who was recognised as a champion farmer in Tobago. She is proud of her grandmother who was an independent and strong woman who continued to farm even in her 70's. She has fond memories of the delicious fruits, cocoa tea, and high quality cassava, sweet potatoes and pigeon peas that her grandmother grew and her family enjoyed.

Although she loved English Literature, she wanted to pursue a career that offered the opportunity to spend time outdoors. The final nudge towards pursuing tertiary level training in agriculture at The University of the West came from her Sixth Form Botany teacher, who was an agriculture graduate of that institution.

Major accomplishments in her field of work

Her major accomplishments have been in three main areas:

Firstly, she had raised the stature of breadfruit, a neglected and underutilised crop but traditionally important for food security in the Caribbean. Her work included expanding the range of cultivars in the region by importing additional cultivars and establishing a collection at the University of the West Indies, St. Augustine Campus with 49 accessions. These accessions have been evaluated for growth, development, seasonality, yield, disease resistance, nutritional content and more recently, there has been DNA characterisation. Studies have been conducted on propagation, orchard management, as well as on consumer acceptance, contribution to food security and farm income. Based on her work on this research, she was commissioned to prepare a strategic plan for the development of a breadfruit and breadnut industry in St. Kitts and Nevis. She initiated, secured external funding for, and co-convened the first International Breadfruit Conference which was held in Trinidad and Tobago in 2015. She was also invited to contribute to a review chapter on breadfruit production for the prestigious publication, Horticultural Reviews.

Her work on hillside tree crop production systems in Trinidad and Tobago and in St. Lucia was geared towards developing sustainable systems on hillsides to address both environmental issues and farmers' livelihoods and was funded by the Inter-American Development Bank. Several fruit tree species including mango, avocado, cashew, sapodilla, and pommecythere were evaluated in on-farm trials and demonstration plots farms.

Currently, she is also engaged with a tree fruit crop project which involves agricultural innovations e.g. plant tissue culture for propagation and IOT for environmental data collection for orchard management. The objective is to stimulate production and consumption of tropical fruits, especially to address vitamin and nutrient deficiencies.

Secondly, she has trained many students over her 32-year career at the University of the West Indies (UWI) in the science and production of various crops. These include several students who have completed postgraduate degrees in Crop Science, Horticulture and Landscape Architecture.

Thirdly, she had made her work available through outreach activities with producers and nurseries, and the general public throughout the Caribbean. Apart from providing hands-on training, several manuals and fact sheets have been made available, including manuals on breadfruit propagation and orchard management which were commissioned by the Food and Agriculture Organisation and are available online.

Her work was produced 117 publications among which is a book on the breadfruit germplasm collection

Her admiration for other female scientists

Her admiration for the following scientists is based on their pioneering focus on crops that are significant to food and nutrition security.

Professor Margaret Sedley, whose work on the botany and physiology of flowering in avocado was closely linked with the development of the avocado industry in Australia;

Professor Ruth Oniang'o, a pioneer in food science and nutrition studies on indigenous crops in Kenya. She also contributed to the initiation of the African Journal of Food, Agriculture, Nutrition and Development, which is today a highly respected peer-reviewed journal which supports knowledge-building in the South and in the North, and for which she serves as Editor.

Submitted by Professor Neela Badrie and Dr. Wendy-Ann Isaac of the Department of Food Production, Faculty of Food and Agriculture, The University of the West Indies.Prof. Badrie serves as the Caribbean focal point in women in science for the Inter-American Network of Academies of Sciences (IANAS)and is a CAS fellow.

Dr. Isaac is a Senior Lecturer and Deputy Dean of Graduate Studies, Research and Innovation

UNESCO's OPEN SCIENCE Webinar

Professor Emeritus Ronald Young

On October 15, 2020, the Canadian Commission for UNESCO through a collaboration with the Bud Hall and Rajesh Tandon, University of Victoria Co-Chairs in *Community Based Research & Social Responsibility in Higher Education* hosted a webinar entitled - "*Open Science Beyond Open Access for and with Communities: A Step Towards the Decolonization of Knowledge*". This webinar targeted the English-Speaking Caribbean. It presented Open Science as a more inclusive approach to science which aimed at increasing local participation from the indigenous, non-western, non-traditional knowledge systems. The concept of citizen science – which embodies greater involvement of the general populace with science to identify, explore and solve problems at the country and community level was presented as tool to understand and engage with our environment.

Retired UWI Pro Vice-Chancellor, Chair of the Science Advisory Sub-Committee of the Jamaica National Commission for UNESCO and CAS Fellow – Professor Emeritus Ronald Young - moderated this webinar. Discussants were Professor Brian Cockburn and Dr. Colin Depradine, Deans of the UWI Faculties of Science & Technology in Trinidad & Tobago and in Barbados respectively. Dr Liette Vasseur, President of the Canadian Commission for UNESCO and UNESCO Chair in Community Sustainability: From Local to Global at Brock University introduced the UNESCO Declaration on Open Science and the focus paper.

Professor Young in his opening remarks noted that it will be necessary to address the inherent tensions between the strong push by developing countries to protect their intellectual property and indigenous knowledge for economic benefit, and the growing global push toward truly Open Science. Lack of infrastructure and investment capital and a skewed trading system that inexorably shifts wealth from the periphery to the center, disadvantage developing relative to the developed economies, and often render patents ineffectual. He suggested that the root problem might be the way in which commodities are traded rather than in the commoditization of science. He also called for greater recognition and encouragement of community science aimed at sustainably advancing scientific awareness, literacy and involvement in the general populace.

Professor Vasseur in her Introduction to the UNESCO Open Science initiatives, referenced the UNESCO 2017 Recommendation on Science and Scientific Research stressing the importance of making scientific knowledge everywhere, available to all, and the need for adequate infrastructural and financial support for science. She emphasized that there was demonstrable value added in opening up access to text and data for Society in general [e.g. in the case of the Human Genome Project], for recognition of traditionally excluded knowledge systems, and for fostering the co-construction of knowledge with communities, for communities. She called for the recognition that scientific research was not confined to work in academic and related enclaves, and for inclusion in the definition of scientific knowledge, of the often excluded, but established body of understanding accumulated by diverse indigenous peoples, using differing epistemologies. This exclusionary cabalization of scientific research, Journal Editorial Boards and of the policies supporting them, is reinforced by the general acceptance of scientific discourse shrouded in jargon, indecipherable even to trained scientists and inaccessible to many. She encouraged funding of indigenous, Global South knowledge-sharing and fostering equity through the development of inclusionary policies embracing non-white, non-male and non-Western persons and philosophies. She called for knowledge-sharing, the decolonization of research and teaching in Higher Education and the recognition and removal of invisible or poorly perceived barriers to access.

Professor Cockburn proposed that advancement of the Open Science agendas will demand equitably functioning Professional-Private-Public, North-South, South-South and in-country partnerships. Openness between industry/ community and academia could be facilitated through internships of Higher Education students with industry. Open Science ensures equity and access to knowledge and reduces communication barriers, however emerging issues may arise. Local libraries should not only serve as repositories but become Open Science publishing houses. Criteria should be established for the evaluation of published articles on the basis of the impact of the work rather than the impact factor of the Journal. Of noteworthy mention is that fact that Universities are increasingly being called upon to become entrepreneurial institutions. The establishment of diversified Boards governing publications and the conduct of Science must ensure the inclusion and respect of appointees from different constituencies thereby bridging the divide which separates different communities: scientific and non-scientific, developed and developing countries, conventional and indigenous knowledge systems. Simply replacing an established clique with a novel one comprising previously excluded groups should be avoided. He noted, with regret, the exclusion of Historians and Social Scientists from this discourse. He stated that the Covid-19 pandemic had disproportionately affected less well-off Universities. This opens opportunities for a degree of recolonization by more well-endowed institutions. He posited that the region was ready for the democratization of science.

For example, an Open Math Fair in Trinidad & Tobago had, surprisingly, generated wide-spread interest through a record level of participation, and an open "Bioblitz" effort to engage the general populace in paying attention to the flora and fauna of the country had resulted in the identification of a new species of snake. The scientific community he contended, could engage more effectively by communicating via social media such as Facebook, Twitter, Instagram etc. Professor Cockburn, however questioned the capacity of scientists to communicate scientific issues with clarity and without jargon.

Dr. Depradine stressed the lack of funding for Science, Technology and Innovation. Externally sourced funding was frequently tied to purchasing donor-related equipment and to the recruitment of international consultants who were often less knowledgeable than their local counterparts. Barbados does not have a ministry with a science portfolio. Over several years student enrolment in the Science and Technology faculty has consistently declined. Students in schools were ignorant regarding the involvement of women either in Science in general or in the Science Faculty at the University. Recent efforts to promote a "Science for All" philosophy with emphasis on outreach and sharing and redefine the image of the Scientist, under the slogan "Embrace your Inner Nerd" were very successful. A Cross-Faculty Science & Technology Festival which engaged business interests, the military, banks, among others, was also very successful. This indicated that society was willing and able to engage. This supports Professor Cockburn's recognition of a regional "zeitgeist" supporting community/ citizen science. These efforts had resulted in a jump in enrolment in the Science Faculty to the highest number ever recorded. Dr. Depradine emphasized that barriers preventing engagement in scientific activity had to be broken and called for greater community involvement in data gathering and analysis. He urged that the findings from community-based research must be fed back to the community and not disappear into inaccessible journal articles. He urged that the UNESCO driven and regionally defined Open Science approaches and policies must be shared with regional leaders and the population in general. The tendency to adopt enlightened policies which are never implemented, must be avoided.

The general discussion involved, in addition to the main speakers, Dr. Angela Alleyne (Barbados), Marcia Creary (Jamaica) and Sandra Richards (Trinidad & Tobago). The discussion centered on the following points:

- The patenting process is often abused *e.g.* in the software industry, and needs revision – but how? To what? And by whom?
- Open Source software systems (*e.g.* R Biostatistics; Linux) have been proving to be quite successful and should be supported *vs* the often exploitative, proprietary software packages.
- New approaches to publishing need to be explored *e.g.* development of University Libraries as Open Publishing houses, but mechanisms for covering costs would have to be found *e.g.* payment for peripheral services, off-prints, *etc.*
- As Science in general and publications in particular open up, maintaining Quality Assurance will be a major issue – distinguishing reliably between high quality, valid research findings and unreliable, weakly supported claims. Mechanisms and criteria will be needed.
- The pandemic provides a good illustration of the contending between genuinely useful and grossly misleading information in open discourse on scientific issues.
- In fostering community involvement in scientific research, two-way communication is important. The tendency of Academia to look down on community collaborators must be avoided. The ability of scientific researchers to communicate their work across disciplines or even within their broad disciplines needs to improve. The development of more specialists in science communication may be essential.
- The rise of the Entrepreneurial University requires a re-examination of the apparent dichotomy between open publication and commercialization. Both are necessary. Dangers to be avoided include the concealment of useful information to maximize profits and the dominance of commercialization efforts by large corporations.
- Sustainable Open Science journals do exist *e.g.* the 12 year old *Journal of Community Engagement & Scholarship* which is double-blind peer-reviewed, with a wholly voluntary Editorial Board and support via a University Library (U. Arizona). Articles are solicited from diverse sources including community and students.
- High impact does not necessarily track with publication in a high impact factor journal. Community impact is measurable and is becoming an increasingly important requirement for academic advancement.
- High impact factor journals with high page charges will almost certainly decline as Open Science journals appear and are successful.

Incorporating Human Factors and Risk Assessment into the Design of Upstream Oil and Gas Projects

Donna Ramkissoon and Kit Fai Pun

The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies

Abstract: *Examination of accident data reveals the majority of catastrophic cases have been attributable to human error in the oil and gas industry sector. Based on a standardised risk assessment approach, this article presents a 9-step process methodology incorporating human factors into risk assessment at the design stage of projects in the sector. The ability to assess the magnitude of the risks posed by human errors would enable the design team to produce engineering design safe for use.*

1. Introduction

In the oil and gas industry sector, systematic review of data collected from incidents often reveals one of two categories of causation – inherent equipment failure and/or human error. Given that there is a proven direct correlation between human factors and accident causation, there is a need to address human factors in the sector. Treatment of human factors has been reactive, focusing on the management of human error rather than its prevention. In fact, there is increasing emphasis in industry to proactively address human factors issues.

According to the International Association of Oil and Gas Producers, Human Factors Engineering is a discipline to ensure that systems are designed in a way that optimises the human contribution to production and minimises potential for design-induced risks to health, personal or process safety or environmental performance (OGP, 2011). Failure to risk assess tasks could potentially result in improper allocation of resources to areas which actually require them and lead to poor or under-design. There has been a need to adopt a proactive approach at the design stage, not only for designing for proper operability and maintainability but being able to quantify the risks associated with the postulated hazardous scenarios. By doing so, the appropriate safeguards and mitigation can be engineered into the design thus attenuating or eliminating the hazard.

Step 1. Identification of Activities	This is to identify the activities from the top-level categories (such as Management of platform safety, Maintenance of platform, Drilling operations, Monitor and control platform status, Planning and administration, and Domestic activity). These activities comprise various tasks which are performed by operations and maintenance personnel either employed or contracted by the organisation.
Step 2. Identification of Tasks in Activities	Each activity can be divided into its constituent tasks. Essentially, task identification entails where humans interact with any process identified in the broad activities. Most of this information can be garnered from operating procedures and maintenance schedules.
Step 3. Performance Influencing Factors (PIFs)	This is to identify the factors which can influence behaviour but more specifically, in a negative way. These failures can be unintentional i.e. a skill-based error or mistake or they may be intentional which is defined as a violation. Human errors or violations result in undesirable consequences to people, assets, and the environment.
Step 4. Opportunities for Human Error	The opportunities for human error include the areas where an operator can introduce an error leading to an active failure.
Step 4. Opportunities for Human Error	The opportunities for human error include the areas where an operator can introduce an error leading to an active failure.
Step 5. Determination of Consequences of PIFs	Identifying PIFs helps to determine the activities which could directly cause a major injury, death or loss of hydrocarbons to the environment, have significant business impact (including production outages) or could contribute to significantly increasing the frequency or consequence potential of the incidents. The consequences will be ranked from those having minor to major impacts.

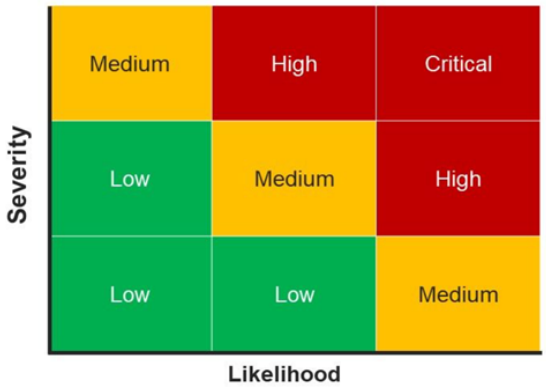

Figure 1. Risk Rank Matrix

Figure 2. Steps to Evaluate Human Factors in Engineering Design

Step 6. Human Error Risk Ranking

This is to adequately assess the consequences caused by human error using risk rank matrix (see Figure 1). The consequences of human error are rated from low to high with an appropriate likelihood of this impact assigned. The risk rank is then determined as a product of the consequence and likelihood and can range from low to critical.

Step 7. Controls and Mitigation

These include measures and/or design features which will prevent the top event from occurring, or attenuate the consequences of the event if the top event does occur.

Step 8. Human Error Risk Ranking after Mitigation

The risk needs to be assessed post-mitigation in order to determine if the mitigation measures proposed are deemed to be adequate or tolerable. This step involves the same process as that involved in ranking the risk pre-mitigation

Step 9. Recommendations Incorporated in Design

This is to evaluate human factors in engineering design (see Figure 2). If the human error risk is deemed to be too high or critical, the design must be modified to prevent the human error from occurring. Recommendations are made at this stage to revise the design to make it safer for use.

3. Closing Remarks

This methodology delineates human error and the performance influencing factors, as well as incorporates the post-mitigation risk rank in the design of upstream oil and gas projects. The procedure would allow for early identification of human error, thus enabling the designer to modify the design to suit the user and so eliminate/reduce the risk associated with the activity. More importantly, the procedure allows for making recommendations which ultimately produce robust designs. The methodology is easy to use, and can be integrated into any organisation by the use of simple spreadsheets or software.

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Ramkissoon, D. and Pun, K.F. (2020), "Assessing human factors at the design stage of upstream oil and gas projects: A risk assessment methodology", *The Journal of the Association of Professional Engineers of Trinidad and Tobago*, 48(2): 60-66

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Kit Fai Pun is presently the president of the CAS Trinidad and Tobago Chapter, and Professor of Industrial Engineering of the Faculty of Engineering at UWI, St Augustine Campus, Trinidad and Tobago. He is a Registered Professional Engineer in Australia, Europe, Hong Kong, and The Republic of Trinidad and Tobago. His research interests and activities include industrial engineering, engineering management, quality systems, and performance measurement (Email: KitFai.Pun@sta.uwi.edu).

Guidelines for the submission of articles

I. Articles should not exceed 1000 words (1 1/2 pages)

II. Images should be submitted as separate files

Articles should be submitted to:

1. pjetoo@gmail.com
2. secretariat@caswi.org

Note: Editors reserve the right to edit the length.