IIW NWC GN 5

Establishing a National Welding Capability (NWC) – NWC Guidance Note GN 5 Implementing the 'Education, Training, Skills and Careers' Building Block

International Institute of Welding (IIW)

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https://iiwelding.org/iiw-jointothefuture/nwc-gn/

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Foreword

Thomas Böllinghaus
IIW President 2023-2026

Luca Costa
IIW Chief Executive Officer

The International Institute of Welding (IIW) was founded in 1948 by the welding institutes or societies of 13 countries that considered it crucial to make more rapid scientific and technical progress in welding possible on a global basis [1], [2], [3]. Its membership today comprises welding organisations from 53 countries worldwide.

IIW provides a unique cooperative platform for experts, practitioners and policy makers in the welding and related industries to share not only technical information and innovation, but knowhow in all areas affecting a country's ability to achieve sustainable development in a sustainable environment and fulfil their responsibilities in a cooperative and converging global community.

As the world population continues to grow, the pressures on manufacturing, infrastructure and power generation, not to mention basic needs such as food, water, shelter and education, will become enormous common challenges. Welding, as an enabling technology that plays a critical role in almost every industry sector, is critical to the world's ability to cope with these pressures and changes.

The IIW community is dedicated to the concept of helping all countries build their own sustainable national welding capabilities to meet these challenges and improve the quality of life including biodiversity. This is evidenced by the recent release of its report **"The Importance of a Country's Welding Industry, its National Welding Capability (NWC) and their Significance to the UN Sustainable Development Goals (SDGs)".**

These NWC Guidance Notes provide practical, step-by-step and easy to use methods for any country to establish or improve its National Welding Capability (NWC), supported by a free knowledge bank of information provided and shared by people from many countries around the world.

People and organisations have contributed information to the IIW National Welding Capability (NWC) Resource Centre and thanks go to them all, but in particular to Mr Miles Goodwin, Dr Emmanuel Gyasi, Dr Michail Karpenko, Mr Alan Mackie, Mr Hugh McPhillips, Prof Vladimir Ponomarov, Mr John Tarboton, who have contributed as reviewers of this NWC Guidance Note.

Thomas Böllinghaus, IIW President 2023-26

Luca Costa, IIW Chief Executive Officer

IIW Vision, Mission and Core Values

Vision

The leading global welding community linking industry, research and education

Mission

Advance welding and joining through a worldwide network

Core Values

IIW is committed to the advancement of welding and joining for a safer and sustainable world

IIW operates based on mutual respect for diversity, culture and languages

Details of Author Applicable to this Guidance Note

Mr Chris Smallbone
Author and Editor
National Welding Capability Project Leader
IIW Past President, IIW Fellow
Inaugural Chair of the IIW Working Group Regional Activities

Chris Smallbone was born in Liverpool, UK, in 1946, trained as a student apprentice at English Electric Company in Liverpool, UK, from 1964-69, qualifying as a mechanical engineer from the Staffordshire College of Advanced Technology (now Staffordshire University) and obtained an MSc in Welding Technology from the University of Aston in Birmingham (1969-1970). He then worked in the fabrication industry in Bolton as a Junior Executive including training welding apprentices and welding technicians at Bolton Technical College in the evenings.

In 1974, he took up the position as Senior Lecturer in Mechanical Engineering at the now Technikon Witwatersrand in Johannesburg responsible for establishing, implementing and training the first formal education groups of welding technologists and technicians in South Africa as well as lecturing at the University of Witwatersrand on various degree courses. He was President of the South African Institute of Welding (SAIW) in 1978 and 1979 before becoming SAIW Executive Director on 1 January 1980.

He subsequently became a Registered Professional Engineer in Australia, Chartered Engineer in the UK, Fellow Engineers Australia, Fellow Institution of Mechanical Engineers (UK), Fellow The Welding Institute (UK), Fellow South African Institute of Welding (SAIW), Honorary Life Member South African Institute of Welding, Gold Member American Welding Society, Honorary Member Romanian Welding Society, Honorary Fellow Welding Technology Institute of Australia (WTIA) and Fellow of the International Institute of Welding (IIW). In 2006 he was honoured by Engineers Australia, the peak engineering body in Australia as being one of the 100 most influential engineers in Australia.

To achieve this success, Chris has been at the forefront of many unique and pioneering major innovations, including as Executive Director, building up two world class national welding Institutes, South African Institute of Welding (SAIW) (1980-1993) and Welding Technology Institute of Australia (WTIA) (1995-2014) supported by many dedicated staff, Board members and volunteers.

In relation only to the topic of this Guidance Note, he also voluntarily established and built up, in conjunction with other groups, a number of other not-for-profit organisations to meet particular needs of Industry. All have been outstanding accomplishments and had major impacts both technically and economically on welding technology, skills development, NDT, pressure equipment and other industries in South Africa and Australia. These included the world class programmes of the South African Qualification and Certification Committee for Non-Destructive Testing (SAQCC NDT), South African Qualification and Certification Committee for Inspectors of Pressurised Equipment (SAQCC-IPE), implementing national welding skills competitions in South Africa, helping establish and voluntarily manage the Skills SA Foundation in 1989 and as President leading a fully multi-racial South Africa delegation and team with Nigel Fitton to the International Skills Olympics in Taiwan in 1993. He also introduced all the SAIW education, training, qualification and certification programmes for welders, welding supervisors, technologists, engineers, inspection personnel, designers, NDT personnel and others, lecturing on many of them.

In Australia, the establishment and operation of the Australian Institute for the Certification of Inspection Personnel (AICIP), the WTIA IIW Authorised Nominated Body (ANB), IIW Approved Training Bodies (ATBs), a national network of approved WTIA training centres,

the WTIA OzWeld School of Welding Technology and support for WorldSkills Australia and WorldSkills International amongst others, were all very successful. In both countries, he was a firm supporter of staff and volunteers being involved personally with standards making bodies, government committees and industry groups. In 2000, he chaired the Australian Federal Government Heavy Engineering and Infrastructure Action Agenda (HEIAA), Focus Group on Education, Training, Innovation, Technology Transfer and Research and Development.

Chris always believes in creating successful teams of staff and volunteers, with great work ethic, loyalty and spirit. Both Institutes ended up in terrific positions because all the people recruited had very good practical abilities and experience, and paid a lot of attention to detail, believing in the Institutes' goals. The Institutes had a financial surplus each and every year, both built their fully owned Institute Headquarters, and even though some years of recession were experienced in both countries, no staff member was ever retrenched.

He has used these successes to assist many countries worldwide by his work in IIW, through implementing models for technology innovation and improving national welding capabilities, including voluntarily assisting and facilitating the holding of 22 workshops in 12 countries from 2003 to 2020, as well as voluntarily assisting some countries in establishing their IIW ANBs and ATBs.

In recognition of his many distinguished contributions and outstanding accomplishments he has been the recipient of over 35 significant welding industry honours and awards from Australia, India, Romania, Slovakia, South Africa, Ukraine, United Kingdom and USA as well as in 2009, The Walter Edström Medal from IIW for his "remarkable and distinguished contributions to the IIW and the international community". Two awards were established in his honour by WTIA (2009) and IIW (2014) and in 2019, IIW implemented the IIW Chris Smallbone Award.

He has had the honour of presenting 41 Keynote/Plenary Addresses at International Conferences and Congresses in over 20 countries. He has also presented 57 papers at international conferences covering welding, NDT and pressure equipment as well as being Chairman of the Organising Committee and Technical Editor of all papers reviewed and presented at 25 WTIA and SAIW International Conferences/Congresses. Upon his retirement as WTIA CEO in February 2014 due to ill health, the honour of WTIA CEO Emeritus was conferred on him in recognition of his legacy.

Author's Roles in the International Institute of Welding (IIW)

In IIW, Chris has played pivotal roles over the past 47 years including major accomplishments and technical impacts across many fronts. Senior positions on the IIW Board of Directors include President (2005-2008), Vice-President (1993-1996 and 2001-2004), President Elect (2004-2005), Immediate Past President (2008-2011), Director and Board Member (1997-2000 and 2014-2017), inaugural Chairman of each of the IIW Board of Directors Groups, Task Group Certification (2002-2005), Working Group Governance (2008 – 2017), Task Group IIW White Paper (2006 – 2014), Task Group History (2015 – 2018), Working Group Regional Activities and Liaison with Developing Countries (WGRA) (1993 – 2017 except for the period 2005-2008 when he was IIW President).

In relation to education, training, qualification and certification, he was Chairman, IIW Commission XIV, Working Group 13 (1992-1999), as well as Chairman of IIW Commission XIV Education and Training (2010 – 2016), the IIW International Authorisation Board (IAB) representative for the Africa, Australasia and Asia (AAA) Region (2008 – 2011 and 2014 – 2017) and Chairman of the IIW IAB Africa, Australasia, Asia (AAA) Group (2008-2011 and 2014-2017). He represented South Africa (1978-1994) and Australia (1995-2016) on various IIW Commissions, Select Committees, Study Groups, International Authorisation Board (IAB) Working Groups A and B and IIW Governing Council/ General Assembly meetings.

Chris was also project manager and co-editor of the IIW White Paper launched in Denver in 2012, project manager of the IIW History Book, linking people, joining nations, authored by David Barnett and launched in Beijing in 2018, coordinator and editor of the very successful IIW welded art photographic exhibitions held in 2019, 2020, 2021, 2023, 2024 and 2025 as well as Chairman, IIW Task Group-Sustainable Development Goals (TG-SDG), 2022-2024, which launched the IIW NWC-SDGs report on 1 May 2024. He is also a member of the recently formed IIW Council of Senators.

He has always been a strong advocate for promoting welding as a means of assisting people to move out of poverty, particularly in developing countries. This has included in 1993, implementing the IIW WeldCare programme, in 2005 as IIW President, the IIW Project: To Improve the Global Quality of Life Through Optimum Use of Welding Technology, and in 2014, the National Welding Capability Project.

Acknowledgement of Reviewers of National Welding Capability Guidance Note GN 5, Education, Training, Skills and Careers

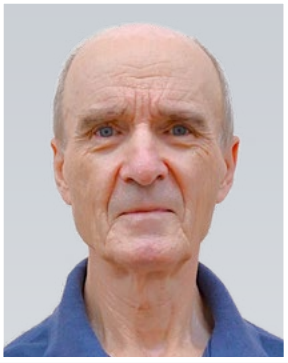
Miles Goodwin is a Professional Board Member of The Welding Institute (UK), serving on a number of its working groups including improving the skills situation in the UK and being on the Editorial Board of the Welding and Joining Matters Journal. He has extensive industrial experience working as a welder, welding technician, welding inspector and welding consultant across a range of industries. Similarly, as a lecturer and instructor at several UK colleges and at industrial companies where Welding Procedure Qualifications and Welder Test Certificates are required.

Michail Karpenko, General Manager, Fabrication 4.0, Welding Centre, Heavy Engineering Research Association (HERA), Auckland, New Zealand. He was born in Kyiv, Ukraine, and obtained a Mechanical and Welding Engineering degree from Kyiv Polytechnic Institute in 1995 and then his International Welding Engineer (IWE) from the Paton Welding Institute in Kyiv. He then obtained his PhD from the Otto-von-Guericke University, Magdeburg, Germany. Since 2006, he has been responsible for all research, education, training, qualification and certification activities at HERA. He was an IIW Director and Board Member (2017-2020).

Emmanuel Afrane Gyasi is the President and CEO, Ghanaian Institute of Welding (GIW). He has a Doctor of Science degree in mechanical engineering from LUT University, Finland. He has been a driving force in building up the national welding capability in Ghana. In 2013, he published his Master's thesis on Quality, Productivity and Economy in Welding Manufacturing-Case Study, West Africa. This identified the dire need to establish a national welding organisation in a country to enable all welding related personnel to have the opportunities to be both nationally and internationally recognised. He has several publications that address topics in welding and manufacturing towards economic development activities such as skills training, job creation and entrepreneurship.

Alan Mackie (DipT(Tech), BEd, MEd) is a retired International Welding Technologist (IWT), International Welding Inspector (IWI-C), Industrial Radiographer (Ir-192, Power Gen) and Education Manager with vast experience in the Sydney and Hunter Institutes of Technical and Further Education (TAFE) in New South Wales, Australia. For many years he was involved with curriculum development, training apprentices, welders, students with special needs, welding supervisors and welding inspectors for both pressure vessels and structural steel etc. Alan managed the welding and fabrication facilities at both Institutes. He has held the positions of Chairman of the WTIA Professional Board and Chairman WTIA NSW Divisional Committee.

Hugh McPhillips is the Chairman, Association for Welding and Fabrication Training and Education (AWFTE), TWI, Cambridge UK, and a Professional Board Member. He is a Consultant specialising in fabrication and welder training having more than 35 years teaching experience. Besides being a National judge for UKSkills Construction Metalwork Competition, as well as an assessor and internal verifier for City & Guilds, EAL, and ECITB, he is also an End Point Assessor for the new National Standards and Ambassador for the New T- Levels Training Qualifications.



Vladimir Ponomarov is a Professor in the School of Mechanical Engineering at the Federal University of Uberlandia (UFU), Uberlandia, Brazil. He has a Doctor of Technical Sciences-Welding Technology and has extensive experience in research, education and training in welding. Prior to joining UFU in 2009, he was Vice-Director of the Paton Training and Qualification Centre at the E.O. Paton Electric Welding Institute in Kyiv. He was involved for many years in the IIW International Authorisation Board (IAB), Working Group A, Education, Training and Qualification Guidelines, and Working Group B, Implementation, Authorisation and Certification, representing both Ukraine and Brazil.

John Tarboton is the Executive Director, Southern African Institute of Welding (SAIW), Johannesburg, South Africa. John's overall responsibilities include the SAIW's extensive education, training, qualification and certification activities which are also used to assist many African countries. John is a qualified and experienced metallurgical and materials engineer, and prior to joining SAIW, he was the Executive Director of the Southern African Stainless Steel Development Association (SASSDA) as well as holding a range of senior technical and marketing positions in Columbus Stainless, the major South African stainless steel producer.

Summary

The **National Welding Capability (NWC) Guidance Note GN 5** is a structured initiative aimed at advancing Education, Training, Skills, and Careers development in alignment with industry and government needs in a country. The framework comprises detailed objectives and strategies, supported by actionable plans designed to be adaptable, practical, and aligned with international best practices.

Key Objectives and Strategies

1. Establish Sustainable Support:

- Collaboration with international and national organizations to benchmark best practices.
- Engage industry, governments, and other stakeholders to secure funding and foster cooperation through structured workshops, prospectuses, and networking.
- Develop a cohesive "E&T, Skills, and Careers Building Block" model, incorporating local and international expertise, with funding strategies for sustainability.

2. Build National E&T Infrastructure:

- Conduct annual analyses of existing capabilities and resources across the country.
- Create national networks of E&T organizations to optimize resources, improve accessibility, and foster collaboration.
- Perform future-oriented analyses of technological needs to ensure training aligns with industry trends.

3. Maintain a Skilled Workforce:

- Develop career pathways and models for welding-related professions.
- Create and sustain mentoring and exchange programs for students and industry professionals.
- Implement ongoing professional development programs to keep lecturers and trainers updated on the latest technologies and methodologies.

4. Introduce Appropriate Training Resources:

- Acquire and align training materials for coordination, inspection, design and research roles at all competency levels in a range of welding related industry professions.
- Support practical training centres by introducing innovative resources such as VR/AR technologies, performance measurement tools, and Industry 4.0 applications.

5. Promote E&T Activities:

- Align E&T outcomes with UN Sustainable Development Goals (SDGs).
- Implement marketing strategies to raise awareness of welding-related professions as careers, targeting diverse groups, including women, youth, retirees, and marginalized populations.
- Showcase success stories to highlight the value and benefits of welding-related education and careers to stakeholders and the general public.

6. Establish Alliances and Networks:

- Foster collaborations for marketing, intellectual property (IP), commercialisation and technology transfer.
- Facilitate participation of NWC members in international activities such as standards committees and government initiatives.
- Develop mechanisms to assess the economic and social impact of E&T investments.

Actionable Implementation Plans

Each strategy is supported by a series of specific, actionable steps, such as:

- Creating confidential databases for resource mapping and networking.
- Establishing workshops to identify industry needs and prioritize solutions.
- Developing draft budgets, resource plans, and marketing initiatives.
- Continuously monitoring and updating plans based on stakeholder feedback and outcomes.

Iterative and Adaptive Framework

The NWC GN 5 action plans are designed to evolve as living documents. Readers and stakeholders are encouraged to contribute additional actions to progress each strategy, ensuring responsiveness to dynamic industry and educational landscapes.

Attributes for achieving a successful National Welding Capability

Enthusiasm

"You can do anything if you have ENTHUSIASM.
"ENTHUSIASM is the yeast that makes your hopes rise to the stars. Enthusiasm is the sparkle in your eyes, the swing in your gait, the grip of your hand, the irresistible surge of will and energy to execute your ideas. Enthusiasts are fighters. They have fortitude. They have staying qualities.
"ENTHUSIASM is at the bottom of all progress. With it there is accomplishment. Without it there are only alibis."

Henry Ford

Persistence

"Nothing in the world can take the place of persistence. Talent will not; nothing is more common than unsuccessful men of talent. Genius will not; the world is full of educated derelicts. Persistence and determination alone are omnipotent.
"The slogan 'press on' has solved and always will solve, the problems of the human race."

Calvin Coolidge, 30th President of USA

"With the four attributes of **ENTHUSIASM, PERSISTENCE, COOPERATION & COLLABORATION**
we can all work together in an excellent team effort to improve the quality of life globally."

Chris Smallbone, IIW President 2005-2008, IIW Fellow

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Part 1: Preface – Detailed IIW National Welding Capability (NWC) Project Objectives

1.1 Introduction

The IIW NWC Project aims to assist a country's industry, government or IIW Members to achieve the following objectives:

- to identify the welding related needs in the country and provide solutions to ensure the country's future sustainability in relation to these needs;
- to implement its own National Welding Capability (NWC) Project;
- to identify the country's existing capability and consolidate the existing welding related 'building blocks' in the country to create the basis for an NWC;
- to analyse, and identify the improvements required in the existing welding related 'building blocks' as well as what additional 'building blocks' are required in the country; and
- to create the mechanisms and processes, to establish and maintain the country's sustainable NWC including the possible establishment or improvement of a national organisation(s) responsible for the promotion of welding and related disciplines.

The welding industry is taken as those organisations and people:

- involved with the total life cycle of welded products/structures including design, manufacture, fabrication, construction, conformity assessment, inspection and testing, operation, maintenance, repair and decommissioning as well as recycling, repurposing and other environmental conditions;
- engaged in, or employing, any of the organisations or people involved above;
- supplying welding equipment or consumables or materials to be welded and,
- involved with education, training, qualification, certification, research and development, work health and safety (WHS), standards and industrial relations aspects of welding.

Successful countries where welding is a fundamental part of its economy tend to have one or more organisations which represent the technological interests of the welding industry in that country. Such a national organisation must be able to:

1. be correctly established in terms of a country's legal, ethical, financial and other compliance requirements with correct governance and management systems in place;
2. cooperate and collaborate with the relevant organisations in the country to ensure that the optimum NWC is achieved and sustained;
3. have adequate highly credible human resources to succeed in the agreed plans;
4. be open for as many of the other organisations and people in the industry to have membership and have ownership of the NWC where applicable;
5. enable companies and people to access technologies and technical information to meet their needs;
6. respond to demonstrated needs of companies and have relevant support for solutions within the organisations in the NWC;
7. develop strong links with industry and other agencies particularly in the NWC;
8. provide ready access to facilities and services in the NWC;
9. not unnecessarily duplicate facilities and services already existing in the country and be capable to proactively highlight how to readily access such facilities and services to any enquirer;
10. seek to collaborate with national and international organisations/agencies to meet industry needs;
11. provide the Forums/Boards/Committees etc. necessary to have all relevant organisations collaborating in the various NWC Building Blocks

1.2 Scope of the NWC Guidance Notes

This NWC Guidance Note GN 5 is one of a series to assist an individual, an industry organisation or a government, to establish a **National Welding Capability (NWC)** in its country. Each NWC Guidance Note covers one of the Building Blocks required to establish and sustain such an NWC. Each NWC Guidance Note may consist of eight PARTS and the reader can select whether to use all or some of the PARTS as guidance in creating the particular NWC Building Block. There are also sections, strategies and references which may have been repeated in other Guidance Notes since each Guidance Note can be used individually for the particular NWC Building Block.

NWC GN 1 Overview of a National Welding Capability (NWC).

NWC GN 2 Research and Development (R&D) Building Block.

NWC GN 3 Technology Transfer and Diffusion (TD) Building Block.

NWC GN 4 National and International Networks Building Block.

NWC GN 5 Education, Training, Skills and Careers Building Block.

NWC GN 6 Qualification and Certification (Q&C) of Personnel and Companies Building Block.

NWC GN 7 Importance of Welding Building Block.

NWC GN 8 Funding Welding-Related Activities Building Block.

NWC GN 9 Non-Destructive Testing Building Block.

NWC GN 10 Necessary Cultures Building Block.

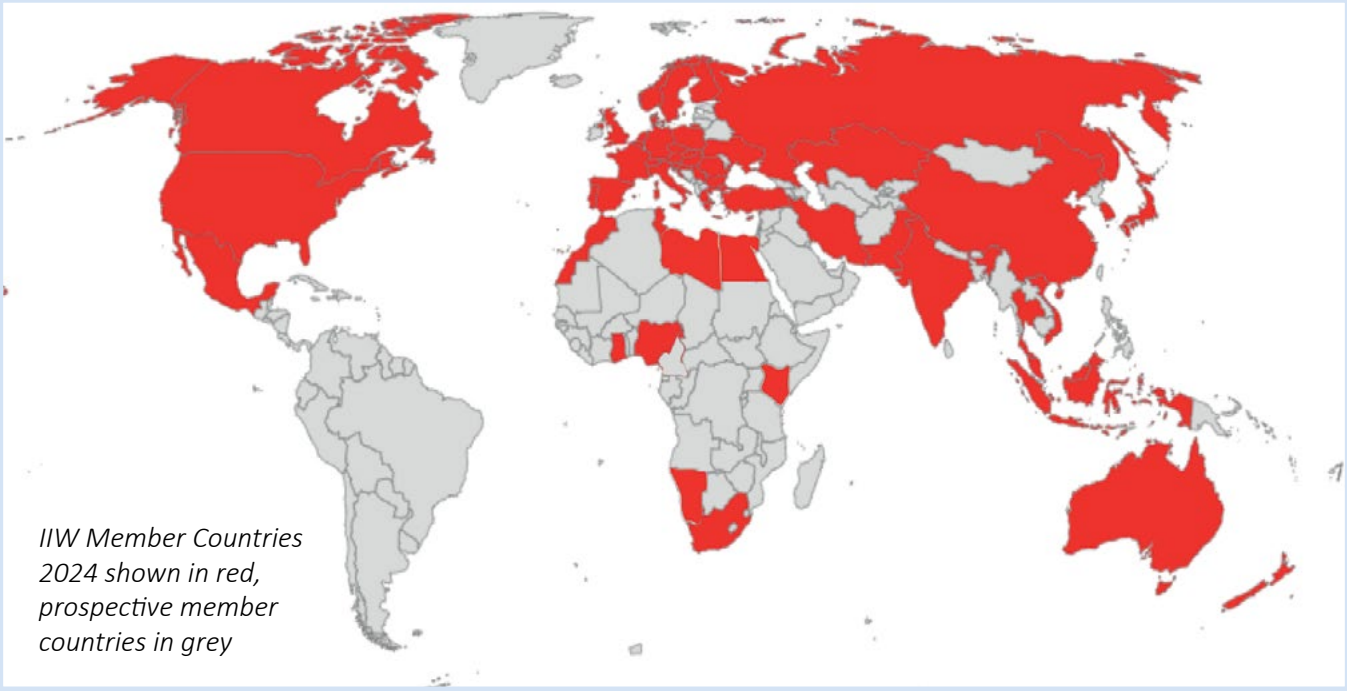
NWC GN 11 Communications and Marketing Building Block.

1.3 How to use this NWC Guidance Note

- The NWC Guidance Note is structured so a potential **"NWC Lead Organisation"** can use the information contained in the NWC Guidance Note in an NWC Project to establish or improve a National Welding Capability in a country. A business plan would need to be devised and implemented with appropriate strategies, financial requirements, action plans, milestones and key performance indicators to meet the required outcomes.
- The concept of this NWC Guidance Note is that by showing possible strategies (which may be necessary to implement the Education, Training, Skills and Careers Building Block) on a Plan-on-a-Page, the user in the **NWC Lead Organisation** can relate any strategy considered useful to a bank of references related to that particular strategy. The information obtained through the references will have been gathered from the experiences of the Author and other organisations and individuals who are prepared to share their successes and lessons, including challenges and failures, with the global community.
- References have been provided with appropriate links where possible, to give examples of past experiences, best practices, sources of information, guidance documents etc, for consideration and possible use by the reader. Where no link exists, IIW is endeavouring to provide the reference document in an IIW National Welding Capability (NWC) Resource Centre for access on the IIW website. Unfortunately, since over time the links in the references may disappear, be changed/moved on the relevant website or be taken off the relevant website, need updating etc, readers are advised to simply check out the reference themselves (for example putting the reference in their browser). IIW will also endeavour to put as many of the documents where links become a problem into the IIW NWC Resource Centre.
- The user will then decide which strategies (those shown as examples in NWC GN 5 or amended or new ones) and information to use to meet the outcomes required in their own NWC business plan.
- The concept and structure related to the "Plan-on-a-Page" is based on the report, Vol 3, Education, Training, Technology Transfer and Research and Development by Focus Group 3 of the Australian Federal Government Heavy Engineering and Infrastructure Action Agenda (HEIAA) [4] as well as the format of the IIW Business Plan 2007-2012.
- It is expected that the NWC Guidance Notes will become part of the IIW National Welding Capability (NWC) Resource Centre as envisaged in Section 10.2 page 157 of the IIW White Paper [5]. It is hoped that they will become living documents with more and more people contributing information based on their experiences in establishing their own NWCs. With the increase and improvements in digital platforms for meetings, programmes could be established whereby NWC groups in different countries could meet either nationally or internationally to share such experiences.
- Readers are also encouraged to share their ideas and information directly with the Author for continual improvement of the Guidance Note.

1.4 The Role of IIW in Education and Training

- IIW has been involved in education and training since 1950 with the establishment of Commission XIV Welding Instruction. At the IIW Annual Assembly in Madrid in 1992, Commission XIV was renamed Education and Training and commenced work on a harmonised global system for Education, Training, Qualification and Certification (E, T, Q & C), taking into account the needs of all nations around the world.
- As a result of the efforts of IIW Commission XIV Working Group (WG13), at the Beijing IIW Annual Assembly in 1994, the Governing Council of IIW unanimously approved resolutions to proceed with an IIW global scheme for the E, T, Q, & C of welding personnel.
- In 1995, the IIW General Assembly in Stockholm then entrusted Commission XIV to prepare a draft guide to cover all aspects involved in the qualification and certification of welding personnel. A new IIW Commission was also formed (Commission VII ***Authorisation and Qualification***) to establish and implement all the requirements for the successful implementation and operation of the IIW International Authorisation Board (IAB) which was established in 2000.
- Commission XIV still continued with its work for the overall membership of IIW, including complementing the activities of the IIW IAB.
- In parallel with these developments, discussions had been held with the European Welding Federation (EWF) regarding a joint E, T, Q & C scheme. There was good sense in doing so since Commission VII, in performing the preliminary work to establish the IIW IAB, was progressively adopting EWF qualifications which were recognised by ISO standards. As an organisation, EWF was also well placed to deliver company certification to complement its own qualification and certification scheme.
- Since the introduction of the IIW-IAB programmes in 2000 and implementation in over 40 countries, at the end of 2024, 70,505 International Welding Engineers (IWEs) have been trained and qualified worldwide, 14,954 International Welding Technologists (IWTs), 53,398 International Welding Specialists (IWSs), 4,895 International Welding Practitioners (IWPs), 34,891 International Welders, 19,488 International Welding Inspectors and 339 International Welded Structures Designers and 3,448 companies have been certified to the IIW MCS ISO 3834 programme at some stage.
- The EWF has also introduced programmes such as Additive Manufacturing and many IIW member countries also have their own national programmes.
- The global welding industry has an enormous network of facilities and resources which can undoubtedly assist in continuously improving education and training in many countries.



IIW Member Countries 2024 shown in red, prospective member countries in grey

1.5 Introduction to United Nations Sustainable Development Goals (SDGs)

- The United Nations (UN), has 193 countries as members and with the challenges of improving the quality of life in countries, in 2015, world leaders launched the UN 2030 Agenda and agreed for the UN to implement 17 Sustainable Development Goals (SDGs) aimed particularly at low and middle income countries. The full Sustainable Development Report 2024 giving the Global SDG Index and country reports is on Sustainable Development Report 2024 (sdgindex.org)
- Each UN country is supposed to measure its progress on an annual basis against the targets and indicators set against each SDG. The title of each SDG and its description together with the number of targets and indicators for each SDG are also shown at https://en.wikipedia.org/wiki/Sustainable_Development_Goals
- The 17 UN SDGs are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those of poverty, inequality, climate change, environmental degradation, peace and justice. The 17 Goals are all interconnected, and in order to leave no one behind, it is important that we achieve the best outcomes that we can by 2030.
- Each SDG has a clear Goal with targets to be achieved by a country by 2030 and indicators for measuring, monitoring and evaluating progress against the Goal. It is not just countries which are being asked to implement the SDGs but also companies, organisations of all types and even individuals. Since the Goals are interconnected, contributions into one Goal can have a positive effect on other Goals.
- There are well documented criticisms and challenges regarding some of the targets for the UN SDGs as well as many not likely to be achieved by 2030 [6]. Although some of these may be true, it does not prevent the welding industry in a country attempting to progress the SDGs to some degree based on the resources available and give benefits to their populations which might not have arisen without having the focused SDG approach in place.
- The International Institute of Welding (IIW) has suggested linking its National Welding Capability (NWC) project and the UN SDGs so that strategies can be introduced by a country including implementing a Flagship Programme with a single global focus "To Assist the Country to Establish, Sustain and Improve Its National Welding Capability and Progress its UN Sustainable Development Goals"[7].
- Such a Programme may have many initiatives and projects associated with it but all related to the single global focus. By focusing available resources on particular goals through projects giving optimal achievable results, one has a winning formula. The IIW **Long Report Volume 2** "Potential National Welding Capability Welding Industry Projects and Resources" has many examples of excellent benefit to individuals, companies and the country.
- Improving a country's National Welding Capability can make a significant contribution to, and have a very positive effect on, many national and international programmes including the SDGs which also build on various existing national and international agreements. Reports such as in [117], [120], [121], [126] and [129] are useful to consider when planning the actions for a National Welding Capability.

Part 2: Importance of Welding, Education, Training, Skills and Careers to a Sustainable NWC

2.1 Benefits and Value of Welding and Joining to a Country's Economy

Welding contributes positively to all human endeavour and the quality of life of all.

- It does this in numerous ways, whether through creating power for lighting and cooking, potable water and safe sanitation, national infrastructure, efficient, safe and effective transportation, accommodation both for living and working, a multitude of machines for different industrial applications, medical, health and safety devices and by many other ways.
- Without welding, people around the world could not switch on a light, turn a tap to access water, travel by train, road, sea or air, or use a computer or a multitude of other applications which improve the quality of life.
- Welding contributes to improving the national and global quality of life including the mental health and physical wellbeing of current and future populations. There are a multitude of examples of welding used in activities including handicrafts, hobbies, home applications besides numerous industrial applications
- Welding technology is an enabling technology used across a wide range of industries in manufacturing, construction, repair and maintenance applications. These range from micro joining of medical devices, electronics and photonics (down to 5 microns), to larger scale applications such as bridges, buildings, infrastructure, defence equipment, mining equipment, boilers and pressure vessels, piping, ships, rail and road transport, water and gas pipelines and components over one metre thick welded in one pass. It is used widely in the manufacture of most consumer products.
- It encompasses the total life cycle of welded products/structures including design, manufacture, fabrication, construction, conformity assessment, inspection and testing, operation, maintenance, repair and decommissioning as well as recycling, repurposing and other environmental conditions. It is critical to the infrastructure of any country.
- History shows many examples of the importance of welding to the world. The formation of IIW itself illustrates this. After the devastation created through World War 2, Europe in particular, was in a terrible mess but countries got together in 1947 and formed ISO and IIW amongst other organisations to somehow build up the quality of life again. 13 countries formed IIW (11 European, USA and South Africa). This number has grown to 53 illustrating the importance countries give to welding

Examples of the value of welding to economies of countries have been shown over many decades

- In 1970, The Welding Institute, UK, carried out a survey to establish the likely industrial losses resulting from weld failure either during fabrication or in-service in order to identify the areas where improvements would yield the maximum cost saving. The total estimated cost of over £400 million per annum represented about 1% of the UK gross national product [8]. A similar exercise based on applications in modern times would be a worthwhile exercise[132].
- A White House study in the mid-1980s found that welding was directly or indirectly related to 50% of the gross National Manufacturing Product of the USA.
- The importance of welding to national economic performance can be shown in numerous ways. One comprehensive study in the USA (2002) surveyed the manufacturing, construction and mining industries in which welding was a critical enabling technology. It found their combined revenue totalled some US$3.1 trillion, or about one third of that country's gross domestic product. Direct welding costs were $34.1B, 70% of which was labour cost. The labour cost for welding activities was in fact about 4% of the total labour costs for those industries [9]. The true value added by welding technology in this example is probably at least ten times the direct welding costs due to the added value to the economy after the implementation and use of the technology.
- The Health and Safety Executive in the UK published a report in 2024 where it had studied 47 individual examples of weld failures on safety-critical metallic components. These illustrated the shortcomings in the application and supervision of welding and highlighted priority areas for improvement of weld quality in industry [132].

- In Canada in 2000, using similar benchmarks, the revenue of the user industries for which welding was a critical enabling technology represented one-third of the Canadian Gross National Product. Welding-related expenditure in the key user industries was over $5 billion, of which payments to employees represented 70% ($3.7 billion). The Canadian market for the sale of welding materials to user industries was about $800 million [10]. References [73] and [74] similarly show the importance of welding today in Canada.
- The German Welding Society (DVS) has regularly arranged for the economic significance of various joining technologies to be investigated and quantified in scientific expert reports (in 2001, 2005, 2009, 2013 and 2017).These originally applied to the value added and employment connected with the production and application of welding in Germany and were then progressively expanded for other joining technologies and for various other countries in Europe and the EU. References [5], [11], [12].
- Such information has been used by the European Union (EU) to establish a Joining Sub-Platform within the Technology Platform "Manufuture". The Manufuture Technology Platform was implemented to create a strategy regarding research and innovation in manufacturing. Part of the justification for the Joining Sub-Platform is that joining is a core element of innovative and sustainable manufacturing and will have its own strategic research agenda funded by the EU [13].
- Since very different structures exist all over the world and statistical data is not available or has not yet been coordinated, it is not possible to make any conclusions for the world based on these values from the European economy. The quantified figures also do not include the cost of weld failures, poor in-service performance, repair and maintenance costs.
- Work has also been performed on showing the world market for welding equipment and materials. Reference [14] shows systematised economic-statistical information on the state-of-the-art and development of the world, regional and national welding markets covering a period 2006-2009. Quantitative and value indices of production, consumption and export-import of the equipment and consumables for welding and related technologies are given. Understanding and quantifying a country's national welding market helps considerably when marketing a national welding capability project [15].
- One of the best examples of a national welding institute being able to show the value of its work particularly related to technology transfer is that of TWI in the UK. Together with industry funding and its own funds, TWI had received significant funding from the UK government for a project "The Joining Forces Programme" aimed in particular at technology transfer to small and medium sized enterprises (SMEs). The £15 million programme ran for five years from 1994 to 1999 and an evaluation on the success of the project was carried out in 2000 by the UK Government Department of Trade and Industry (DTI).
- Reference [16] shows the excellent results from many aspects. In particular, the results of the value-for-money evaluation were so good that WTIA used the principles of the evaluation to show Australian Federal and State Governments and industry the value of the projects which it successfully undertook from 1998 to 2011.
- Furthermore, in 2018, based on this previous work by both TWI and WTIA, HERA's Welding Centre prepared its own successful approach to measuring and showing the value of its products and services to the New Zealand economy [17].
- To optimise the benefits of welding to a country's economy, innovation must play a significant role and this will require a major cultural change in many companies and individuals particularly in consciousness raising of the importance of innovation to company competitiveness and industry survival.
- Innovation through technology also appears a necessity for a country to be globally competitive. Innovation can be defined as 'To bring in something new, make changes (ideas, methods etc.) whether in simple or complex forms'. It includes applying inventions and the adoption of research and development (R&D) outcomes. Education, training, skills and careers related to individuals will play essential roles.

2.2 Importance of Welding Related Education, Training, Skills and Careers to a Country

Results of Federal, State and Local Government education and training (E&T) initiatives in different countries, as well as success stories from local and overseas sources, can all be used to show the importance of education, training, skills and careers to a country.

- According to an American Welding Society (AWS) report in 2003, by employing a qualified welding supervisor, a company could save up to US$17,044 per welder per year as follows: Reduced weld metal volume $3,319; Reduced arc time per weldment $4,281; Reduced rework, scrap and rejects $3,244; Reduced work effort, motion and delay time, $6,200 [18].

- To improve a country's NWC, many lessons can be learnt from studying various "Winning Nations" [19]. "Winning Nations" have a number of cultures. These include a skills respect culture, a quality culture and a productivity culture [20], [21], [22]. There are countries where government and industry sectors have combined to create such cultures particularly through the application of national standards which automatically lead to the need for companies to have competent people and hence the catalyst for lifelong education, training, qualification and certification of people where appropriate.
- In Japan, the Japanese Welding Engineering Society (JWES) published its WES 8103 Standard for Certification of Welding Coordinators in December 1970, enhancing Japan's reputation for having the cultures mentioned previously.
- In Canada, the Canadian Welding Bureau (CWB), was formed in 1947 with the main objective of giving government and industry greater confidence and assurance in the design, fabrication, construction and erection of welded steel, particularly high rise structures.
- The Canadian Standards Association (CSA) had been given the mandate in the 1930s to start welding standards development and the creation of a national body to administer them.
- Two key standards, W59 and W47.1 were put in place and the formation and role of CWB (now known as the CWB Group) was to act as the official administering body to ensure the uniform rollout and enforcement of the standards across Canada, including embedding the requirement for adherence to these standards in the National Building Code.
- The CWB thus became the organisation, supported by industry and government bodies, to ensure the integrity of welded steel, and later aluminium and rebar structures, welding inspection companies and inspectors and welding consumables through the certification of fabricators, construction companies, inspection and test centres, welding consumables as well as personnel, and the continuing provision of appropriate standards through one of the national standards organisations.
- Similarly in Germany, where the certification of companies from as far back as 1926 with the German Railways eventuated with DIN standards forming the basis for the EN 729 and EN 719 standards which culminated in the ISO 3834 ***Quality requirements for welding – Fusion welding of metallic materials*** and ISO 14731 ***Welding coordination – Tasks and responsibilities*** used globally today [23].
- The European Union has deemed fabricated steel and aluminium components as safety critical. This has led to the introduction of requirements whereby suppliers of such products must conform with the EN 1090 standards series which regulate the fabrication and assembly of steel and aluminium structures as well as help achieve CE marking. This has also been a catalyst for companies and personnel being required to embrace qualification and certification in various areas.
- In recent amendments to ISO 14731, the term Responsible Welding Coordinator has been removed with a greater emphasis on the welding coordination team. The establishment of a welding coordination team in a company should lead to increased training of a wider range of people in the company covering all the necessary welding related activities [24], [90].
- Other cultures which are involved in acting as catalysts for lifelong learning include work, health and safety matters, environmental matters, ethics, careers, customer service and innovation.
- Whether a country's economy is considered developed, developing or an economy in transition, innovation is constantly required to meet the growing needs of its population.
- Companies also need to continually innovate to remain competitive. Innovation includes new products and processes, significant changes to existing products and processes and significant changes to management and organisational structures.
- The growth of automation and digital technologies for example, is also transforming the manufacturing sectors in countries. As Industry 4.0 continues to evolve, the demand for crucial digital skills is growing significantly. Digital skills such as data analytics, robotic engineering, and automation are becoming essential in the manufacturing industry and businesses are increasingly investing in reskilling and upskilling their existing workforce while also recruiting new talent with relevant expertise [25], [26].
- Understanding the need for innovation, the availability of technology receptors in companies, effective technology transfer and appropriate research and development (R&D) are all dependent, to a large extent, on the education, training and related skills of the people in the industry.
- None of the above can occur if the correct human resources are not available. Many countries are in the position of having a dearth of well-qualified and experienced personnel in the welding-related fields. Education and training therefore underpins so many other factors influencing an industry's performance and competitiveness.

- It is incumbent upon both government and industry in a country to investigate, recommend and implement measures that will ensure that the optimum E&T is performed to produce outcomes to meet the needs of the different welding-related industry sectors in the country including skills levels and career paths and routes for people [23], [24], [27].
- The inclusion of qualifications and certifications for different types of welding personnel in national and international standards as well as customer specifications shows the importance of personnel education, training and skills levels to the quality and reliability of welded products/structures.
- Workforce development takes time. As the welding industry continues to evolve and new technologies continue to be introduced, the focus on establishing a qualified and engaged talent pipeline of people has never been more critical. Encouraging people to explore the potential of careers in the welding industry has to be a significant activity.
- Appropriate E&T, skills and careers arrangements are essential if companies are to achieve and maintain international competitiveness in a global economy. Investment in skills is a key way in which industry can adjust to the changing market environment. In terms of assisting the welding industry in growing a national welding capability, a key reason for positive progress will be through the continued success of the country's vocational education and training system, its universities and the activities of the welding industry organisations.
- Highly skilled employees, who generally feel more valued, are more flexible and better able to adapt to changes in processes and product design than their lower skilled counterparts and can respond more rapidly to changes in market demand.
- High level skills will become more important to a country's industry as its economy moves towards a reliance on greater skills intensity and knowledge-based industries. This also includes not just technical skills but soft skills as promoted by organisations such as the National Association of Colleges and Employers (NACE) in the USA with the concept of "Competencies for a Career-Ready Workforce" [89].
- Economies with lower skills levels might well be at a disadvantage in a global knowledge-based economy where rewards for firms and individuals will flow increasingly to the technologically skilled and innovative, that is with broadly based skills and abilities.
- Increased skills levels in firms are likely to lead to improved international competitiveness and an improved market share in domestic and international markets.
- There must also be sufficient competent researchers in the country to be able to perform the R&D to deliver optimum outcomes in the optimum time so that the technology can be delivered (by technology deliverers) to people to receive it (technology receptors), assimilate it, develop it further if necessary, and apply it.
- There are excellent examples of networks successfully established to bring industry and all levels of government together to supply the E&T, skills and careers to create viable industry sectors and overcome constraints as well as fostering partnerships between Small and Medium Enterprises (SMEs), larger firms and training providers [28], [29], [30].
- Marketing should promote the benefits of education, training, skills, R&D, technology and innovation at the same time.
- The development of the International Institute of Welding (IIW) E, T, Q and C programmes and their implementation in 47 countries worldwide illustrates the importance and need for world class personnel to be available in the welding industry in a country [31].
- The vast majority of developed economies have well established sustainable programmes for the recruitment, training and qualifying of welding personnel of all types and levels to meet industry needs. Many developing countries have serious challenges however such as lack of training and education facilities, resources and teachers, basic needs such as transport, sanitation, food and water not being met as well as regional disparities amongst others.
- Consider the different types of personnel who may need E&T to acquire the necessary skills and knowledge to perform their work competently: These could include:
  - Research and Development: researchers
  - Technology Diffusion: technology developers, technology manufacturers, technology suppliers, technology deliverers and technology receptors
  - Education and Training: lecturers, teachers, instructors, students including school children and school leavers
  - Qualification and Certification: examiners, auditors
  - Industry Personnel: managers of all levels and types, designers, sales, marketing, purchasing and contracts personnel, specifiers, engineering personnel, welding engineers, technologists, specialists, practitioners, welders, artisans, apprentices using welding, other types of artisans using welding, inspectors, hobbyists and handymen

- Government: regulators, representatives of departments related to science, research, technology, education, training, industry development amongst others.
- Various targeted groups such as school children, school leavers, women and girls, young professionals, refugees, immigrants, retirees, prisoners and people with special needs.

- All these personnel will require career paths and career routes available to them to achieve success [23], [24].
- Ideally, all companies no matter how small, can institute 'on-the-job' training including upskilling and retraining of existing employees, to equip human resources with greater knowledge and skill and in turn, develop a learning culture. This philosophy will add value to the individual, the company and to national prosperity.
- IIW also shows the importance of education, training, skills and careers in its recently released report **"The Importance of a Country's Welding Industry, its National Welding Capability (NWC) and their Significance to the UN Sustainable Development Goals (SDGs)".**
- The report provides **guidance**, including **practical ideas and recommendations,** on how a country's welding industry can improve its national welding capability and simultaneously progress targeted UN Sustainable Development Goals (SDGs) where resources are available.
- It can be **downloaded free of charge** https://iiwelding.org/iiw-jointothefuture/iiw-and-sustainable-development/
- It consists of a:
  - Short Report
  - Long Report Volume 1 "NWC and SDGs Interconnected and Interdependent in the Welding Industry"
  - Long Report Volume 2 "Potential National Welding Capability Welding Industry Projects and Resources"
- An individual's appreciation for the value of education can be shown by the following exhibit. The bronze sculpture, 'Master of the Universe' (1989), has been installed outside the Edward Boyle Library at the University of Leeds. The piece was donated by Douglas Caster, who completed his degree in Electronic and Electrical Engineering at Leeds in 1975.
- Mr Caster said: "The sculpture represents how I feel about my education at Leeds: exposure to different kinds of knowledge that came together and enriched my life. I hope it inspires generations of students to stay curious and keep learning so that they may also continue to enrich their lives."[65].

Master of the Universe [65]
Sir Eduardo Paolozzi

Part 3: Key Challenges in Implementing and Sustaining an Education, Training, Skills and Careers Capability

There are significant challenges in establishing and sustaining an education, training, skills and careers capability in a country. To establish the infrastructure for the education, training, qualification and certification of welding related personnel also involves major costs which need to be supported by both industry and government in the first instance and then its operations sustained by ongoing demand. Unfortunately the demand can vary immensely depending upon the amount of projects and manufacturing taking place in a country. This often results in 'feast and famine' periods resulting in education, training, qualification and certification resources and infrastructure and teaching expertise being lost.

3.1 Drivers and Challenges

The inability to service and sustain industrial/business markets due to a country's current and future skills situation can be a major challenge to national growth. The development of a skilled workforce at all levels and in the correct numbers is the most important goal for a country to be globally competitive, since competent people make things happen.

- It is essential to ensure that companies in the different industry sectors have available to them appropriately trained and competent employees, in optimum numbers at all levels, to enable them to successfully meet current and future market demands.
- It is critical that the E&T, Skills and Careers needs of the industry are established, made known and are able to be funded.
- It will be critical for companies to improve their understanding of the philosophy and workings of the country's vocational E&T system so that they can make optimum use of the system and training providers can be more responsive to industry requirements [32]. Countries can also learn from regional experiences [33].
- Companies can fall behind in complying with numerous international and regional Conformity Assessment Standards such as those specifying ISO 3834 ***Quality requirements for welding – Fusion welding of metallic materials*** and ISO 14731 ***Welding coordination – Tasks and responsibilities or*** EN 1090 standards series which regulate the fabrication and assembly of steel and aluminium structures as well as assist in achieving CE Marking [34], [35].
- Competitor nations may be improving quality and productivity all the time so one must continually strive to produce very good quality training, properly funded and easily accessible, to produce a world-class workforce.
- There is a need to increase exports, offset imports and retain work in a country to be performed preferably by national personnel working for local companies, or at least national personnel of the specified standard working for overseas contractors.
- The marketing and promotion of the welding industry, including advocacy for education, training, skills and careers, as well as successful communications with all relevant parties is essential. A coordinated approach between governments, industry, industry bodies and training organisations is essential to address the root causes of a skills shortage and find solutions.
- These will involve close co-operation and collaboration with the government and industry organisations with infrastructure already established and responsible for welding education and training, qualification and certification [32]. This co-operation and collaboration and not working in "silos", also includes other industry associations not necessarily in the welding field but with similar objectives in Education, Training, Skills and Careers and giving greater impact when approaching governments and other agencies with common causes particularly for funding [30].
- To implement a visionary plan with appropriate initiatives can often be an up-hill battle due to such silo effects caused by responsible bodies accompanied by complacency, personal agendas or "turf", or small ideas [88]. An Industry Sectoral Project (ISP) approach can overcome many of these challenges whilst at the same time contributing to national approaches where applicable.
- To ensure that welding fabricators, construction and maintenance companies are in a position to meet world's best practice, the development and establishment of a Welding Coordination Team (WCT) is a

simple management process leading to improved productivity and cost efficiency, improved integrity and reliability of products and compliance with ISO 3834 and ISO 14731. Each person in such a team will be appropriately qualified and/or certified with the experience and competency to perform the tasks allocated [24], [34].

- Creating and continuing to foster the connection between policy makers, industry, education and community is imperative for success. This includes maintaining regular communication and providing the appropriate channels for the sharing of ideas and problem solving.
- The welding industry needs a range of activities which could be used to communicate with both industry and people of all ages. For example, podcasts that cover what is happening in the world of welding by speaking to people passionate about welding and fabrication and producing original thought leadership video content dedicated to educating the industry and building awareness with people.
- Having a journal and newsletters brings relevant, informative content that highlights welding practices, professionals, education, news, research, and lifestyle [91].
- People from many industry sectors, such as asset owners, educators, decision-makers, welders, influencers, suppliers and consultants, can be brought together in many ways to create a co-ordinated approach to finding solutions. Cluster groups such as SMART Groups, Technical Groups, Research Groups, as well as conferences and events are excellent opportunities to discuss issues around industry needs and solutions, current trends and advances, education, training, skills and careers, welding and joining, health and safety, and obtain support to implement solutions [28], [36]. [37], [38], [39], [40].
- For many developing countries, one of the biggest challenges is how to assist poor people with the opportunities to improve their quality of life.

3.2 Skills and Training

The OECD and ILO have produced a report [121] in which it is stated that policy makers have largely focussed on boosting the supply of skills, namely the number of people with vocational or academic qualifications while relatively little policy attention has been paid to the use of skills in the workforce and the alignment between the competencies of workers with the needs of the business. This can have a major effect on productivity and will be dealt with further in Guidance Note GN 6.

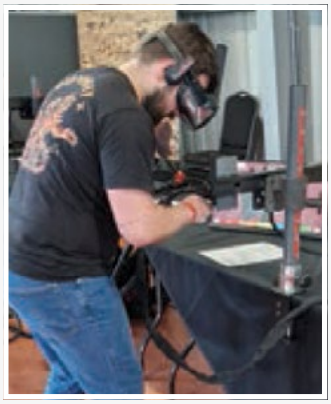
There may be many reasons for an identified skills shortfall in a country to meet industry needs in sectors utilising welding.

- Skills and knowledge in industry have often been reduced in more developed countries over the past 15 years due to the fragmentation of large businesses and downsizing, with the loss particularly of more experienced senior personnel and facilities for on-the-job training and mentoring.
- Industry has often failed to train, due in part to this loss of senior personnel as mentors. The lack of on-the-job training facilities and resources particularly for apprentices in Small and Medium Enterprises (SMEs) can be a serious problem even in developed countries.
- The loss of instructor skills, facilities and resources at training organisations may also be widespread. Many training organisations may acknowledge a skills shortage of their own, fuelled by a chronic shortage of good lecturers, an aging population of trainers and fewer young people coming up to take their place. They often cannot compete with industry salaries and might not have the finances to hire top-class people either locally or from overseas.
- A sustainable number of technology receptors/implementers at engineer, technologist and technician/specialist levels are also required for innovation to take place as well as meet the need for competent personnel required by various product application standards.
- There are often many personnel-related reasons why skilled shortages may occur in the welding industry. For example, not enough replacement personnel for the aging population in many developed countries, poor image of welding as a career, unstable career paths, inadequate salaries particularly for staff of training providers, lack of secure work, perception of a dirty unsafe industry, poorly funded and inadequate training centres and instruction, amongst others.
- There could be a need to improve the culture and image of 'manufacturing' for young people, the public and educationalists. In countries with growing populations and economies, this may be a bigger challenge. It is critical to ensure that standards are maintained with no belittling of skills or lack of a culture of respect for skills in a community otherwise these can contribute to an understandable reticence of young people to enter the welding industry.
- A full record of the capabilities and capacities of both E&T organisations and industry may not have been maintained e.g. technologies, specialised equipment, facilities and personnel available as well as alliances not being created to maximise the use of such

specialisation by as many individuals and companies as required.

- Having formal networks of training centres in a country with full knowledge of their capabilities and capacities helps in this regard including identifying further opportunities to improve the NWC [28], [41], [42].
- Besides the more formal E&T courses to be provided, there may be a lack of shorter courses to provide the updating/upgrading of people's knowledge and skills. Besides a higher level of skills being required in general, a broader range of skills is often also required, and such skills need updating more often than in the past. This is often met through a comprehensive package of courses, both virtual and face-to-face, provided by local and overseas experts and is often related to providing the latest information and skills on a particular topic [36], [37].
- The welding industry might not be working closely enough with the existing government and industry organisations which manage and administer the infrastructure and systems already in place for the country as well as provide the funding for E&T. A very good example of such an infrastructure in the UK showing Regulatory Bodies, Quality Bodies, Awarding Organisations, Qualification Frameworks, Learning Providers amongst others, is shown in reference [32].
- As mentioned previously, the welding industry is involved with the total life cycle of welded products/structures including design, manufacture, fabrication, construction, conformity assessment, inspection and testing, operation, maintenance, repair and decommissioning as well as recycling, repurposing and other environmental conditions.
- Depending upon the needs identified in the country and what infrastructure and resources already exist, it is often necessary to establish the education, training, skills and careers solutions for personnel wider than welding in the fabrication, construction and maintenance industries including personnel involved in pressure equipment, bolting, corrosion and non-destructive testing.
- A good example of such a situation involves the steel fabrication quality standard AS/NZS 5131:2016 Structural Steelwork-Fabrication and erection [98]. There are similar examples in a number of countries with education and training in the pressure equipment, bolting, corrosion and non-destructive testing fields.
- The importance of offering lifelong learning through short courses and micro-credentials is becoming more significant whether used for the first steps of the career of a person in a developing country or upskilling people already qualified and skilled in highly developed countries. [84], [85], [86], [87].
- Ideally, being able to provide opportunities extending through a person's life from "cradle to grave" would be an excellent achievement. With the improvements in modern welding education and training in developed countries, these could be transferred to developing countries with improved approaches within elementary schools in rural villages to secondary schools and then tertiary levels of education and training. The advent of the use of training techniques such as Virtual Reality (VR), Augmented Reality (AR) and Virtual Learning Environment (Metaverse) in the welding field could increasingly assist particularly during the first stages of overcoming the constraints people may be subjected to due to their living circumstances [44], [70], [93], [123], [125]. An inexpensive piece of equipment for use in elementary and secondary schools to encourage young people to take up careers in welding would be very useful.
- The Southern Counties Branch of The Welding Institute, UK, held a very successful virtual welding competition in June 2024 at the Tank Museum (Dorset). An objective of the event was to help young people understand that there are many potential jobs in welding and in other engineering professions [123].





A welder, a trainee and a non-welder during the Weld-Off Competition.
Photo credit, Mike Baverstock, The Welding Institute, Southern Counties Branch.

3.3 Working 'Smart'

There is a need to increase productivity, competitiveness, economic growth of manufacturing, construction, repair and maintenance industries through using smarter people and technology.

- Industries need highly skilled people to create a high value, high wage and high-skilled nation. Increased labour force participation in a country and ways to achieve this are necessary. The need to translate economic growth into rapid per capita income growth is emphasised in [129].
- Having a national vocational training curriculum supported by national training resources is a smart way of working due to the input from the expertise and experiences of many people and organisations of many types and sizes, particularly SMEs.
- Using improved teaching and training methods which is a continual process [43], [44], [45], [46].
- The availability of the best training resources on a national basis as well as having access to top quality resources for both classroom training and practical training should be a key objective [43], [44], [45], [46], [91].
- To be ahead of competitors as well as meeting the needs of the people in a country, future technology directions need identifying so that E&T and the appropriate skills levels required for meeting future industry needs can be met at the appropriate time [5], [47], [48], [49], [50], [51], [52].
- Information should initially be gathered on the E&T capabilities and capacities of a country, both in industry and training organisations. Existing funding of the welding E&T activities should be established and analysed and the relevance of the E&T using public funding to meet industry needs established [32], [33], [40], [41], [42], [43], [110], [111].
- Whatever welded application is to be considered, technology transfer will play a key role. Technology has to be developed, delivered, received, adopted, adapted, implemented and then feedback be given at each stage for improvement and further future use of the technology. Competent people are required at each stage and hence the need for training and qualification of such people to build up the talent pool and skills base [92].

3.4 Focus on People

There is a need to significantly increase the required number of skilled people at all levels in industry.

- In a welding related industry sector, the range of technologies and competent people required on a lifelong basis, would involve welders, welding related apprentices, welding coordination personnel, welding inspectors and other inspection personnel, NDE technicians, designers, researchers, as well as other support people such as Stores personnel, QC Welding Coordinators, Environmental Welding Coordinators, OH&S Welding Coordinators, Purchasing and Contracts personnel [24].
- The implementation of the concept of a Welding Coordination Team (WCT) in line with the welding related activities in ISO 14731 is a very useful approach for supporting E&T, Skills and Careers [24], [34].
- Instructors are required for the training of each of these different types of personnel and it is essential to continually upgrade the competency levels of welding instructors at training centres and companies to world's best practice to improve efficiencies as well as ensuring the latest and best training resources and facilities are available to them [41], [42], [53], [54], [55], [56], [57].
- Implementing programmes to assist secondary schools to develop and support educational programming, capital equipment, consumables and personal protective equipment (PPE) that all create and upgrade quality learning environments in school technology programs is essential. [46], [57], [91].
- Interestingly, even though computers have helped people and industry make rapid progress in various fields, an OECD study on academic performance at schools found that countries that have invested less in introducing computers in school have improved faster, on average, than countries that have invested more, and that the sole advantage of computers is that they are cheaper than teachers [82].
- Giving people opportunities to earn qualifications and certifications, offering better opportunities for careers and employment at all levels including upper-level management, research and technology innovation, is important.
- As previously mentioned, E&T should result in credible personnel qualifications and certifications which should also be portable both within a country and overseas, and the qualifications and certifications should therefore be recognised on a national and international basis if at all possible [31], [32].

- Industry should create new employment opportunities by making the best of a country's and international employment practices thus improving industry performance and give people incentives and careers opportunities to develop and master new fields. Systems for communicating current employment opportunities could also be introduced [36], [37], [69], [73], [97], [126].
- Government policies should broker the re-training of job leavers and older workers for re-employment for sustained employment and should support industry in its ability to attract and bring in overseas personnel where required.
- There is a need to link in with the Government initiatives to provide secondary students with improved career paths from school to work; such initiatives could include part-time apprenticeships and traineeships, training of schoolteachers to teach welding, provision of training resources [32], [45], [46].
- Without reducing standards, there should also be flexibility in allowing trainees to move along career paths using different routes without undue constraints preventing them from moving along or between career paths. For example, identify each career path in terms of the qualifications required and analyse them to determine the flexibility of the routes to obtain them in terms of recognition of prior learning, recognition of micro-credentials, availability of facilities and resources for individuals to be trained and examined. This would need to involve secondary schools, colleges in the VET system and higher education organisations such as universities in close cooperation and collaboration with government appointed boards and committees such as Skills Councils [32].
- There should be links to establish closer partnerships between higher education institutions and industry and the development of an effective, affordable research and research training system to contribute to national economic development, international competitiveness and the attainment of social goals [43], [98].
- The UK is a very good example of a relatively large country and major world economy which has established a pragmatic model for welding and integrity related research in an innovation ecosystem that ensures industry relevance. The Structural Integrity Research Foundation (SIRF) was established as a 10-year programme in 2012 by TWI Ltd, Lloyd's Register Foundation and BP with public funding support and in cooperation with Brunel University as the lead academic partner. The aim of SIRF was to ensure that university research into issues related to structural integrity had industry relevance, with an ambitious target for increasing research activity, and was in direct response to a UK Government industry led university initiative championed by David Willetts, the former UK universities minister.
- Operationally, the programme was delivered through the National Structural Integrity Research Centre (NSIRC), which is a multi-university postgraduate cohort based on TWI's Cambridge site, and which continues beyond the life of the SIRF programme.
- The economic impact of SIRF has been estimated as being worth £189 million to the UK economy (or £109 million without the capital impact of setting up the Foundation). To date, over 320 PhD and MSc students have been enrolled with NSIRC, representing over 35 different nations. 89% of NSIRC graduates are now employed in the industry https://url.uk.m.mimecastprotect.com/s/dMJ9Cp5GiBBDncPfwu4b0Dh?domain=twi-global.com
- TWI trains the students on project management and industrial impact, whilst the university provides training on technical publication and collectively both train on scientific rigour. HERA in New Zealand, a country with a relatively smaller economy, has a very successful example [98].
- Opportunities to undertake education and training may vary depending upon the cultures and situations in the particular country. One also needs to attract people to existing and future careers in the welding industry.
- To attract people to the welding industry there must be a reliable estimate of the personnel requirements of the industry for a foreseeable time period. An ongoing assessment of these needs is therefore very important to attract and retain people. [38], [39], [40].
- There should also be strategies in place to overcome challenges for various groups such as school children, school leavers, women and girls, young professionals, refugees, immigrants, retirees, prisoners and people with special needs to be able to access opportunities in the welding industry in a country. Examples exist in various countries on how strategies have been put in place to assist such groups to have improved opportunities [43], [57], [58], [59], [63], [72], [78], [79], [116], [118].
- At different stages of life, mentoring can play a significant role in ensuring a person's success. Mentors can give guidance, expand the person's network, improve skills and challenge the person to do better. A Protector is a Mentor who acts as both a guardian and advocate

and the Mentee needs to be able to freely express their concerns confidently and receive support and protection to overcome their fears and susceptibilities. The Protector does this.

- At some time during one's life, there are times when decisions need to be made which cause trepidation, particularly when it means leaving the security and comfort of one's known surrounds. Such times could include leaving home to move towns for study or employment to improve oneself, or to change the course of one's career [65].
- In industry, some companies have mentoring programmes which play a key role in giving benefits to both the company and the Mentee [60].
- The establishment of a learning ecosystem in a company would encompass all the components contributing to a learners overall experience. In the context of learning and development at a company, this can include the people, content, technology, data, tools, culture, strategy, governance, and any other factor that affects how an employee acquires new knowledge [119].

3.5 Importance of Welding and Image of Welding Concerns

A common complaint in countries is that even if sufficient career paths and routes are available in the country, an insufficient number of people are attracted to the welding industry to meet demand particularly due to a poor image of welding.

- This poor image is often called the 3Ds: 'dirty, dangerous and demanding' or in Japan, 3Ks: 'kitanai, kiken, kitsui' and various countries have implemented 'image of welding' programmes to dispel these terms and images.
- A major effort is therefore required in a country to improve the image of welding as a career whether in production, manufacturing, design, research, operations, etc.
- Many examples exist around the world of campaigns and projects to improve the image of welding. Awards, grants, skills competitions, welded art exhibitions are a few examples [61], [62], [63], [64], [65], [66], [67], [127]. Another approach could be having 'Importance of Welding' campaigns.
- WEMCO is a standing Committee of the American Welding Society (AWS) representing manufacturers making products for welding process and application. It has over 80 company members. WEMCO created the annual Excellence in Welding Awards to recognise individuals and organisations that are instrumental in raising the image of welding and sustainability of the industry and have shown exemplary dedication to promoting the image of welding in their communities [61].
- IIW WeldCare: Success Story Number 4. Image of Welding Campaign, 2008, shows very successful

CWB Foundation Women of Steel Forging Forward Programme hosted at Northwestern Polytechnic

strategies initiated by the American Welding Society (AWS) to help tackle skills shortages in the USA. In particular the formation of the AWS Foundation and its capital campaign enabled a range of programmes to be implemented. AWS generously shared its ideas and experiences with the other IIW Members to assist them in also tackling the challenge of developing the skilled welding workforce in their countries and contributing to the global IIW Image of Welding Campaign [62].

- During the same period, IIW WeldCare: Success Story Number 1, shows an excellent team effort between three national governments (Canada, Holland and Australia), industry bodies, national welding institutes and South African Industry to assist disadvantaged young people to train and qualify as welding inspectors as well as find them employment in industry [99]. This resulted in further opportunities for such trainees in non-destructive testing and other types of training. The combination of a major infrastructure project (Mossgas), an industry-wide training board with significant funding (SAFCTF), a top class training organisation (SAIW) as shown by the comprehensive audit the training was subjected to, was an excellent example of an ecosystem involving education and training covering a wide range of people from disadvantaged people with no experience organised with PROTEC, through to highly qualified and experienced trainees already working in industry, as well as major industry related trade unions, companies and individuals [40], [110], [111].
- In 2009, the DVS-German Welding Society initiated a project promoting young engineers to take part in Working Units and International Conferences of the International Institute of Welding (IIW) [63]. The young engineers have the opportunity to meet national and international experts and to get the experience of presenting and discussing their papers in a foreign language in front of an international audience at an early stage of their careers. DVS and some of its members have provided financial sponsorship enabling several hundred young people to attend IIW meetings. The programme has been very successful whereby IIW now promotes the Young Professionals programme, and other IIW Member countries support their young engineers to attend IIW activities such as the IIW Annual Assembly.
- In South Africa in 1994, the SA Skills Foundation in conjunction with The Learning Laboratory, produced a book and video titled "Techno Routes-Gateway to Future Skills and Careers, An Introduction to the World of Welding Technology". These were distributed free of charge to schools, colleges and training centres across South Africa and the Foreword written by the Minister of Labour helped reinforce the importance of welding [64].
- Since 2019, IIW has held very successful welded art photographic exhibitions with excellent Digital Collections as outcomes. The latest "IIW 2024 Digital Collection Welded Art Photographic Exhibition: Progressing UN SDG 4 on Lifelong Learning Opportunities" is freely downloadable through Reference [65] with the links to all its other exhibitions being available at the back of the Collection. More than 50 artists from 18 countries participated ranging from school children, apprentices, welders, welding instructors, university graduates and researchers and professional career artists.
- Many countries participate in the 88 Member Country WorldSkills International competitions which take place every two years. This also encourages countries to hold their own national competitions including selecting the country's representatives for the WorldSkills International welding competitions [66].
- SkillsUSA has introduced its own welding sculpture competition. Competitors demonstrate their ability to design and produce a welded sculpture and to describe all aspects of the creation of their design. Welded sculptures are displayed for the national competition along with a professional portfolio documenting evidence of creating the original work. Each participant is interviewed regarding the design and creation of the piece. https://www.skillsusa.org/competitions/skillsusa-championships/categories-and-descriptions/
- In March 2024, The Bulgarian Welding Society (BWS) held a national skills competition "Best young welder 2024" which also included a presentation of a welded art collection on a previously announced theme. The competition was attended by 20 students from 10 professional high schools from all over the country. The competition was held for the fifth consecutive year under the auspices of the Bulgarian Ministry of Education and Science and with the assistance of the Bulgarian Welding Society (BWS). The students presented to the jury and their peers their works on the topic "Quality Education Sustainable Development Goal 4-Through the Eyes of Young Bulgarian Welders". The compositions were evaluated on criteria such as compatibility with the declared theme, strength, functionality and performance [67].
- The Indian Institute of Welding has an open age skills competition including participants creating an exhibit

from scrap materials. In 2023, it conducted the 'Welded Marvels 2023 – Project Trash to Treasure' with 28 entries and the awards were presented to the winners during the IIW International Congress (IC 2024) at Bengaluru [65].

- The American Welding Society (AWS) Foundation is a good example of an organisation supporting programmes to ensure the growth and development of the welding industry through research and educational opportunities. Every year the AWS Foundation awards more than $3,5m to students and industry professionals who wish to pursue their aspirations to meet the challenges ahead.
- This funding, obtained by donations from individuals and companies, enables a wide array of programmes to be implemented. Such programmes include amongst others, free-of-charge educational tools, videos, posters etc, scholarships for individual's education and research opportunities, welding workforce grants to improve and expand training facilities, advice and resources on careers and job opportunities [68].
- The importance of welding to a country is well illustrated with the formation of the Canadian Welding Bureau (CWB) in 1947 to ensure, and assure, the integrity of welded structures in Canada.[69]
- Founded in 2013 by the CWB Group, the CWB Welding Foundation is a Canadian registered charity with nation-wide reach that supports the welding industry by increasing public safety awareness in welding and addressing the welding skilled trade shortage and mismatch in Canada. It develops and facilitates education-based programs and initiatives, beginning in elementary school and into career and professional development and re-skilling, to reduce barriers that affect key groups: elementary, secondary, and post-secondary students and educators, Indigenous women, at-risk youth, disabled, and the disadvantaged. Through welding camps and experiential learning programs, students can explore their interests, build their skills, and consider welding as a potential career [69].
- Together with partners and donors, the Foundation helps schools access modern equipment, infrastructure, consumables and training that reflect industry needs. They also offer professional development to welding instructors and, with support from partners, they provide a range of awards and bursaries to help students continue their journey. The Foundation has made a gallery of success stories relating to their programs available on their website [69].

3.6 Linking with Industry Needs

To make a significant contribution to a country's National Welding Capability (NWC), the first steps should involve conducting a needs analysis on an Industry Sectoral Project (ISP) basis and not simply a generic national approach which often could be termed a scattergun approach. Strategies should be based on reviews of the economic and industrial sector needs of the country. Such ISPs could be part of a national model to obtain support from different industry sector organisations and governments.

Industry Sectors utilising welding include amongst others:

Mining, rail, bridges, buildings, residential and commercial steel construction, pipelines, medical, rolling stock, roads, automotive, aircraft, shipbuilding, trucks/buses, pressure equipment, oil and gas, alumina processing, petrochemical, power generation, coal fired, nuclear, gas turbine, solar energy, wind, renewables, water, aerospace, pharmaceuticals, agriculture and food.

Consider the typical types of organisations which could have a role in this NWC building block as well as progressing the UN SDGs:

- Industry: purchasers, specifiers, owners/end users, project managers, design, fabrication, construction, manufacture, repair and maintenance companies and their related industry associations, compliance, NDT and inspection companies and their related associations, welding equipment and supply companies, material producing and distribution companies, trade unions.
- Research and Development: government supported national laboratories, universities, colleges, private companies, public companies, welding supply companies, national welding institutes/associations/societies.
- Technology Diffusion: government supported national laboratories, universities, colleges, private companies, public companies, welding supply companies, national welding institutes/associations/societies.
- Standards-Making and Regulatory Bodies: Many countries have either established or supported a not-for-profit organisation in the country to coordinate standardisation activities and facilitate the development of national standards by working with government, industry and the community. Such organisations have a multitude of committees in numerous industry sectors thus becoming excellent avenues for networking. In some countries the national body may delegate the responsibilities for standards development to organisations with the specific expertise.

- Education and Training: universities, colleges, technical and vocational colleges, schools, private training centres, industrial training centres, education and training industry boards, skills sector councils.
- Qualification and Certification: universities, professional engineering or scientific associations, national welding institutes/associations/societies, compliance, inspection, NDT institutes/associations/societies, accreditation bodies, certification organisations.
- Government Departments: Federal, State and local levels.
  Short, medium and long-term plans for E&T, Skills and Careers with each industry sector would be excellent results [40].
- The E&T, Skills and Careers plans must have industry relevance since if they address the specific needs of a company or industry, they have the potential to raise the level of commercial investment in them. Industry engagement is therefore critical particularly in approaching governments for financial support. By grouping companies in their industry sectors, one can get them thinking strategically about their future needs and hence E&T, technology and R&D requirements [28], [40], [47], [50], [51], [52].
- Continual identification of the E&T, skills and careers needs of the different industry sectors is therefore critical. An Industry Sectoral Project (ISP) approach rather than a national general "scattergun" approach is preferred for optimum results [38], [39], [40].
- Cooperation and collaboration with government and industry organisations will enable industry to effectively influence any established training framework as well as ensure that industry's needs are met and that the education and training system is responsive to industry's needs. Similarly, it could assist in raising small companies understanding of training arrangements and hear and feedback their concerns into the system [32].
- It is also important that the NWC Lead Organisation ensures that it has adequate representation and influence on various boards, councils and committees which are addressing the education, training, skills and careers aspects related to all the different types of welding related people and activities.
- Having an IIW Authorised Nominated Body (ANB) in a country can assist companies to comply with international, European and other product or application standards on requirements for competent personnel e.g. ISO 3834, ISO 14731 [31], [34], [35], [133].
- By meeting personnel requirements of international product/application standards, companies are advantaged in terms of trade and conformity assessment. This in turn adds higher value to an industry's and a company's (including SMEs) capability to compete globally.
- Flexibility of training (in respect of time, scope and location using manufacturers' latest equipment, technologies etc.) needs to be introduced whilst training organisations should be benchmarking against world's best practice and upgrading in all aspects of E&T.
- There is also a need to identify industry skill requirements so that funding can be channelled for training into correct areas to meet the real needs of industry, both immediate and future [40].
- Knowing industry needs are being met will also ensure that more efficient, cost-effective use is made of training funds at training organisations. Studies are needed in a country to build this critical information. For example, investigating how different and/or comparable countries are planning for and managing future E&T, skills and careers requirements [25], [26].
- In most countries, probably 98% of companies are classed as SMEs with the number of employees being relatively small. Many of these SMEs can be grouped either geographically or industry sector-wise into groups which form excellent networks. Unfortunately the companies in such groups are often the ones which are reluctant to contribute financially to developments [16].
- In Australia it appears that 97-98% of companies are classified as Small, Medium, Micro Enterprises (SMMEs) with 60% being companies with less than 10 employees and the remainder with less than 200 employees. Anecdotal evidence could suggest that up to 10% of these may seek to improve themselves through the adoption of proven technology and only 1% are probably prepared to invest in new technology. A challenge in a country is to identify these 1 percenters.
- An important problem is that often, SMEs are not represented on the various committees, skills boards and councils etc, so their voices are not heard and they are not included in key planning programmes, etc, yet they are meant to be key recipients of the results of the training established.
- One solution is to establish a model known as an NWC Industry Specific Group (ISG) which would comprise the technology based SMEs, multi-nationals/major end users, education and training providers and government departments in an area/town/region supported by a technology manager from, or arranged by, the NWC Project Lead Organisation.
- One would then identify areas/towns/regions of the country where the identified training needs of industry

in that area/town/region can be determined and met, as well as technical support for companies can be provided, by the formation of an NWC ISG.
- The network of ISGs then becomes a formidable grouping not just in the identified areas/towns/regions but also on a national basis giving greater opportunities for success with the increased cooperation and collaboration [92].

3.7 Lecturers and Instructors

To supply appropriate training and qualifications for people requires efficient and effective infrastructure including the appropriate number and types of facilities and resources as well as competent instructors, examiners and auditors which are all often considered too costly to establish and maintain in the welding field and hence are often neglected in many countries without significant industry and government funding.

The quality of the lecturers and instructors available for all levels and types of training is one of the most important issues in achieving resulting competent people.
- A shortage of skilled competent lecturers and instructors is often a key problem in a country.
- The industry, government and the teaching profession must place a high value on E&T personnel in terms of remuneration, careers opportunities, support and the working environment. Good education and teaching personnel are often enticed away through higher remuneration packages and better working conditions in industry.
- The promotion of careers opportunities in the E&T organisations is therefore important as well as the training of lecturers and instructors and their continual updating on latest techniques and technologies [41], [42], [43], [45], [46], [53], [54], [55], [56], [57], [60], [91].
- Competent personnel at all E&T types and levels are also needed to identify the E&T required, perform the E&T, deliver the E&T outcomes for personnel in industry either within the E&T organisation or within the companies in industry and assist in it being received, adopted, adapted and implemented successfully to increase company or industry performance. Such types and levels include practical welding instructors, welding inspection and NDT instructors, lecturers for welding coordination and design personnel at technician, technologist and graduate levels as well as research personnel.
- Continuing Professional Development (CPD) programmes are also very important for E&T staff. Besides the continual updating activities previously mentioned, a number of more unusual activities could be introduced. The exchange of people between E&T

Some Potential NWC-SDG Industry Sectoral Project (ISP) Areas

Photos supplied by INOX India

Agriculture & Food

Rail & Road Transport

Water

Energy

Pipelines

Renewables

Building & Construction

Marine Platforms

Pharmaceutical & Medical Devices

Pressure Equipment

Aerospace

organisations and industry is often very beneficial for transferring ideas and knowledge and achieving better outcomes. Sabbaticals which normally apply predominately to university staff, could be introduced for vocational education and training staff, thus allowing such staff to have extended exchange periods as mentioned earlier.

- To maintain better contact with local industry, a percentage of the VET person's employment time could be available for consultancy work within companies.
- Between 2000 and 2008 the Welding Technology Institute of Australia (WTIA) conducted a whole range of industry and research study missions across Europe, Japan, Canada and the USA which included representatives of E&T organisations. Since the timing of these study missions also coincided with the IIW Annual Assembly each year, participation in meetings of the relevant IIW Technical Commissions also took place [128].
- Since 2011 there have been seven IIW Welding Research and Collaboration Colloquia (WRCC) which provided a unique opportunity for technical exchanges between educationalists and researchers from universities, VET, industries and governments in different regions. Similarly, since 1988, over 40 IIW International Congresses have been held across the world to promote information exchange, co-operation and collaboration between countries in different regions of the world.
- The training centre itself must also be of the optimum standard particularly if one wishes to attract the correct level of staff, employers and their trainees. This could involve implementing the principles of ISO 3834 and ISO 14731 within the management and administration of the centre leading to improved quality and productivity in the management and administration. Examples could include improved workshop layouts, preparation, storage and use of consumables and test pieces, destructive and non-destructive testing of weld samples, health and safety aspects, environmental aspects, testing and record keeping of trainees, maintenance and upkeep of training equipment and samples.
- The "Ideal Training Centre" should be a key objective for governments, industry and educationalists. A guidance note on how a practical welding training centre can use the implementation of elements of ISO 3834 " Quality Requirements for Fusion Welding of Metallic Materials" and its various parts and ISO 14731 "Welding coordination: Tasks and responsibilities" to improve its management and performance including quality and productivity is being created.
- The use of training techniques such as Virtual Reality (VR), Augmented Reality (AR) and Virtual Learning Environment (Metaverse) are increasingly being implemented [44], [70], [93], [123], [125]. Such techniques can also be used in national outreach programmes focused on awareness building and "try a trade" welding to attract people particularly in remote and rural areas. By working with a network of partners such as technical educators, technology and innovation leaders and post-secondary administrators, simulators are integrated into learning environments and used at career awareness events and initiatives to introduce young people to welding and joining in a risk-free, confidence-building format [91], [123].
- A flexible approach to delivery using E-Learning materials which can be easily accessed to allow people who are looking to change career, the opportunity to "earn while they learn", coupled with block practical training

CWB Foundation Educator Training Programme

Training of four Tanzanian welders as instructors at SAIW

at weekends or designated periods to complete the programme could be implemented.
- Besides organisations such as AWS, CWB Group, SAIW and IIW-India offering Train the Trainer courses, some welding supply companies offer training to help welding instructors learn effective instructional strategies and access the educational resources to provide future welding professionals with the training to problem-solve and navigate through the steps required to train successful welders.

3.8 Funding

In economics, market failure is a situation in which the allocation of goods and services by a free market is not efficient, often leading to a net social welfare loss. Hence intervention to rectify the situation through funding support. In dealing with governments and industry, one must make sure that you can show the market failure, the identified and verified needs of the country and or industry, the proposed solutions to rectify the market failure, support from industry and other appropriate organisations and an acceptable return on the government and industry financial support.

This is often the basis on which many funding support mechanisms are implemented both nationally and internationally by governments, aid agencies and industry organisations.

- Practical welding training is often viewed by management of E&T organisations as a high-cost area with less financial return than other courses with high student numbers, high income and low costs;
- Good marketing of the importance of welding to each industry sector and the country can have a very positive effect on the availability of funding for training [39], [40].
- How to overcome the obstacles of having short-term Governments and hence short-term policies on funding could be a problem. To ensure sustainable funding, governments and industries should consider having a 20 year cross party agreement for an ongoing training strategy, fully funded to ensure skills shortages are met, and with an infrastructure established with a proven track record on results and worth to the economy of the country.
- Identification of national, local and international sources of funding for E&T is also essential [100], [101], [102], [103], [104], [105]. These could also include Aid and Donor organisations such as. AFD, CIDA, CIDCA, EURADA, IAEA, ILO, FCDO UK, GIZ, OECD, UNCTAD, JICA, UNDP, UNESCO, UNICEF, UNIDO, USAID, World Bank Group. See pages 71 to 74, Section 3.8, in the IIW NWC-SDGs Long Report Volume 2. https://iiwelding.org/iiw-jointothefuture/iiw-and-sustainable-development/
- Examples of some success stories with aid and donor agencies are shown in [99], [105] and [106]. If the success of NWC Project activities can be included in government and industry documents and promoted by such organisations, this will enhance the credibility of the project significantly [29], [106], [109].
- Monitoring and analysing grant funding programmes in other countries is important particularly where governments are giving financial support to E&T due to "market failure". Government grant programmes with matching industry funding were implemented in Australia with great success [94], [95], [96], [107], and in South Africa [40], [110], [111].
- In general, governments like to be approached not just with problems but with solutions to the problems including good returns on any financial investment which it makes. This could include recommending new grant programmes particularly if industry financial support is also forthcoming.
- Monitoring of grant programmes including government reports analysing the results of the various programmes is very important particularly if good reviews of your project are given [29], [109].
- With government grant funding, it is important to show a good return on the government's or industry's financial investment. In the Australian examples above, a return of a minimum 10:1 was expected and achieved using calculation methods as mentioned in [16] and [17] and agreed with government and industry.
- Creating a skills respect culture for governments and industry to invest in E&T and skills development is very important [19], [20], [21], [22].
- Creating a culture for governments and industry to invest in raising the image of welding-related job opportunities which normally may not have the same star appeal as say job opportunities in other industry sectors helps attract students to welding [24], [39], [40].
- By charging market related fees, and delivering credible products and services, E&T can be self-financing in particular areas. Experience has shown that in Australia and South Africa at all levels above the practical welding level, employers paid for approximately 95% of employees to attend credible courses for welding coordination, inspection, design and other personnel

including specialised courses. Such funding support would include course fees, travel and accommodation expenses as well as the time spent away from work. If the costs were very significant, some employers could insist on the employee signing a contract to remain in the company's employ for a specified time after qualifying.

- Digital learning and AI-driven training are changing welding education by making it more accessible, cost-effective, and immersive. Traditional training, while effective, often involves high material costs, safety risks, and inconsistencies in instruction. With virtual reality (VR), augmented reality (AR), and artificial intelligence (AI), trainees can develop their skills in controlled environments, reducing waste and improving learning outcomes.
- It is at the practical welding and apprenticeship levels that funding is often a problem both for the trainee and the E&T supplier. Probably the correct types, magnitude and sustainability of apprenticeship funding will be one of the biggest funding challenges in most countries.
- In some countries, organisations have been established which recruit and train apprentices for future employment in companies. In the UK, organisations such as the WEC Group Engineering Academy [112] and CATCH [113] offer such services. Such approaches could be used as models in establishing similar organisations in a country.
- Some countries also have industry sector organisations which use a levy system to help its industry to overcome the main workforce challenges of meeting the requirements for skilled people at all levels. For example, the Engineering Construction Industry Training Board (ECTIB) had forecast that 25, 000 additional workers would be needed for major projects in its industry sector by 2026. By having a levy on engineering construction industry employers and steered by a Board comprised of senior leaders from industry, needs analyses, business plans, strategies, grants, new entrant programmes, regional skills hub funding and many other activities are being funded[114].
- There are also similar examples in the USA and Canada. For example, The United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada ("UA") has an industry sector approach as well as regional hubs in both countries. The UA spends over $100 million annually on training program efforts involving approximately 100, 000 journeymen and apprentices in over 400 local training facilities at any given time. In addition to its five-year apprenticeship programs, centres offer continuing education opportunities that could include journeymen training and certification, as well as an associate degree program [115].
- In South Africa in the 1980s, a number of major "capex" infrastructure projects were planned and via a levy system, extensive amounts of money were set aside to train people for these projects. A South African Fabrication and Construction Training Trust Fund (SAFCTF) was established and together with SAIW a very successful welding industry related training programme was implemented for the first major capex infrastructure project (Mossgas). Unfortunately, the government and industry did not proceed with the next planned capex infrastructure projects so the training fund was disbanded and such targeted industry training on a major scale did not take place. The concept of an industry sectoral project approach was very good and worth considering if such opportunities arise again in a country. This was probably the first time in South Africa that the construction companies had joined together to properly coordinate the personnel requirements for a big project [40], [110], [111].

Some more coordinated basic approaches by the NWC Lead Organisation or individual training organisations using a national, regional or industry sector project approach to reduce E&T costs could include:

- Companies in industry often sponsor activities or specific roles such as the 'Chair' of an activity often to ensure such activities take place or due to it enhancing their standing in the industry community. Sasol in South Africa sponsored the Chair of Welding Engineering at SAIW for a three year period and the South African Rolled Steel Producers Coordinating Council (SARSPCC) financially supported the SAIW Welding Industries Training and Technology Fund [130], [131].
- Companies producing materials which are welded or selling equipment (welding, NDT etc.) can be pursued to contribute materials and equipment to a project whether in education, training, research or development. Such companies see the benefits of this as part of their marketing and promotion. Companies have ways of donating materials or lending equipment which can often dovetail in with their income tax regimes.
- Organisations such as AWS and CWB Group, amongst others, have programmes to assist schools and colleges fund resources and facilities to assist with the E, T, Q and C activities [68], [76].
- In a properly coordinated national, regional or industry sector project approach, scrap materials or consumables left over from industry fabrication or construc-

tion activities, PPE and other safety items as well as services such as testing of welders and welding procedures at free or discounted prices, training of lecturers and instructors including upgrading, as well as accreditation and certification of training centres can be negotiated.

- In many countries, the government pays for the infrastructure such as schools, laboratories, testing equipment etc, so it wishes to optimise the use of such infrastructure. In NSW TAFES in Australia, private providers are allowed to use some TAFE facilities and resources outside the hours being used by TAFE so as not to conflict with TAFE activities. There is also no reason why such facilities in any country could not be considered for use on a 24 hours a day seven days a week basis (24/7) if demand requires it.

3.9 Cooperation and Collaboration

Cooperation and collaboration both nationally and internationally are critical to the success of the NWC. Important recommendations which emanate from cooperation and collaboration activities are the need for periodic strategic planning exercises involving a range of people and organisations, the need to conduct periodic surveys/needs analysis of industries' requirements, the importance of issuing regular progress reports and results of independent audits/reviews of such progress, increasing industry involvement in projects, products and services, stable finances and not asking people to put money into a bottomless pit by continually losing money, as well as being able to show the value to the country and individuals of the benefits from the projects and initiatives. Many opportunities exist for cooperation and collaboration and a few are shown below.

- Linking in with international groups to coordinate E&T, skills and careers development in welding [13], [31].
- Investigating how a country can have E&T and skills development cooperation and collaboration with another country's organisations [28].
- International marketing (collaboration, funding etc) [31].
- Sharing of available E&T facilities, expertise and resources both in a country and with other countries [45], [46], [91].
- Linking in with international experts to bring their knowledge and expertise to a country [28].
- Creating more effective links between public and private industry E&T sectors [32].
- Working with organisations and communities in rural, less serviced regions or facilities, using activities such as mobile careers units, mobile training units, "Try-a-Trade" using simulators [71], [72], [91].
- Creating routes for more effective E&T and skills development cooperation and collaboration [28], [32].
- Through well thought out collaborative and cooperative activities, welding technology awareness training could be implemented even in the formative years of schooling and throughout secondary education. This may encourage students to develop careers engaging welding technologies with a well-structured hierarchical pattern leading to high achievements [23], [24], [57].
- Using webinars and guest speakers including retirees, to inform young people about their working lives, projects and experiences in the welding industry.
- Having reports which could also be used as models for implementation in other countries. In particular, such reports can be used to identify the industry skills needs and help people at various levels and situations obtain the skills required for the potential employment opportunities. A variety of reports and methods of disseminating them exist.
  1. A Welding Industry Employment and Salary Report which would provide information on the employment landscape of welding professionals in the country as well as giving insight into different welding career paths by examining welding professionals' employment and salary profiles [73].
  2. An industry report demonstrating an ongoing commitment to providing professional services that aid in the safety and quality of welding and the success of the welding industry as well as the need to ensure sufficient people are entering the industry [68], [74], [75], [76].
  3. Reporting back to the community on progress and achievements is also very important and good examples are the CWB Association Impact Report 2021-2022 [75], the CWB Foundation Ten Year 2013-2023 Report [76] and the Post-Secondary Applied Research and Program Support Report as well as the AWS Foundation Impact Reports [68].
  4. Reporting back to appropriate stakeholders on the key items pertinent to them. For example, government grants will have reporting procedures both on project progress and on project finances [94], [95], [96], [107].
  5. With the wide range of stakeholders involved and the need for excellent communications, a variety of reports will need to be implemented for the appropriate groups.

6. Releasing the progress reports on government/ industry funded training as well as high level external audits on the success and value of the results of the training can be very effective both in terms of public credibility as well as obtaining further support [40], [110], [111].
7. Having national or regional hybrid Conferences each year in the country covering the successes and challenges of the preceding year would be of great benefit by allowing as many people as possible to attend.
8. At the International level, IIW has forums such as Commission XIV, International Congresses and Conferences which if held as hybrid events enable many people and organisations to become involved to receive reports of successes, opportunities and challenges.
9. Webinars have become a very good activity for transferring knowledge and information. A very good example of assisting developing nations in particular, is that of the Welding Innovations Network (WIN) whereby the CWB Group (Canada), The Indian Institute of Welding (IIW-India), Heavy Engineering Research Association (HERA), New Zealand, and the Southern African Institute of Welding (SAIW) hold free webinars across four time zones thus allowing any person globally to access the knowledge and information.

- Developed countries could also give guidance to other countries on the importance to have legally binding formal agreements where Intellectual Property (IP), commercialisation, consortia alliances amongst others are implemented;
- Advice for a developing country on the need to aim to have financial stability and sustainability in an NWC Lead Organisation without the reliance on on-going government grants for sustainability. There are examples throughout the world of countries which have succeeded in achieving this and these can be used as guides to achieve such sustainability;
- Having people who can promote stakeholder engagement and advocacy through engaging with government officials and bureaucrats in relevant departments to promote standards, certification, training, compliance and support for welding related personnel including the skilled trades;
- Cooperation and Collaboration in ethics in education and training is very important to maintain credibility in any system.
  1. There are examples across the world of students, examination bodies, certification bodies abusing the system so strict governance and quality management systems are implemented to prevent corrupt practices. Cheating in examinations is a common occurrence and with the significant increase in the use of Artificial Intelligence, remote teaching, learning and examinations, reports of such cheating have increased [80].
  2. Examples of people allegedly falsifying certificates or misrepresenting their qualifications, certifications, experiences and positions held both in industry, professional institutions and academia or have conflicts of interest, do occur at various levels of personnel and in organisations.
  3. Care must also be taken however, since particularly after the Covid Pandemic, there are reports that student discontent with the quality of teaching has risen [81] and online courses which were supposed to bring higher education within the reach of everyone, have dropout rates that typically exceed 90% [82]. Some concerns are that increased profits for individuals and teaching organisations is a key driver. In general, universities now have both Student and Staff Academic Integrity Policies to attempt to overcome problems involving staff and students https://policies.une.edu.au/view.current.php?id=00304
  4. A useful approach is to look for 'ethical leadership' in people at all levels. The most successful leaders inspire others to embrace a common goal through recognition of shared values. They build and maintain effective relationships by living and leading with integrity. The Royal Academy of Engineering in the UK recently had a report published on ethics in the engineering profession [83].

With delegates from Department of Energy and Electricity, NECSA and SAIW are, far left: Michel WARNAU, IAEA Section Head for Technical Cooperation in Africa; and middle front , Lerato Makgae, IAEA Chief Director, National Liaison Office.

5. The International Organisation for Standardization (ISO) has also introduced standards which involve ethical behaviour. ISO 19600:2014 – Compliance Management Systems-Guidelines and ISO 26000 Social Responsibility Guidance Document.
6. In the welding related institutions, codes of ethics and government regulations normally enable personnel to be accountable for their actions [108]. Welding related professionals have a duty to uphold the highest standards of professional conduct including openness, fairness, honesty, integrity, respect for life, law, the environment and public good, accuracy and rigour, leadership and communication.
   Fidelity to public needs, including safety, health and welfare, needs to be also shown in the welding institutions where at every personnel level, qualifications and certifications plus codes of ethics have been introduced to ensure devotion to high ideals of personal honour and professional integrity, knowledge of developments in the area of professional relevance to any services that are undertaken and competence in the performance of any professional services.
7. The teaching of the need for ethics including good governance should be a compulsory short course of a few hours appropriate duration at all levels of education and training including real life examples of abuse so that the students are better prepared for being able to handle future situations which they might find themselves in [124].Such examples of abuse are often mentioned informally, but a structured approach would have more beneficial results for future prevention.

- The recent announcement that South Africa's Energy Minister Kgosientsho Ramokgopa will unveil details of a new 2 500MW nuclear power plant means that skills, ethics and safety standards around South Africa's nuclear industry are more important than ever.
- In line with this, the Southern African Institute of Welding (SAIW) is powering ahead with its collaboration with the International Atomic Energy Agency (IAEA), and the Nuclear Energy Council of South Africa (Necsa). Facilitated by the Department of Energy, this initiative is in the process of establishing a Nuclear School of Excellence, within the Necsa Learning Academy, and introducing advanced training techniques to bolster the continent's nuclear sector (see photo below).
- The School of Excellence is scheduled to commence in the first half of 2025 and will offer a range of specialised courses focusing on welding and non-destructive testing within the nuclear sector, nuclear safety, precision measurement, and consultancy services.
  https://www.saiw.co.za/saiw-enhances-nuclear-standards-in-africa-through-strategic-collaboration/

3.10 The Importance of UN SDG 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

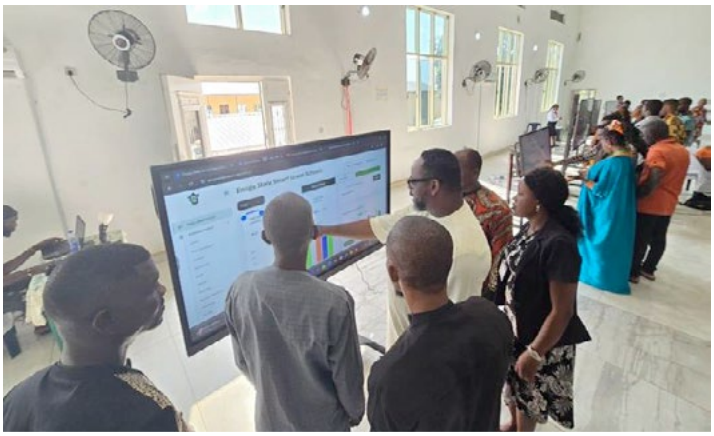
The UNIDO report [117], UNDP report [120], World Economic Forum Report [126] and the African Human Capital Heads of State Summit in 2023 [129] help identify challenges which could be turned into Sustainable solutions. UN SDG 4 can have a significant effect on all the other 16 UN SDGs.

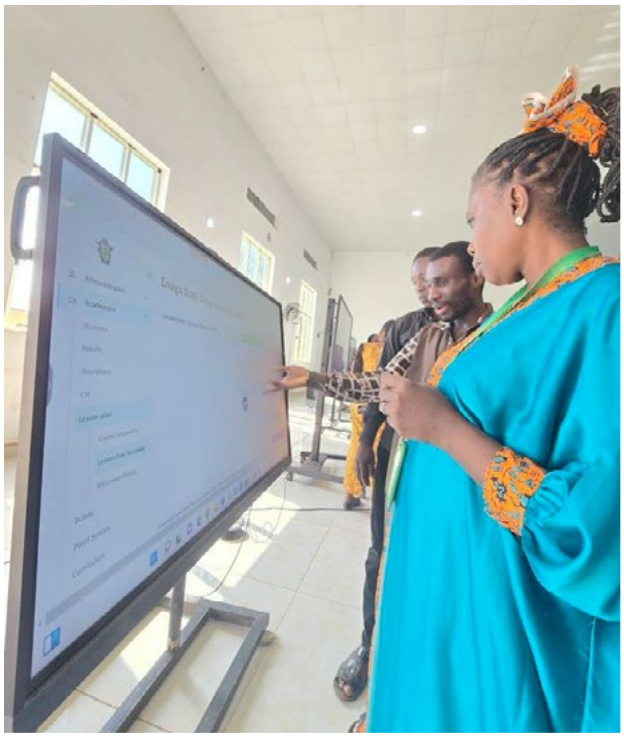
- In all countries, education is a key activity to help people to get out of poverty. Promoting education and training which results in credible personnel qualifications and certifications, which should also be portable both within a country and overseas, as well as if appropriate, being recognised on an international basis, is important to help people obtain work and develop careers.
- Results of Federal, State and Local Government education and training (E&T) initiatives in different countries related to UN SDG 4, as well as success stories from local and overseas sources, can all be used to show the importance of education, training, skills and careers to a country. Sustainable Development Report 2023 (sdgindex.org) For this to continue to improve however, the outcome orientated targets for UN SDG 4 must be achieved.
- These could include improved resources and facilities, free primary and secondary education, equal access to quality pre-primary education, affordable technical, vocational and higher education, increased number of people with relevant skills for financial success, elimination of all discrimination in education, universal literacy and numeracy and education for sustainable development and global citizenship.
- Developed countries can play a key role in assisting developing countries implement projects which could easily lead to improving lifelong learning. These include efficient and economical education and training via upgrading of schools and educational facilities, modern training course resources, remote training, education and examination methods, inexpensive virtual reality training, grants, scholarships and careers opportunities for a diverse range of people.

- Notwithstanding the above, in many developing countries, regional disparities can be significant in terms of children being able to read and write. Much of this is attributed to poor attendance levels at school and leads on to the meagre participation of youth and adults in formal and non-formal education and training. A major challenge is to improve participation in education at all levels substantially. Reference [77] shows some of the possible challenges in a country's VET system.
- The Nigerian Federal Government has embarked on a revamp of the basic education curriculum from January 2025 to enhance the employability and practical skills of students in primary and junior schools, both public and private. This will also involve teacher training, the development of instructional guides and infrastructure improvements. The curriculum aims to equip Nigerian students with modern skills such as digital literacy, robotics, and various vocational and entrepreneurship opportunities making students more self-reliant and competitive, aligning with global standards. https://www.educationvanguard.com.ng/2024/10/14/fg-introduces-15-skills-in-new-basic-education-curriculum/
- A number of projects for improving education and training at the school level in developing countries have been introduced with excellent results as quoted by Bjorn Lomborg in various studies [118]. One of the most phenomenal solutions was to improve school learning by using tablets with educational software for one hour per day. This makes each student learn much faster because the tablet is teaching at exactly the level adjusted to the student. In Malawi, this was identified by economists as one of the best policies for Malawi with every dollar spent teaching the student better with tablets would deliver an amazing $106 of long term higher productivity. Malawi has already put almost half a million children in front of educational tablets and the goal is to get adaptive learning on tablets to all 3.5 million children in the first four grades in this decade [118].
- India has embraced a cheaper lower-tech solution in which schools shuffle students' classes for one hour each day so all students go to the class that is at their actual learning level. It needs no new technology, it is also much cheaper and one year of this approach has been shown to have the learning equivalent to two years of normal schooling. Colombia is now trialling this approach to improve literacy in low-income communities and rural schools [118]. Teaching students at their own level is incredibly effective.
- To ensure a steady flow of students into the welding industry in developing countries, it is therefore essential that young people at primary and secondary school levels are given every opportunity to progress positively in their education. The link below gives a summary document of a model and some global work particularly being applied in Africa. It includes links to

Featured Technology being introduced includes:

- WOWBiiInteractive Boards
- EDVES AI-Supported Lesson Development Tool
- EDVES Assessment Platform
- Smart Green School Innovation Studios
- Digital and Multimedia Libraries





a new book and also a podcast that does a good job summarizing the project model that is being explored. https://docs.google.com/document/d/1nem_tTbI-2YrplQLtxkMCFWGAPq-sEdQjs5MEipUt5ZE/edit?usp=sharing

- The link below shows a white paper on the model in Nigeria. The links to workforce education are explicitly designed through the PEARL projects and digital badges. The project is currently working on on-boarding teachers and Experiential Learning (EL) Leaders. A Centre for Experiential Learning and Innovation (CELI) will engage with employers and stakeholders to customize projects and badges based on workforce needs and opportunities. Such a Centre is a useful design solution- a partner in Uganda is also developing a Centre with a focus on sustainable agriculture. It is useful to manage public-private partnerships and also to support professional development and research. https://assets-global.website-files.com/653c514e62e72b8ce10f073a/65563098a262d8724d9c76cb_Enugu%20Education%20Transformation%20Plan.pdf
- The first PEARL Institute was held in November, 2024 and trained 265 of the top-scoring teachers in the Experiential Learning Curriculum, equipping them with the skills and knowledge to help facilitate project-based learning within the state of Enugu, Nigeria, in preparation for the 260 new schools that are coming online in the next 2 years. The Institute also engaged stakeholders with a focus on building an Experiential Learning ecosystem towards connecting EL with economic and sustainable development. In November, 2024, the Governor of Enugu mandated that all State-supported schools including vocational and tertiary integrate experiential learning within their programs and curricula. Commissioner of Education and University at Buffalo Professor Ndubueze Mbah is leading the Smart Green School Initiative and can be reached for additional information. https://www.linkedin.com/in/prof-ndubueze-leonard-mbah-05531253 https://drive.google.com/file/d/1SFD7oksnjw6qH-KQCKiS8gIUXVSIiMDLf/view?usp=sharing (Institute Report/ slides)

  The Enugu Curriculum also includes integrated technology – every classroom has an interactive smart board (Wowbii) and teachers and students have (or will have) tablets. The technology is a critical component of the model and is making a huge difference for both the students and the teachers. The schools also have digital librarians and a digital library. The library using an interesting offline technology called Kolibri allows ebooks and resources to be loaded onto student tablets and then read offline since there is limited and sporadic connectivity. UB Digital Librarian, Cindi Tysick (https://library.buffalo.edu/staff/ctysick) is leading this work and can be contacted for additional information.

Part 4: Typical Plan-On-A-Page: Goal, Objectives and Key Strategies

A typical **Goal** could be: **To Implement and Sustain the Education, Training, Skills and Careers Building Block of a National Welding Capability (NWC)**

To achieve the **Goal** of implementing the Education, Training, Skills and Careers Building Block, the following typical **Objectives** might need to be realised:

Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Each **Objective** requires a number of key strategies to be put in place so that it will be successfully achieved. For easy reference and use, the Goal, Objectives and suggested strategies have been put into a **Plan-on-a-Page** shown below. This Plan-on-a-Page becomes the focal point from which all further actions emanate.

- The benefits of the Plan-on-a-Page and associated action plans include amongst others:
  - continually clarifying the thoughts of all NWC Project participants as a road map in the efforts to create a successful NWC for the country;
  - showing the progress, efficiencies, performance and quality of outcomes of the NWC Project on an on-going basis through the strategies being implemented and their links to the action or operational plans;
  - assisting any person or organisation to understand why the NWC Project exists, what is expected from the Project, how it will achieve its expectations and the potential role for such a person or organisation to be involved in, or invest in, the achievement of the NWC Project's expected outcomes.
- Such people and organisations may include, amongst others:
  - a new, existing or potential participant in the NWC Project;
  - a potential new organisation in the NWC Project;
  - government and aid agency representatives;
  - new NWC Project staff members;
  - any person interested in any aspect of the NWC Project;
  - industry, research and educational representatives considering involvement
  - other interested associations, societies, institutes or groups
  - other nations which may wish to reciprocate on the development of their NWCs.
- Other benefits of the Plan-on-a-Page include:
  - improving the image of both welding and the country's NWC objectives by showing people that the NWC Project consists of a professional, progressive, modern, pro-active, enthusiastic group of organisations, including industry champions and volunteers, worthy of support and involvement;
  - enabling any Board, committee, working group, organisation or individual involved in the NWC Project to know and understand their responsibilities and performance being achieved as well as monitor the success of activities they are involved with;
  - determining future NWC Project resources, e.g. staff requirements, NWC project membership, amongst others.
  - being able to capture the benefits and value of a wide range of NWC related activities as well as enabling participants or potential participants to understand and demonstrate the value of their participation in the NWC. This can result in increased participation by NWC Member representatives in the NWC or by new participants becoming involved.

Typical Plan-On-A-Page: Goal, Objectives and Key Strategies

GOAL: To Implement and Sustain the Education, Training, Skills and Careers Building Block of a National Welding Capability (NWC).				
Objective A	Objective B	Objective C	Objective D	Objective E
To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development	To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations	To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations	To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year	To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks
Key Strategies	Key Strategies	Key Strategies	Key Strategies	Key Strategies
1A Examine and analyse how other countries have implemented successful E&T, Skills and Careers models and move towards developing a best practice model for application in the country.	**1B** Establish an Education, Training, Skills and Careers Board, and appropriate committees, at the NWC Lead Organisation including representation of all relevant parties.	**1C** Assist E&T organisations and individuals (including in recruitment, careers development and training) in ensuring sufficient numbers, types and levels of lecturers and trainers are available to meet the identified industry needs.	**1D** Identify each year, the estimated numbers of personnel requiring welding-related E&T at all levels and types of courses in each industry sector including qualification and certification requirements.	**1E** Implement the appropriate processes for agreements and collaboration on items such as marketing and promotion, IP, technology transfer and diffusion, commercialisation and other legal issues related to E&T outcomes.
2A Continually examine and analyse the different E&T, Skills and Careers funding programmes implemented by Governments (all types e.g. Federal, State and Local), industry bodies, aid agencies and independent sources.	**2B** Perform a situation analysis on an annual basis on which E&T, Skills and Careers centres, facilities, resources, expertise, capabilities and capacities are presently available in the country to assist the NWC Project.	**2C** Identify the training and qualification requirements for lecturers and trainers and working with E&T organisations implement the necessary training and examinations for them on an ongoing basis.	**2D** Acquire/align training resources (lectures and materials) and introduce the programmes to meet the need for inspection personnel in welding, NDT, pressure equipment, fabrication, construction, corrosion and bolting.	**2E** Create the communication processes, market awareness and training programmes for the E&T careers outcomes to achieve optimum take-up by groups such as school children, school leavers, women and girls, young professionals, older people such as retirees, immigrants, refugees, prisoners and people with special needs, amongst others.

Key Strategies	Key Strategies	Key Strategies	Key Strategies	Key Strategies
3A Draw up and implement a structure and programme to obtain participation by companies in the ongoing E&T, Skills and Careers requirements/ needs analyses and funding proposals including the benefits of networking and collaboration, sharing funding contributions, sharing resources and facilities and commercial benefits.	**3B** Harness industry, public and private E&T, Skills and Careers organisations and their capabilities regarding E&T, skills and careers, capacities, technologies, facilities, equipment, lecturers and trainers competencies by having a full ongoing record of such information and creating local and international networks and alliances to maximise use of the capabilities.	**3C** Create and communicate the models for careers for all types and levels of welding-related personnel including the different jobs available and the paths and routes to achieving them.	**3D** Acquire/align training resources (lectures and materials) and introduce the programmes to meet the need for welding coordination personnel for IWE, IWT, IWS, IWP, and supervisors for manufacturing, fabrication, construction, repair and maintenance.	**3E** Establish and implement methods for assessing and /or measuring the value and benefits of the investment in E&T, Skills and Careers by the individual companies, industry sectors and governments
4A Identify, establish and workshop with industry cluster groups including geographical, sectoral, asset owners, users and suppliers to ascertain their ongoing E&T, Skills and Careers needs.	**4B** Cooperate and collaborate with the government and industry organisations with infrastructure already established and responsible for welding education, training, qualification and certification of all types of welding related personnel including apprenticeships.	**4C** Introduce programmes for the exchange of E&T, Skills and Careers personnel between local E&T, Skills and Careers organisations and industry	**4D** Acquire/align training resources (lectures and materials) and introduce the programmes to meet the need for design and research personnel in welding-related manufacturing, fabrication, construction, repair and maintenance.	**4E** Create and maintain a gallery of E&T, Skills and Careers development success stories including value and benefits to all appropriate parties including the country.
5A Compile and agree on an 'E&T, Skills and Careers Building Block' model to take to Government and industry leaders for their support, including financial, and implementation.	**5B** Analyse the present situation and source solutions on an ongoing basis for what is required to upgrade each E&T, Skills and Careers organisation in the NWC Project network to meet the future needs of industry.	**5C** Implement processes such as study missions both in and out of the country, technology diffusion mechanisms, exposure to overseas and local experts, whereby lecturers and trainers will be continually updated on latest technologies and teaching techniques	**5D** Acquire/align training resources (lectures and materials) and introduce short programmes to cover personnel not included in strategies 2D, 3D and 4D.	**5E** Promote and support the involvement of E&T, Skills and Careers` personnel in the work of the IIW technical working units, national industry boards, standards committees and government and industry initiatives.

Key Strategies	Key Strategies	Key Strategies	Key Strategies	Key Strategies
6A Create an income and expenditure budget and action plan for the implementation and sustainment of the best practice NWC E&T, Skills and Careers model.	**6B** Perform future directions analyses of technologies so that industry's future E&T, Skills and Careers requirements are met at the appropriate time and where necessary assist in strategies 4B and 5B.	**6C** Ensure all E&T, Skills and Careers organisations have direct or indirect representation on the various E&T, Skills and Careers Board related committees established as part of the NWC 'E&T, Skills and Careers Building Block' model agreed in Strategy 5A.	**6D** Draw up guidelines and assist with obtaining resources for organisations to establish, manage and sustain the ideal practical welding training centre at each level and type of training being undertaken.	**6E** Produce ongoing reports, including an annual report, showing progress and achievements of the overall E&T, Skills and Careers model including the value and benefits to the country, industry, governments, individuals and other stakeholders.
7A Align the NWC E&T, Skills and Careers model with the UN Sustainable Development Goals (SDGs) where appropriate needs, resources and viable projects are present.	**7B** Introduce and sustain a cohesive network of infrastructure, facilities and resources within main stream education, further education and higher education to ensure that the career paths and routes are available for lifelong learning career progression and job opportunities.	**7C** Create and maintain a network of mentors for students and companies within both VET and academia systems as well as industry.	**7D** Implement reward and appreciation programmes and processes for people and organisations such as awards programmes, grants, skills competitions, welded art exhibitions and competitions.	**7E** Promote and market the E&T, Skills and Careers activities of the organisations in the NWC Project network including raising the importance of welding and image of welding as a career.

Part 5: Examples of Action Plans for Each Objective and Strategy from the Plan-On-A-Page Including References and Links for Each Strategy

The start of a typical **NWC Lead Organisation Action Plan** is shown in the examples below for each Strategy in each Objective. Each Action Plan then becomes a 'living' document which may be continually updated and shared with the NWC Project team as a communication tool. Each Strategy can have any number of applicable actions. Only a few actions are shown as ideas in these examples below since it is at the discretion of the NWC project leaders as to what, and how many, actions to take for each strategy.

Examples of documents, references, links, reports and other resources which might be useful are shown under each Action Plan. Such resources can be used at the discretion of the reader for information to assist them in implementing the strategy. Many of these references are not included in the numbered references in the text in Parts 1, 2 and 3.

The numbered references and links shown in Part 6 are those applicable to the text in the Foreword and Parts 1, 2 and 3. Part 7 shows references attributed to specific countries.

The listings of references and links which may be relevant in supporting each strategy in the Plan-on-a-Page may be:

- examples of the experiences of individuals or organisations in implementing aspects of that particular strategy;
- information available which can provide background from governments or industry on aspects appertaining to the particular strategy;
- documents such as standards, specifications, forms, diagrams from existing or past activities to assist with that strategy;
- papers, books, magazines, videos, training course materials and other media resources etc. which give information on particular aspects and related activities to the strategy; and
- websites, libraries, companies and other direct links where information such as the above can be directly obtained

Where a document is available online, the title is hyperlinked to the specific resource.

Where possible, IIW has attempted to obtain scanned copies of documents which do not have hyperlinks and has put them into the IIW NWC Resource Centre with an appropriate number which is linked in this document to the Reference.

Where there is no hyperlink nor IIW NWC Resource Centre number, the cited document is recommended but must be sourced independently from the owner or publisher of the document as shown since IIW is not able to provide a copy of that particular document.

Users of this NWC Guidance Note can use, adapt and expand the information including Objectives and Strategies and Action Plans to suit their own individual needs. A questionnaire used by the Author with various countries is also useful to assist in identifying such needs and challenges [122].

Many of the documents are from the Author's experiences and any person is welcome to send references (documents or links) to the Author and IIW Secretariat to be considered for inclusion in the updating of the Guidance Note.

In the IIW NWC-SDGs Report "**The Importance of a Country's Welding Industry, its National Welding Capability (NWC) and their Significance to the UN Sustainable Development Goals (SDGs)**" nearly 200 linked references are shown on pages 50 to 57 of the Long Report Volume 2 "Potential National Welding Capability Welding Industry Projects and Resources" https://iiwelding.org/iiw-jointothefuture/iiw-and-sustainable-development/

Note: Under the heading "By Whom" in every Action Plan Table, the CEO of the NWC Lead Organisation has been put in in every action simply as an example. Obviously, for each Action, a person may be delegated by the CEO to be responsible for that action and the action plan changed accordingly from CEO to that person's designation.

Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Strategy 1A: Examine and analyse how other countries have implemented successful E&T, Skills and Careers models and move towards developing a best practice model for application in the country.

Action – What		By Whom	When
1	Contact the International Institute of Welding (IIW) to obtain contact details of key people in different countries who can assist with this information. https://iiwelding.org/	CEO	
2	Contact other countries of your choice and obtain information to investigate and analyse their systems. https://iiwelding.org/	CEO	
3	Based on the Author's experiences, the following IIW members have a significant amount of information available publically and easy to access.	CEO	
4	Contact the German Welding Society (DVS) and obtain information to investigate and analyse the German system. https://www.dvs-home.de/en/	CEO	
5	Contact TWI Ltd UK and obtain information to investigate and analyse the UK system. https://www.twi-global.com/contact/twi-addresses/united-kingdom	CEO	
6	Contact the CWB Group, Canada, and obtain information to investigate and analyse the Canadian system. https://www.cwbgroup.org/	CEO	
7	Contact the American Welding Society (AWS) and obtain information to investigate and analyse the US system. https://www.aws.org/	CEO	
8	Contact the Japan Welding Society (JWS) and obtain information to investigate and analyse the Japanese system. https://en.jweld.jp/	CEO	
9	Contact the Southern African Institute of Welding (SAIW) and obtain information to investigate and analyse the South African system. https://www.saiw.co.za/	CEO	
10	Contact the Heavy Engineering Research Association (HERA) and obtain information to investigate and analyse the New Zealand system.	CEO	
11	Contact the European Welding Federation (EWF) and obtain information to investigate and analyse how a regional organisation functions. https://www.ewf.be/	CEO	
11	Compare and contrast the different models highlighting key elements in each system which may be useful to use in your country's model.	CEO	
12	Contact the Author if you wish to discuss possible other contacts, resources and ideas.	CEO	
13	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- DVS German Welding Society, Research/Technology/Education. IN FOCUS. Welding Qualification in the DVS. Companies-Procedures-Personnel. www.dvs-ev.de https://www.die-verbindungs-spezialisten.de/index.php?id=2740
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- Barnett, D., Lighting the Flame – The History of Welding in Australia, Published by WTIA 2014 ISBN 978-1-920761-99-8.
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Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Strategy 2A: Continually examine and analyse the different E&T, Skills and Careers funding programmes implemented by Governments (all types e.g. Federal, State and Local), industry bodies, aid agencies and independent sources.

Action – What		By Whom	When
1	Form a group from within the NWC Lead Organisation E&T, Skills and Careers Board to produce and implement an ongoing plan to regularly check with government departments the funding programmes becoming available in the country or internationally and to advise the CEO or his nominated representative on people who to contact.	CEO	
2	Investigate and list all potential industry bodies, training boards, skills sector councils, companies, independent aid agencies and Foundations from where funding might be obtained for possible future projects. The NWC Lead Organisation in the country could seek to work with donor and aid organisations such as AFD, CIDA, CIDCA, EURADA, IAEA, ILO, FCDO UK, GIZ, OECD, UNCTAD, JICA, UNDP, UNESCO, UNICEF, UNIDO, USAID, World Bank Group. See pages 71 to 74, Section 3.8, in the IIW NWC-SDGs Long Report Volume 2.	CEO	
3	Plan and implement an ongoing programme to meet with government(s), national and international aid representatives to obtain better explanations and more detail on different programmes both presently available, becoming available, or programmes government may be interested in supporting if put forward to it by the NWC Lead Organisation particularly to support the E&T, Skills and Careers Model in Strategy 5A.	CEO	
4	Plan and implement an ongoing programme to meet with representatives of non-government organisations where funding programmes are or might become available particularly to support the E&T, Skills and Careers Model in Strategy 5A.	CEO	
5	Create a data-base of contacts at all organisations contacted and which may have the potential to provide funding including feedback of what was achieved at each on-going contact or meeting with them.	CEO	
6	Create confidential reports giving feedback to key NWC Project people in areas for which funding may be being sought including other potential projects which might be supported.	CEO	
7	Where relevant, approach Governments for financial support for E&T, Skills and Careers projects developed in the NWC Project even if no appropriate government programmes presently exist. Governments often welcome new innovative ideas for grant programmes.	CEO	

Action – What		By Whom	When
8	In a properly coordinated national, regional or industry sector project approach, create guidelines on how the NWC Lead Organisation or individual training organisations can approach companies or organisations to obtain either funding or materials/services in lieu of funding as shown below, and draw up a plan and enact them: • sponsor activities or specific roles such as the 'Chair' of an activity or secondment of personnel. • contribute materials and equipment to a project whether in education, training, research or development. • contribute free or discounted consumables such as gases or electodes/wires. • contribute scrap materials or consumables left over from fabrication or construction activities in industry. • allow the use of facilities either free of charge or at discounted prices. • obtain PPE and other safety items. • obtain services such as testing of welders and welding procedures, training of lecturers and instructors including upgrading, as well as accreditation and certification of training centres at free or discounted prices.	CEO	
9	Each reader to continue to create additional actions to progress the strategy.		

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Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Strategy 3A. Draw up and implement a structure and programme to obtain participation by companies in the ongoing E&T, Skills and Career requirements/ needs analyses and funding proposals including the benefits of networking and collaboration, sharing funding contributions, sharing resources and facilities and commercial benefits.

Action – What		By Whom	When
1	Analyse and sectorise each company with potential to participate in an E&T, Skills or Careers or other potential project.	CEO	
2	Target each sectorised company to participate in an appropriate E&T, Skills and Careers needs analysis cluster group either on an industry, regional/geographical, size of company or membership sector basis amongst others.	CEO	
3	Compile a prospectus and use it to show companies the benefits of an Industry Sectoral Project (ISP) approach and joining an NWC Project ISP cluster group including networking, cooperation and collaboration, optimising project funding contributions, sharing resources, facilities and commercial benefits.	CEO	
4	Form the different E&T, Skills and Careers groups envisaged in the NWC Lead Organisation structure and invite each company to join the appropriate group in accordance with the NWC Lead Organisation specification for each group.	CEO	
5	Draw up and implement a programme of meetings for each ISP cluster group including further needs analysis meetings, project meetings and normal business meetings amongst others.	CEO	
6	If an industry association or grouping exists for a particular industry sector, approach its representatives for their support and involvement in the project.	CEO	
7	Prepare to hold the programme of meetings.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

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Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Strategy 4A: Identify, establish and workshop with industry cluster groups including geographical, sectoral, asset owners, users and suppliers to ascertain their ongoing E&T, Skills and Careers needs

Action – What		By Whom	When
1	Based on having an Industry Sectoral Project (ISP) approach, the number and type of industry sectors which will each have an ISP cluster group formed by the NWC Lead Organisation will be decided.	CEO	
2	In accordance with the programme in Strategy 3A, hold the first workshop for each particular ISP cluster group to discuss its needs in E&T, Skills and Careers and other subjects decided by the ISP cluster group. For example, the same cluster groups may be used for other aspects of the NWC Project such as R&D and Technology transfer.	CEO	
3	Invite additional workshop participants who may add value to the discussions and possible solutions to meet the identified needs of the sector e.g. Government and specialist E&T, Skills and Careers representatives.	CEO	
4	Based on each ISP cluster group's final workshop report, compile a list of projects with estimated costs which would give solutions to the identified needs of each ISP cluster group.	CEO	
5	Based on the concept of the total cost of a project being shared by the relevant ISP cluster group(s) participants, finalise a programme of E&T, Skills and Careers projects to be completed within the NWC Project Member organisations.	CEO	
6	Where capabilities are not available within NWC Project Member organisations involve other organisations with such capabilities to participate in the projects.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

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Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Strategy 5A: Compile and agree on an 'E&T, Skills and Careers Building Block' model to take to Government and industry leaders for their support, including financial, and implementation.

Action – What		By Whom	When
1	Compile a draft document detailing the NWC Lead Organisation structure containing the industry groups and organisations in each section of the NWC E&T, Skills and Careers Building Block model as well as a programme for implementation, finances, benefits to the country and expected outcomes.	CEO	
2	Test the draft document by a group of agreed NWC Project experts on a confidential basis.	CEO	
3	Finalise the draft document based on feedback received and have it approved by key stakeholders in the NWC Lead Organisation.	CEO	
4	Improve and finalise the prospectus showing the E&T, Skills and Careers model and arrange presentations with the appropriate senior government and industry representatives.	CEO	
5	Conduct the appropriate meetings with the different government and industry representatives and compile feedback to improve the draft document and model as well as input to strategies on their support and funding.	CEO	
6	Each reader to continue to create additional actions to progress the strategy.		

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Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Strategy 6A: Create an income and expenditure budget and action plan for the implementation and sustainment of the best practice NWC E&T, Skills and Careers model.

Action – What		By Whom	When
1	Compile draft outline budgets for the envisaged NWC Project E&T, Skills and Careers model over both a two year and five year period including NWC Project activities related to E&T, Skills and Careers and other required related activities such as administration, marketing and promotion amongst others identified.	CEO	
2	Create an action plan identifying and prioritising each step for establishing and sustaining each part of the NWC Project E&T, Skills and Careers model including every envisaged activity which must be resourced.	CEO	
3	Estimate the necessary resources for each activity required each year to grow the NWC Lead Organisation including staff, facilities, services etc and based on the agreed draft resources plan, create an annual expenditure budget for a two and five year period for all the E&T, Skills and Careers activities to be performed by the NWC Lead Organisation.	CEO	
4	Based on the annual expenditure budget, create potential income streams to balance expenditure i. e. education and training fees, project fees, government grants, industry contributions, seminars, conferences and workshops fees.	CEO	
5	Estimate the necessary resources for each activity required each year to grow each of the NWC Project organisations including staff, facilities, services etc and based on the agreed draft resources plan, create an annual expenditure budget for a two and five year period for all the E&T, Skills and Careers activities to be performed by each of the NWC Project organisations.	CEO	
6	Compile all the information into a written report complete with recommendations including overall funding of the NWC Project (or each ISP to be implemented), action plans and timelines, roles and responsibilities.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

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Objective A: To establish sustainable industry and government support for cooperative and collaborative E&T, Skills and Careers development.

Strategy 7A: Align the NWC E&T, Skills and Careers model with the UN Sustainable Development Goals (SDGs) where appropriate needs, resources and viable projects are present.

Action – What		By Whom	When
1	Analyse the recommended projects for each of the 17 SDGs on pages 6 to 49 of the IIW NWC-SDGs Long Report Volume 2, for possible inclusion in the NWC E&T, Skills and Careers model. https://iiwelding.org/iiw-jointothefuture/iiw-and-sustainable-development/	CEO	
2	Select IIW NWC-SDGs projects for inclusion in the model.	CEO	
3	Check whether any of the IIW NWC-SDGs projects are also being implemented in other countries and if so make contact with project representatives to share ideas.	CEO	
4	Implement the selected IIW NWC-SDGs projects into the action plans of the NWC E&T, Skills and Careers model.	CEO	
5	Show anticipated values and benefits of outcomes for all E&T, Skills and Careers model IIW NWC-SDGs orientated projects.	CEO	
6	Compile all the information into a written report regarding anticipated progress of selected IIW NWC-SDGs complete with recommendations for further actions.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

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- United Nations Development Programme (UNDP) Human Development Report 2023/2024 Overview Breaking the gridlock. Reimagining cooperation in a polarised world. chromeextension://efaidnbmnnnibpcajpcglclefindmkaj/ https://hdr.undp.org/system/files/documents/global-report-document/hdr2023-24overviewen.pdf

- IIW also shows the importance of education, training, skills and careers in its recently released report "The Importance of a Country's Welding Industry, its National Welding Capability (NWC) and their Significance to the UN Sustainable Development Goals (SDGs)". The report provides guidance, including practical ideas and recommendations, on how a country's welding industry can improve its national welding capability and simultaneously progress targeted UN Sustainable Development Goals (SDGs).
  It can be downloaded free of charge https://iiwelding.org/iiw-jointothefuture/iiw-and-sustainable-development/
  Simply using the Find text link, locate all text referencing education and training, in particular, pages in the sections shown below.
  Short Report, Page 12, Section 11, Industry Sectoral Projects (ISPs) which can be used to identify E&T needs.
  Long Report Volume 1 "NWC and SDGs Interconnected and Interdependent in the Welding Industry", Pages 23-27, Section 4.4, Pages 28-31, Section 4.5, Pages 67-84, Section 5, Pages 91-92, Section 6.7.
  Long Report Volume 2 "Potential National Welding Capability Welding Industry Projects and Resources", Pages 8-49, Section 1, Pages 50-57, Section 2, Pages 69-70, Section 3.7, Pages 71-74, Section 3.8.
- IIW, on a similar basis to international organisations such as ISO and IEC, is also a supporter of the United Nations (UN) project to continuously improve, both locally and globally, the 17 UN Sustainable Development Goals (SDGs) agreed to by world leaders in 2015. https://en.wikipedia.org/wiki/Sustainable_Development_Goals
- The newly-introduced ISO/UNDP PAS 53002:2024 provides organisations with a practical framework to implement the UN Sustainable Development Goals (SDGs) into their operational and strategic plans. This guideline, launched on 12 September 2024, aligns with UN SDG 17 (Partnerships for the Goals), promoting collaboration between businesses, governments, and civil society to achieve sustainable outcomes.
- ISO/UNDP PAS 53002:2024 Guidelines for contributing to the United Nations Sustainable Development Goals (SDGs). https://www.iso.org/standard/87945.html

Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations.

Strategy 1B: Establish an Education, Training, Skills and Careers Board, and appropriate committees, at the NWC Lead Organisation including representation of all relevant parties

Action – What		By Whom	When
1	Linking to Strategy 5A, investigate existing Education and Training (E & T), Skills and Careers models for individuals and organisations in other countries both from a formal recognition viewpoint and contributor to, and beneficiary of, projects and services.	CEO	
2	Draw up a prospectus for the E&T, Skills and Careers Board including, if necessary, to meet both the requirements for recognition by the country's relevant body and with IIW as an IIW Authorised Nominated Body (ANB). The prospectus for the Board should also indicate the envisaged roles and responsibilities of each of its Committees and their members including their goals and objectives as well as resources required to establish and sustain them.	CEO	
3	Appoint appropriate staff to establish and administer the Board, its Committees and IIW ANB including establishing and operating its management system.	CEO	
4	Decide which organisations should be invited to become members of the Board and its Committees and invite them to send a representative to attend the first Board and each Committee meeting.	CEO	
5	Hold a strategic planning meeting of the Board and staff to create a "Plan-on-a-Page" for E & T, Skills and Careers related activities with a goal, objectives, strategies and accompanying action plans and Key Performance Indicators (KPIs). The plan could include meeting the requirements for recognition in the country's national system and recognition as an IIW Authorised Nominated Body (ANB) and will fit in with strategy 5A.	CEO	
6	Identify and estimate the resources required to achieve the E&T, Skills and Careers goals over a two year and five year period.	CEO	
7	Create a plan to resource the E & T, Skills and Careers NWC Project activities.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

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- IAB-361 IIW System for Certification of Welding Inspection Personnel – Criteria to be satisfied by ANBs seeking to implement the IIW system for certification of welding inspection personnel.
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- IAB-442 IIW Guideline – Alternative Route.
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Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations.

Strategy 2B. Perform a situation analysis on an annual basis on which E&T, Skills and Careers centres, facilities, resources, expertise, capabilities and capacities are presently available in the country to assist the NWC Project.

Action – What		By Whom	When
1	Compile a "capability" questionnaire to be used for obtaining and assessing the facilities, equipment, classrooms, laboratories, personnel and competencies in an organisation conducting E&T, Skills and Careers activities in the country as well as organisations outside the country which could be utilised in the NWC Project.	CEO	
2	Compile a list of organisations, including contact details, covering industrial, education and training, research and development, equipment and consumable suppliers, inspection and testing companies and laboratories with potential capabilities.	CEO	
3	Contact each organisation to establish with the aid of the questionnaire what capabilities they have to assist the E&T, Skills and Careers NWC Project activities.	CEO	
4	Meet with each organisation's representatives to formally agree which services can be provided by the organisation to the NWC Project E&T, Skills and Careers model as well as link in with other strategies in the NWC Project.	CEO	
5	Establish a data base of capabilities including processes for reviewing and updating capabilities on a regular basis.	CEO	
6	Create a strategy and plan to establish a national network of NWC Project E&T, Skills and Careers organisations with a system and programme of linking centres in to cooperate and collaborate in ensuring a top class system.	CEO	
7	After gathering all the relevant information on the internal and external environments of the network, assess the network's current strengths, weaknesses, opportunities and threats through a SWOT analysis to guide its goals and objectives.	CEO	
8	Linking in with Action 6, implement a plan to improve capabilities in the network and create the top class system to meet the industry's requirements.	CEO	
9	Each reader to continue to create additional actions to progress the strategy.		

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Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations.

Strategy 3B: Harness industry, public and private E&T, Skills and Careers organisations and their capabilities regarding E&T, skills and careers, capacities, technologies, facilities, equipment, lecturers and trainers competencies by having a full ongoing record of such information and creating local and international networks and alliances to maximise use of the capabilities.

Action – What		By Whom	When
1	Linking in with Strategy 2B, create a national network of NWC Project E&T, Skills and Careers organisations with a system and programme of linking centres in to cooperate and collaborate in ensuring a top class system. These organisations would also include technology and R&D organisations being part of the technology transfer activities required in the country.	CEO	
2	Identify and analyse any networks of Educational, Training and Technology Support Centres (TSCs) both locally and internationally which may exist particularly in IIW member countries.	CEO	
3	Compile a prospectus and presentation for the establishment and sustainability within the NWC Lead Organisation of an Educational, Training and Technology Support Centres Network including membership, authorities, responsibilities, resources and funding requirements, benefits and expected outcomes.	CEO	
4	Identify and contact local and international organisations including companies, universities, training and R&D centres with identified educational, training and technological capabilities to invite them to become part of the Educational, Training and Technology Support Centres (E&T &TSC) Network.	CEO	
5	Establish and implement an organisational structure within the NWC Lead Organisation to accommodate the NWC Project E&T& TSC Network to operate effectively and efficiently both nationally and regionally.	CEO	
6	Allocate the resources particularly individuals to work with the E&T&TSCs to meet the needs of industry as well as manage and administer the NWC Project E&T&TSC Network.	CEO	
7	Continually compile an analysis of industry needs as well as a Future Directions analysis and implement a series of projects to transfer technology to meet the present and potential future needs of industry including Strategies 5D and 6D.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

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Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations.

Strategy 4B: Cooperate and collaborate with the government and industry organisations with infrastructure already established and responsible for welding education, training, qualification and certification of all types of welding related personnel including apprenticeships.

Action – What		By Whom	When
1	Obtain, read and understand as much as possible about the national education and training system. Then arrange and visit the relevant government departments and key representatives to gain a full understanding on how the national system of education and training is structured, how it functions, how it is funded overall, how each training body is funded, the roles, responsibilities and authorities of each training body and government links to industry, etc.	CEO	
2	Discuss formal and informal involvement of government in the NWC Project	CEO	
3	Arrange and visit the key industry bodies formally involved with, or approved by, government in welding education and training to understand the relationships associated with funding, bursaries, grants, qualification and certification, training resources, recognition of training bodies, auditing and assessment processes etc.	CEO	
4	Discuss possible formal and informal involvement of each relevant government and industry body in the NWC Project including representation on the Board and committees.	CEO	
5	Compile a confidential report to the E&T, Skills and Careers Board with recommendations on how the NWC Lead Organisation should interact both formally and informally with the industry and government bodies including cooperation and collaboration with services, products and projects.	CEO	
6	Based on the outcomes of discussions on the report and recommendations, implement a series of actions with government and industry bodies including their formal involvement with the NWC Project.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

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Harmonic Growth [65]
Markus Köhler

Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations.

Strategy 5B: Analyse the present situation and source solutions on an ongoing basis for what is required to upgrade each E&T, Skills and Careers organisation in the NWC Project network to meet the future needs of industry.

Action – What		By Whom	When
1	Use the envisaged NWC Project E&T, Skills and Careers model in Strategy 6A for both a two year and five year period related to E&T, Skills and Careers and other required activities such as administration, marketing and promotion amongst others identified.	CEO	
2	Compile a list of E&T, Skills and Careers activities each NWC Project Member will be involved in.	CEO	
3	Compare the list of activities with the needs identified and list each specific shortfall in capabilities.	CEO	
4	Discuss each specific shortfall within the relevant NWC Project E&T, Skills and Careers groupings and if not possible to meet the shortfall locally, propose a plan to find the resources to fill the shortfall from the national and international support centre networks.	CEO	
5	If necessary make a formal agreement to support the organisation or individual supplying the service to fill the shortfall.	CEO	
6	Each reader to continue to create additional actions to progress the strategy.		

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Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations.

Strategy 6B: Perform future directions analyses of technologies so that industry's future E&T, Skills and Careers requirements are met at the appropriate time and where necessary assist in strategies 4B and 5B

Action – What		By Whom	When
1	Identify and agree which groups of individuals and organisations are to be invited to participate in the future directions technologies and E&T, Skills and Careers needs analysis and the key objectives with each group.	CEO	
2	Form a working group to perform the technologies and E&T, Skills and Careers needs analysis and agree the processes to be implemented including the resourcing of a person to perform the consultations.	CEO	
3	Identify which individuals and organisations to be consulted could be covered by completing a questionnaire and which ones could attend a workshop.	CEO	
4	Compile a questionnaire to survey what the anticipated prioritised needs are.	CEO	
5	Compile an invitation to a Future Directions workshop including the objectives and a workshop programme as well as a questionnaire for completion by each workshop attendee.	CEO	
6	Compile a programme of workshops to cover industry sectors, research organisations, E&T organisations, government departments, quangos, employer associations, unions, funding agencies.	CEO	
7	Hold workshops and compile a confidential report on each workshop including findings.	CEO	
8	Send out a questionnaire on a personalised and confidential basis to individuals who could not attend a workshop, follow up with telephone or site discussions to finalise responses from these individuals.	CEO	
9	Put all reports, completed questionnaires, notes on all communications, contact details of all contacts into a data base.	CEO	
10	Consolidate all needs analysis reports into one report including recommendations on technologies trainees need to be trained on, in what numbers and by which training centres as well as companies providing on-the-job training.	CEO	
11	Each reader to continue to create additional actions to progress the strategy.		

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Objective B: To establish and sustain a national E&T, Skills and Careers infrastructure including facilities and resources involving industry, public and private E&T, Skills and Careers organisations.

Strategy 7B: Introduce and sustain a cohesive network of infrastructure, facilities and resources within main stream education, further education and higher education to ensure that the career paths and routes are available for lifelong learning, career progression and job opportunities.

Action – What		By Whom	When
1	Form a working group to create the plan for the establishment of a cohesive sustainable network of facilities and resources with appropriate infrastructure to provide the lifelong learning, career paths and routes as well as employment opportunities for individuals and also to meet the needs of industry in a particular area/town/region.	CEO	
2	Establish a model known as an NWC Industry Specific Group (ISG) which would comprise the technology based SMEs, multi-nationals/major end users, education and training providers and government departments in an area/town/region supported by a technology manager from, or arranged by, the NWC Project Lead Organisation.	CEO	
3	Using the results from strategies 3C, 2B, 3B, 4B, 5B, 6B identify areas/towns/regions of the country where the identified training needs of industry in that area/town/region can be met, as well as technical support for companies can be provided, by the formation of an NWC ISG.	CEO	
4	From the results of Strategies 3C, 2D, 3D, 4D, 5D and 6D, identify each career path in terms of the qualifications required and analyse them to determine the flexibility of the routes to obtain them in terms of recognition of prior learning, recognition of micro-credentials, availability of facilities and resources in the area/town/region for individuals to be trained and examined.	CEO	
5	Identify any constraint which might arise at each stage of the learning period from "cradle to grave" and find appropriate solutions for such constraints.	CEO	
6	Link in the formation of an ISG with one or more Industry Sectoral Project (ISP) approaches as shown in Strategy 3A. Prioritise the order for establishing ISGs in a particular area/town/region.	CEO	
7	Target 'champions' to join the ISGs and ISPs to cover industry sectors, research organisations, E&T organisations, government departments, quangos, employer associations, trade unions, funding agencies amongst others.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- National Model for Optimum Innovation through Welding and Joining Technology. C. Smallbone. 53rd WTIA International Welding and Joining Research Conference, Darwin, Northern Territory, Australia, October 2005. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0051-2024.

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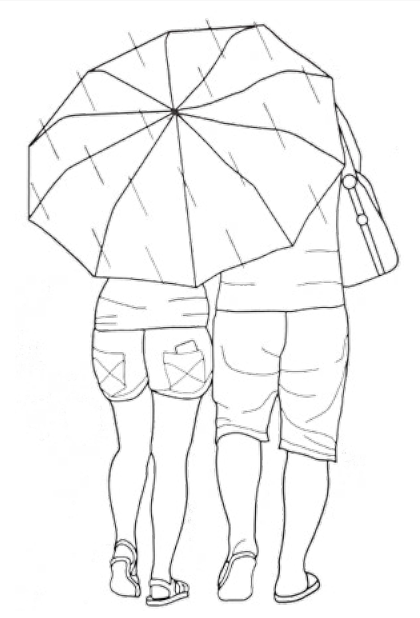
- The exhibit by Sergey Minakov, features a series of three welded sculptures of couples that reflect different ages of life: teenage, adult and senior. At each stage of life, one uses one's learning experiences to make choices which influence many aspects of life, such as work, health and love and hence the importance of lifelong learning for every stage of life [65].

First Date



In the Rain

Comfortable

Through the Ages [65]
Sergey Minakov

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Strategy 1C: Assist E&T organisations and individuals (including in recruitment, careers development and training) in ensuring sufficient numbers, types and levels of lecturers and trainers are available to meet the identified industry needs.

Action – What		By Whom	When
1	Once the Member organisations of the NWC Project E&T, Skills and Careers Board are known, hold a meeting to discuss the E&T personnel needs and challenges facing NWC Project Members including the results from Strategies 2B and 3B.	CEO	
2	Form an NWC Project Working Group on NWC Project E&T Personnel to initially determine the present and anticipated future needs/shortfall of all the various types of personnel such as lecturers, trainers, instructors, examiners, auditors etc within the E, T, Q and C industry.	CEO	
3	Compile a confidential report on the personnel needs identified and a plan to find solutions to the identified needs.	CEO	
4	Develop and agree a process to be implemented for NWC Project Members to be able to define E&T personnel requirements and obtain the assistance of other NWC Project Members to identify and informally help with the recruitment of suitable people to fill the key E&T positions of lecturers and instructors which will have been identified and become available.	CEO	
5	Develop a formal agreement to prevent 'poaching' of key E&T personnel between NWC Project Members.	CEO	
6	Compile a confidential list of people nationally and worldwide who could be contacted by individual NWC Project Members with respect to sourcing people for E&T positions in the NWC Project.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- Australian Government, Department of Education, Employment and Workplace Relations, Targeting Skills Needs in Regions Program Evaluation, August 2011, ISBN 978-0-642-78081-2, WTIA Pages 29-30 and 103. https://www.voced.edu.au/content/ngv%3A495
- EWF/IIW Welding Qualification System, Implementation and Challenges, Rute Ferraz and Italo Jose Fernandes, The Welding Institute, Welding and Joining Matters, Issue 11, 2025. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0068-2024.

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Strategy 2C: Identify the training and qualification requirements for lecturers and trainers and working with E&T organisations implement the necessary training and examinations for them on an ongoing basis.

Action – What		By Whom	When
1	Establish if criteria exist for a person to be classified as a competent lecturer or trainer including welding related qualifications, experience and teaching qualifications at each of the IWE, IWT, IWS, IWP, IWIP, practical welding, NDT, pressure equipment, bolting, corrosion, fabrication, construction and apprentice training levels as outlined in Objective D.	CEO	
2	Investigate if and where Train-the-Trainer courses and Continuing Professional Development (CPD) programmes exist around the world for each required type and level of lecturer or trainer.	CEO	
3	Analyse those which do exist and if suitable agree their potential use in your country reaching formal agreements to use them or develop your own.	CEO	
4	If suitable courses or programmes do not exist, develop and agree your own criteria, guidelines, courses and programmes.	CEO	
5	Finalise the criteria for a person to be a competent lecturer or trainer including welding qualifications, experience and teaching qualifications at each of the IWE, IWT, IWS, IWP, IWIP, practical welding, NDT, pressure equipment, bolting, corrosion, fabrication, construction, and apprentice training levels.	CEO	
6	Modify and test the courses and programmes through holding special workshops for upgrading existing lecturers and trainers to be classified as competent.	CEO	
7	Compile a programme for ongoing workshops for lecturers and trainers.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- Australian Government, Department of Education, Employment and Workplace Relations, Targeting Skills Needs in Regions Program Evaluation, August 2011, ISBN 978-0-642-78081-2, WTIA Pages 29-30 and 103. https://www.voced.edu.au/content/ngv%3A49526
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- AWS Certified Welding Educator Program (CWE). https://www.aws.org/Certification-and-Education/Professional-Certification/Certified-Welding-Educator/?step=1
- CSWIP Welding Instructor, CSWIP Specialist Welding Instructor, Certification Scheme for Welder Training Organisations (CSWTO). www.cswip.com/certification/welding-instruction

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Strategy 3C: Create and communicate the models for careers for all types and levels of welding-related personnel including the different jobs available and the paths and routes to achieving them.

Action – What		By Whom	When
1	Obtain and analyse existing models from around the world for careers in both Education, Training, Qualification and Certification (E, T, Q and C) organisations as well as in industry.	CEO	
2	Compile a career path model for your country showing both existing welding related careers in your country and potential careers as industry grows and more careers and career paths develop both in E, T, Q and C organisations as well as in industry.	CEO	
3	Compile a means, such as a digital booklet, of communicating the potential career paths including types of job positions, salary ranges, education and industry sectors, location of education and industry sectors, which could be available to a person.	CEO	
4	Compile a list of NWC Project recommended organisations which a person could contact to investigate employment opportunities, grant/bursary opportunities, as well as approved training centres and educational organisations offering both training courses leading to apprenticeships and certification as well as formal qualifications such as diplomas and degrees.	CEO	
5	Analyse each career path in terms of the need for education and training courses, qualification and certification requirements, locations, costs and frequency of opportunities for people to obtain education, training, qualification and certification.	CEO	
6	Where gaps in career paths or routes exist, make recommendations to the E&T, Skills and Careers Board on possibilities of closing such gaps.	CEO	
7	Create an on-line process within the NWC Project structure for people to be made aware of employment opportunities both in E, T, Q and C organisations as well as industry.	CEO	
8	Create an on-line system for individuals to advertise and promote their availability for employment both within the E, T, Q and C organisations as well as industry.	CEO	
9	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- Clear Pathways to Success: CWB Foundation, Industry, Education and Labour Collaborate to spark the Nuclear Welding Workforce of the Future, WELD Magazine, Spring 2021, Pages 092-093. https://www.weldmagazine.com/weldmagazine/library/item/weld-spring
- Filling The Gap: Advanced Pressure Welder Training Program Impact Report, CWB Foundation, WELD Magazine, Fall 2023. https://www.weldmagazine.com/weldmagazine/library/item/weld-fall2023/4131793/
- CWB Group Offers Exposure to Automotive Welding and Collision Repair. https://www.weldmagazine.com/weldmagazine/library/item/weld-summer2023/4104106/
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- GN 14 WTIA Guidance Note on Your Career as Responsible Welding Coordinator.
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- EWF/IIW Welding Qualification System, Implementation and Challenges, Rute Ferraz and Italo Jose Fernandes, The Welding Institute, Welding and Joining Matters, Issue 11, 2025. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0068-2024.

Inspiring Skills Excellence in Wales (ISEiW) competitors, together with prepared test pieces, ready for the North Wales welding final, held at Coleg Cambria's Bersham Road campus in Wrexham. Credit Carl Parrish.

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Strategy 4C: Introduce programmes for the exchange of E&T, Skills and Careers personnel between local E&T, Skills and Careers organisations and industry.

Action – What		By Whom	When
1	Maintain a confidential register of NWC Project E&T, Skills and Careers personnel with the agreement of NWC Project Organisations which employ the personnel.	CEO	
2	Prepare and agree a draft Continuing Professional Development (CPD) Programme for such personnel including sabbaticals and exchange programmes between local E&T, Skills and Careers organisations themselves and with companies in industry locally and internationally.	CEO	
3	Identify and list possible opportunities for exchange of personnel both short term and medium term between E&T organisations themselves and with companies in industry.	CEO	
4	Complete a guidance document on the conditions applicable to such exchanges taking place including employment conditions and CPD recognition.	CEO	
5	Have programmes and related documents legally checked and approved by all appropriate parties.	CEO	
6	Implement the programmes as mentioned in Action 2 above.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- Australian Government, Department of Education, Employment and Workplace Relations, Targeting Skills Needs in Regions Program Evaluation, August 2011, ISBN 978-0-642-78081-2, WTIA Pages 29-30 and 103. https://www.voced.edu.au/content/ngv%3A4952

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Strategy 5C: Implement processes such as study missions both in and out of the country, technology diffusion mechanisms, exposure to overseas and local experts, whereby lecturers and trainers will be continually updated on latest technologies and teaching techniques.

Action – What		By Whom	When
1	Maintain a confidential register of NWC Project E&T, Skills and Careers personnel with the agreement of NWC Project Organisations which employ the personnel	CEO	
2	Each year, prepare and agree a Continuing Professional Development (CPD) Programme for such personnel including study missions, training courses, site visits, exhibitions, conferences and seminars by local and international experts	CEO	
3	Discuss and finalise agreements with organisers with respect to the conditions applicable to NWC Project personnel being able to attend such events or activities	CEO	
4	Finalise a guidance document on the conditions whereby the personnel can attend such events or activities including recognition in terms of CPD units	CEO	
5	Have CPD programmes and related documents legally checked and approved by all appropriate parties	CEO	
6	Implement the programmes for exposure of personnel to such events and activities including both local and overseas experts as mentioned in Action 2 above.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- The OzWeld Technology Support Centres Network: A Unique Model for Technology Innovation by Industry, ASM/ AWS 6th International Conference on Trends in Welding Research, 15 – 19 April 2002, Pine Mountain, Georgia, USA, Chris Smallbone, Executive Director, Welding Technology Institute of Australia. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0005-2024.
- Smallbone C and Kocak M, "IIW White Paper: Improving Global Quality of Life Through Optimum Use and Innovation of Welding and Joining Technologies", Published by IIW 2012. https://iiwelding.org/wp-content/uploads/2023/08/IIWWhite-Paper-first-Edition.pdf
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- Cooperative Research Centre for Welded Structures (CRC-WS) Annual Report 2003-2004, Page 14, WTIA National Diffusion Networks Project including Industry Sectoral Projects. https://wsf.uow.edu.au/crc/PreviousAnnualR/AReport34.pdf

Overseas expert Dr Vladimir Ponomarov, Vice-Director of the Paton Training and Qualification Centre at the E.O. Paton Electric Welding Institute in Kyiv, updating trainees on latest training techniques in India in 2007 and in Cuba in 2014, at that time as a Professor of the Uberlandia Federal University of Brazil.

Credit Professor Vladimir Ponomarov.

- An Australian Government Initiative, AusIndustry, Industry Cooperative Innovation Program (ICIP), Customer Information Guide-Version 2, March 2006, Page 11 Developing a Consortium Agreement.
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- The Benefits of Industry Study Missions to a Country's National Welding Capability, Chris Smallbone, IIW Fellow, IIW President 2005-2008, SAIW Executive Director 1980-1993, WTIA Executive Director 1995-2014. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0015-2024.
- A Comprehensive Advanced Materials Joining and Forming Technology Roadmap-Final Report, Prepared by Tom McGaughy, Hyunok Kim and Harvey Castner, EWI, Columbus, Ohio, 28 April 2017. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0004-2024.
- NIST Advanced MFGTech Program Roadmap for Accelerating Production of Large Structures and Systems, Dennis Harwig, Katie Hardin, Larry Brown, Bill Mohr, Joshua James, and Tom McGaughy, EWI, 2024.
  https://ewi.org/introducing-a-u-s-roadmap-to-accelerate-production-of-large-structures-and-systems/
  https://ewi.org/wp-content/uploads/2024/07/RAPLSS-Final-Roadmap-Report-2a.pdf
  https://www.nist.gov/oam/accelerating-development-large-scale-structures

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Strategy 6C: Ensure all E&T, Skills and Careers organisations have direct or indirect representation on the various E&T, Skills and Careers Board related committees established as part of the NWC 'E&T, Skills and Careers Building Block' model agreed in strategy 5A.

Action – What		By Whom	When
1	Identify the organisations which you believe should have representation on each of the main E&T, Skills and Careers Board committees and sub-committees. These would include key organisations having significant influence with industry and governments. The SAIW 1988 FWP article shows a good example of this approach. Appendix B, Pages 43 and 50 with all participants being very important in providing resources.	CEO	
2	Identify a person in each identified organisation whom you could term a potential 'champion' for the NWC Project.	CEO	
3	Contact each identified person and have an informal discussion on the NWC Project and the possibility of the organisation playing roles in the Project due to being represented on particular E&T, Skills and Careers Board committees.	CEO	
4	If positive, send a formal invitation to the organisation including relevant documentation so that its involvement is fully understood and the organisation is committed to fulfil its roles and responsibilities.	CEO	
5	Once an organisation commits to being represented on a Committee or sub-committee, ensure that the organisation receives good customer service, continual encouragement for their organisation's involvement and feedback of the contributions which it is making and the good outcomes being achieved due to the NWC Project including the organisation's involvement and its representative's personal involvement.	CEO	
6	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- "SAIW-A Quantum Leap", Ms Dorothy Steele, FWP Journal, March 1988, VOL. 28 NO.3SA ISSN 0015-9026, Published Jointly by the SAIW, SAIF and SAIPE. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0006-2024.
- DVS German Welding Society Education Committee. https://www.die-verbindungs-spezialisten.de/index.php?id
- SAIW's leap to a world class institute, African Fusion, March-April 2024, Pages 6 and 7. https://user-54716422671.cld.bz/African-Fusion-March-April-2024/8/

Objective C: To continuously maintain a sustainable number, type and level of E&T, Skills and Careers personnel in the NWC Project organisations.

Strategy 7C: Create and maintain a network of mentors for students and companies within both VET and academia systems as well as industry.

Action – What		By Whom	When
1	Compile a guidance note on establishing a mentor system for students attending an education and training organisation either in person or remotely.	CEO	
2	Compile a guidance note on establishing a mentor system within a company for employees undertaking their on-the-job training or re-training at the company.	CEO	
3	Compile a guidance note on establishing a mentor system for a company which implements education and training activities for its employees.	CEO	
4	Hold a programme of workshops to show individuals and organisations how to implement the different mentoring programmes.	CEO	
5	Compile a method of assessing the success and benefits achieved by the different mentoring programmes implemented.	CEO	
6	Introduce a feedback system for each mentor, student and company to improve their systems	CEO	
7	Promote the mentoring programmes on a nationwide basis.	CEO	
8	Establish a feedback system for successful mentoring stories	CEO	
9	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- A Guide to Mentoring Staff, M Unger, P Hopkins, Journal of Pipeline Engineering, Vol 17, No 4, Fourth Quarter, 2018. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0052-2024.
- A Reflective Guide to Mentoring and being a teacher-mentor, Victoria State Government, Education and Training, February 2016. Chromeextension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.education.vic.gov.au/Documents/school/teachers/profdev/Reflectiveguidetomentoringschools.pdf
- The role of the mentor in professional knowledge development across four professions, Gillian Peiser, John Ambrose, Beverley Burke, Jackie Davenport, International Journal of Mentoring and Coaching in Education, Vol. 7 Issue: 1, Pages 2-18, January 2018. https://www.researchgate.net/publication/322687901_The_role_of_the_mentor_in_professional_knowledge_development_across_four_professions
- During a person's life, at different stages, mentoring can play a significant role in ensuring the person's success. A Protector is a Mentor who at such different stages acts as both a guardian and advocate. The person needs to be able to freely express their concerns confidently and receive support and protection to overcome their fears and susceptibilities. The Protector does this [65].

The Protector and Mentor [65]
Mike van Dam

- University of Alberta AWS/CWBA Student Chapter https://sites.ualberta.ca/~ccwj/index.html
  https://www.linkedin.com/company/ccwj/ https://www.instagram.com/cwba_aws_uofa/
- CWB Association Chapter name: University of Alberta CWBA Student Chapter
  https://www.cwbgroup.org/advocacy/membership/university-of-alberta-student-chapter
- AWS Chapter name: University of Alberta AWS Student Chapter
  https://sections.aws.org/alberta/university-of-alberta-aws-student-chapter/

Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Strategy 1D: Identify each year, the estimated numbers of personnel requiring welding-related E&T at all levels and types of courses in each industry sector including qualification and certification requirements.

Action – What		By Whom	When
1	The E&T Board conducts an analysis of which industry sectors in the country should require welding education and training, breaks down the different companies in each industry sector into types of services and products offered, company sizes and locations, which courses they are likely to require, the estimated number of different types and levels of personnel likely to be trained on the different courses and at what rate on an annual basis.	CEO	
2	Based on the location of each training centre in the National Network of Approved Training Bodies (ATBs) and the types of courses which each ATB could hold, estimated numbers of trainees are allocated to each type of course at each ATB.	CEO	
3	Discuss the results with each ATB and agree whether or not to proceed with advertising and promoting the courses, and obtaining the required numbers of students to hold the particular courses identified for that particular ATB.	CEO	
4	Based on the numbers realized for each course, the estimated numbers used in the first instance can be analysed against the actual number of attendees realized and decisions made on the subsequent actions required for each course at each ATB in the Network.	CEO	
5	Based on the courses and qualifications and certifications resulting, marketing and promotion of subsequent courses is implemented.	CEO	
6	Each reader to continue to create additional actions to progress the strategy.		

References for consideration

- Welding Skill Development Scenario in India, G.A.Soman, Chairman, National Skill Competition-Welder, June 2016.
- Key Needs and Actions for Education, Training, Skills and Career Paths for Welding Personnel, Prof G.L. Datta, Workshop on National Welding Capability, Pragati Maidan, 11 April 2014.
- Clear Pathways to Success: CWB Foundation, Industry, Education and Labour Collaborate to spark the Nuclear Welding Workforce of the Future, WELD Magazine, Spring 2021, Pages 092-093. https://www.weldmagazine.com/weldmagazine/library/item/weld-spring
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- Weld-Ed National Centre for Welding Education and Training, Nord Advanced Technology Centre at Lorain County Community College, Elyria, Ohio. www.weld-ed.org

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- National Industry Plan-Do We Need One, C. Smallbone, WTIA 46th Annual Conference-Planning, Production and Productivity, Perth, Australia, 1998. IIW National Welding Capability (NWC) Resource Centre Document Number: IIW NWC-0064-2024.
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- Engineering UK Engineering Skills Needs-Now And Into The Future Discussion Paper. https://www.engineeringuk.com/media/318943/engineering-skills-needs_euk-discussion-paper_fv.pdf https://www.engineeringuk.com/media/318956/skills_snapshot_skilled_metal_trades.pdf

Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Strategy 2D: Acquire/align training resources (lectures and materials) and introduce the programmes to meet the need for inspection personnel in welding, NDT, pressure equipment, fabrication, construction, corrosion and bolting.

Action – What		By Whom	When
1	Investigate the types of inspectors trained and certified throughout the world and make decisions on which inspector programmes will need to be introduced into your country and the types and numbers of inspectors which will need to be trained and certified in your country each year through the NWC Project.	CEO	
2	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training and examinations needs at each welding inspector level including IIW IWIP programmes and national welding inspector programmes.	CEO	
3	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training and examination needs at each pressure equipment inspector level for both new and in-service pressure equipment.	CEO	
4	Investigate existing programmes and E&T NDT training resources locally and around the world which could be used to meet the training and examination needs at each inspector level.	CEO	
5	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training and examination needs at each fabrication and construction inspector levels in line with EN1090.	CEO	
6	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training and examination needs at each bolting inspector level.	CEO	
7	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training and examination needs at each corrosion inspector level.	CEO	
8	Depending upon the programmes and system of inspector training centres to be established in your country, formally agree the use of training notes, training aids, model questions and answers, lesson plans etc with the supplier of the resources.	CEO	
9	Offer the use of the resources to the existing, and any future, training centres in terms of the formal agreement reached with the supplier of the resources.	CEO	
10	Investigate the practical training samples available around the world for purchase for use on the various inspector training programmes to be introduced.	CEO	
11	Calculate the number and types of practical samples required for training purposes including priority of obtaining them based on the estimated programme of courses to be introduced to meet the identified needs.	CEO	

Action – What		By Whom	When
12	Create a network of organisations which could be contacted both to purchase or obtain the use of practical samples.	CEO	
13	Have each practical sample tested for compliance with stated defects and entered into a data bank of approved samples.	CEO	
14	Obtain feedback on a regular basis on the suitability of the training resources for the different levels of personnel being trained.	CEO	
15	Working with the supplier of the resources, amend the resources to give better alignment with the training requirements.	CEO	
16	Each reader to continue to create additional actions to progress the strategy.		

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Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Strategy 3D: Acquire/align training resources (lectures and materials) and introduce the programmes to meet the need for welding coordination personnel for IWE, IWT, IWS, IWP, and supervisors for manufacturing, fabrication, construction, repair and maintenance.

Action – What		By Whom	When
1	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training and examination needs at each welding coordination level including IIW IWE, IWT, IWS and IWP programmes and national welding engineer, technologist and supervisor programmes.	CEO	
2	Depending upon the programmes and system of welding coordination training centres established in your country, formally agree the use of training notes, training aids, model questions and answers, lesson plans with the supplier of the resources.	CEO	
3	Offer the use of the resources to the existing, and any future, training centres in terms of the formal agreement reached with the supplier of the resources.	CEO	
4	Obtain feedback on a regular basis on the suitability of the training resources for the different levels of personnel being trained.	CEO	
5	Working with the supplier of the resources, amend the resources to give better alignment with the training requirements.	CEO	
6	Each reader to continue to create additional actions to progress the strategy.		

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Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Strategy 4D: Acquire/align training resources (lectures and materials) and introduce the programmes to meet the need for design and research personnel in welding-related manufacturing, fabrication, construction, repair and maintenance.

Action – What		By Whom	When
1	Investigate the types of personnel trained in welding design throughout the world and make decisions on which designer programmes will need to be introduced into your country and the types and numbers of designers which will need to be trained in your country each year through the NWC Project.	CEO	
2	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the in-formal training requirements to be introduced for welding design personnel in different industry sectors e.g. shipbuilding, pressure equipment, structural steel, railway rolling stock, etc.	CEO	
3	Investigate existing formal programmes and E&T training resources locally and around the world which could be used to meet the training and examinations to be introduced at each welding designer qualification level including IIW IWSD programmes and national designer programmes.	CEO	
4	Depending upon the programmes and system of designer training centres established in the country, formally agree the use of training notes, training aids, model questions and answers, lesson plans with the supplier of the resources.	CEO	
5	Offer the use of the resources to the existing, and any future, training centres in terms of the formal agreement reached with the supplier of the resources.	CEO	
6	Obtain feedback on a regular basis on the suitability of the training resources for the different levels of personnel being trained.	CEO	
7	Working with the supplier of the resources, amend the resources to give better alignment with the training requirements.	CEO	
8	Investigate the types of research personnel trained throughout the world and make decisions on which programmes will need to be introduced into your country and the types and numbers of researchers which will need to be trained in your country each year through the NWC Project.	CEO	
9	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training and examinations to be introduced for researchers covering items such as project management and industrial impact, technical publication and scientific rigour.	CEO	
10	Depending upon the programmes and system of researcher training centres established in the country, formally agree the use of training notes, training aids, model questions and answers, lesson plans with the supplier of the resources.	CEO	
11	Offer the use of the resources to the existing, and any future, training centres in terms of the formal agreement reached with the supplier of the resources.	CEO	

Action – What		By Whom	When
12	Obtain feedback on a regular basis on the suitability of the training resources for the different levels of personnel being trained.	CEO	
13	Working with the supplier of the resources, amend the resources to give better alignment with the training requirements.	CEO	
14	Each reader to continue to create additional actions to progress the strategy.		

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Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Strategy 5D: Acquire/align training resources (lectures and materials) and introduce short programmes to cover personnel not included in strategies 2D, 3D and 4D.

Action – What		By Whom	When
1	Investigate the types of welding related personnel trained (but not necessarily certified) throughout the world and make decisions on which programmes could be introduced into your country and the types and numbers of personnel which will need to be trained in your country each year through the NWC Project.	CEO	
2	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training requirements to be introduced for welding related personnel in different industry sectors and different technologies e.g. shipbuilding, pressure equipment, structural steel, railways, welding processes, inspection techniques etc.	CEO	
3	Investigate existing programmes and E&T training resources locally and around the world which could be used to meet the training requirements to be introduced for personnel related to welding coordination e.g. Stores personnel, QC Welding Coordinators, Environmental Welding Coordinators, OH&S Welding Coordinators, Purchasing and Contracts personnel as well as appreciation course for engineering personnel.	CEO	
4	Depending upon the programmes and types of training centres established in the country, formally agree the use of training notes, training aids, model questions and answers, lesson plans with the supplier of the resources.	CEO	
5	Offer the use of the resources to the existing, and any future, training centres in terms of the formal agreement reached with the supplier of the resources.	CEO	
6	Obtain feedback on a regular basis on the suitability of the training resources for the different levels of personnel being trained.	CEO	
7	Working with the supplier of the resources, amend the resources to give better alignment with the training requirements.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

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Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Strategy 6D: Draw up guidelines and assist with obtaining resources for organisations to establish, manage and sustain the ideal practical welding training centre at each level and type of training being undertaken.

Action – What		By Whom	When
1	Create guidelines on what would be required by a practical welding training centre to be considered "ideal" and have the guidelines approved by the Q&C Board.	CEO	
2	Create a detailed guidance note on how a practical welding training centre can use the implementation of elements of ISO 3834 " Quality Requirements for Fusion Welding of Metallic Materials" and its various parts and ISO 14731 "Welding coordination: Tasks and responsibilities" to improve its management and performance including quality and productivity. Assist training organisations with advice on how to implement the elements as well as how they can audit the systems established on a regular basis.	CEO	
3	Identify, create or source, access and adapt, resources to assist a practical welding training centre to implement Action 2.	CEO	
4	Create a system such that external training course resources are readily available so that practical welding training centres can access, obtain and use them to continually improve their training course resources?	CEO	
5	Create methods or resources which a practical welding training centre could use to monitor, measure and improve the performance of its instructors and trainees based on the numbers, ranges and levels of trainees qualifying and the training times required for trainees to qualify on each practical welding training course?	CEO	
6	Create resources to measure and improve the efficiencies of a practical welding training centre in each of the following areas: ◗ quality and productivity in the management and administration of the training centre, including types of welding and cutting equipment available; ◗ workshop layouts including work study; ◗ preparation, storage and use of materials and consumables; ◗ maintenance and upkeep of training equipment and samples; ◗ destructive and non-destructive testing of weld samples, ◗ health and safety aspects; ◗ environmental aspects; ◗ testing and record keeping of trainees; ◗ costs of conducting training courses; ◗ mentoring of students; ◗ advice to trainees on grants, careers, possible employment; ◗ promoting successful trainees to companies; ◗ retaining staff.	CEO	

Action – What		By Whom	When
7	Provide examples of how to use, and evaluate the results of, training techniques such as Virtual Reality (VR)/Augmented Reality (AR)/Virtual Learning Environment (Metaverse) training in terms of their use and application with different levels of welding personnel and types of applications and show the benefits which can be achieved and deficiencies or limitations to be avoided in the use of VR, AR and Metaverse techniques. Assist the training organisations with implementation of the systems if required.	CEO	
8	Provide resources to practical welding training centres to help improve the cultures of the trainees and instructors related to: ◗ respect for skills; ◗ quality; ◗ productivity; ◗ work, health and safety matters; ◗ environmental matters; ◗ ethics; ◗ careers in welding; ◗ customer service; ◗ innovation; ◗ risk assessment.	CEO	
9	Provide resources, including Continuing Professional Development (CPD), for the continual training and qualification of practical welding training Instructors, to ensure their ongoing competency.	CEO	
10	Provide resources to improve the image of welding including the perceptions in some cultures that welding can have certain negative effects on trainees, such as: ◗ afflictions of the respiratory system; ◗ infertility or impotence; ◗ cancers.	CEO	
11	Provide examples or resources to practical welding training centres on how applications linked to Industry 4.0 could be introduced into their centres. For example: ◗ Industry Internet of Things (IIoT); ◗ Artificial Intelligence (AI); ◗ Wearable devices; ◗ Cobots: ◗ Additive manufacturing; ◗ 3D Printing.	CEO	
12	Each reader to continue to create additional actions to progress the strategy.		

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Objective D: To introduce the appropriate E&T courses and resources to meet the required numbers of competent personnel trained each year.

Strategy 7D: Implement reward and appreciation programmes and processes for people and organisations such as awards programmes, grants, skills competitions, welded art exhibitions and competitions.

Action – What		By Whom	When
1	Investigate the types of welding related reward and appreciation programmes and processes which exist globally for individuals and organisations and make decisions on which could be introduced into your country.	CEO	
2	Introduce a specific NWC awards programme as well as support existing awards programmes at schools, colleges, universities, associations, IIW, amongst others.	CEO	
3	Introduce a programme of practical skills competitions within E&T organisations or companies, regionally, nationally and internationally where applicable including WorldSkills International.	CEO	
4	Introduce a programme of competitions for Young Professionals or support such competitions in E&T organisations, associations, individual companies, nationally or internationally.	CEO	
5	Introduce or support a welded art exhibition and/or competition either live sculpting or photographic, remotely, digitally or live showing, at E&T organisations, associations, individual companies, nationally or internationally.	CEO	
6	Compile and introduce a programme of activities to showcase the results of each of the above actions.	CEO	
7	Establish a grants programme aimed at different categories of people for use in identified E&T activities.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

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Eight to Eighty-Eight [65]
Ann Gildner

Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Strategy 1E: Implement the appropriate processes for agreements and collaboration on items such as marketing and promotion, IP, technology transfer and diffusion, commercialisation and other legal issues related to E&T outcomes.

Action – What		By Whom	When
1	Compile a list of potential agreements and collaborations which will be necessary across all aspects of the NWC Project between NWC E&T, Skills and Careers Project Members in marketing, promotion, IP, technology transfer and diffusion, commercialisation and legal issues.	CEO	
2	Determine the types of resources existing in each NWC E&T, Skills and Careers Project Member organisation available for marketing, promotion, IP, technology transfer and diffusion, commercialisation and legal issues within the NWC Project.	CEO	
3	Discuss with each NWC E&T, Skills and Careers Project Member its requirements for resources to achieve effective marketing, promotion, IP, technology transfer and diffusion, commercialisation and legal issues within the NWC Project.	CEO	
4	Implement the necessary agreements with each NWC E&T, Skills and Careers Project Member in terms of NWC Project Member resources and processes which can be made available to the NWC Project.	CEO	
5	Compile a plan to close any gaps arising to ensure effective marketing, promotion, IP, technology diffusion, commercialisation and legal issues of NWC Project matters.	CEO	
6	Compile a plan for each item in action 1 above to be implemented in the NWC Project.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

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Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Strategy 2E: Create the communication processes, market awareness and training programmes for the E&T careers outcomes to achieve optimum take-up by groups such as school children, school leavers, women and girls, young professionals, older people such as retirees, immigrants, refugees, prisoners and people with special needs, amongst others.

Action – What		By Whom	When
1	Identify the target groups and associated organisations with industry and governments and the best methods to target these organisations with the objective of obtaining their support for the NWC Project E&T, Skills and Careers outcomes and participation by individuals in the programmes.	CEO	
2	Develop personal relationships with individual 'champions' in each target organisation who will be the links to the organisations and people in each target group.	CEO	
3	Compile a programme of meetings with the specific individual "champions" and their agreed networks using the various communication methods implemented for the NWC Project.	CEO	
4	From the outcomes of the meetings with each group, compile a proposal on how individuals in each group can participate in the NWC E&T, Skills and Careers programmes.	CEO	
5	Continue to communicate with the rest of the 'champions' network and cultivate further relationships with individuals as and when the opportunity arises.	CEO	
6	Identify and work with each training organisation implementing the different programmes for the different groups.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

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Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Strategy 3E: Establish and implement methods for assessing and /or measuring the value and benefits of the investment in E&T, Skills and Careers by the individual companies, industry sectors and governments.

Action – What		By Whom	When
1	Investigate existing models and reports to industry and governments on values and benefits of welding related activities to a country financially and socially.	CEO	
2	Based on the anticipated activities to be carried out in your country's NWC Project, compile a draft document on the estimated value and benefits of the welding related activities of each NWC Project Member including methods of assessment.	CEO	
3	Obtain agreement from the relevant NWC Project members on the draft document.	CEO	
4	Make an informal approach to government representatives to obtain feedback on the contents of the draft document and its relationship to government expectations on the financial 'returns' on government grants which may become available to the country's economy.	CEO	
5	Create templates for each NWC Project Member to capture and report on the value and benefits of its activities on a quarterly basis.	CEO	
6	Using the information captured, incorporate it into specific confidential reports to the NWC Lead Organisation's Board of Directors, T & R, E & T, Q & C, Committees and other key groups.	CEO	
7	Continually verify all information received to ensure the credibility of the information being reported to groups and being used for marketing and promotion including financial support.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

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Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Strategy 4E: Create and maintain a gallery of E&T, Skills and Careers development success stories including value and benefits to all appropriate parties including the country.

Action – What		By Whom	When
1	Analyse examples from worldwide sources of how success stories are used to promote a country's successes and support for obtaining the necessary resources to sustain the NWC Project.	CEO	
2	Hold a workshop for NWC Project Members on how to use a template document for creating success stories including the value and benefits of the outcomes achieved.	CEO	
3	Have each template document reviewed, improved and approved for use with a process for feedback from users of the template.	CEO	
4	Implement a process for approval of success stories within the NWC Project.	CEO	
5	Establish methods for both the location and promotion of each success story including in Strategy 3E. For example, promotion in newspapers, television, websites, Facebook, Linked in, company magazines, etc.	CEO	
6	Create and implement a programme of success stories to build up an appropriate portfolio	CEO	
7	Create a method for showing the value and benefits of each success story including financial benefits.	CEO	
8	Each reader to continue to create additional actions to progress the strategy.		

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Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Strategy 5E: Promote and support the involvement of E&T, Skills and Careers personnel in the work of the IIW technical working units, national industry boards, standards committees and government and industry initiatives.

Action – What		By Whom	When
1	Compile a list of organisations on which it is believed that E&T, Skills and Careers NWC Project members should have representation and involvement with and ensure that this is possible through meeting the appropriate requirements of these organisations such as memberships.	CEO	
2	Establish and implement the processes which enable E&T, Skills and Careers NWC Project members to be nominated and participate in the appropriate activities of the relevant organisations.	CEO	
3	Establish a mechanism supported by NWC Project Members whereby the financial and administrative support for attendance at, and involvement in, relevant meetings is available for those people nominated. This could be through company sponsorship, grants or other methods.	CEO	
4	Establish processes for feedback of outcomes from the meetings attended so that they can be transferred into the NWC Project to optimal effect.	CEO	
5	Review on an annual basis the effectiveness of the involvement of each individual in the organisations plus determining the value and benefits to the NWC Project in each case.	CEO	
6	Each reader to continue to create additional actions to progress the strategy.		

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Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Strategy 6E: Produce ongoing reports, including an annual report, showing progress and achievements of the overall E&T, Skills and Careers model including the value and benefits to the country, industry, governments, individuals and other stakeholders.

Action – What		By Whom	When
1	Compile a list of objectives for reports targeted at each category of stakeholder in the NWC Project plan.	CEO	
2	Analyse typical reports used in other local or international organisations as to their suitability for use.	CEO	
3	Create templates for each report required.	CEO	
4	Hold a workshop for employees of the NWC Lead Organisation and other NWC Project organisations on the types of reports required, completed templates, frequency etc.	CEO	
5	Plan and implement a programme for delivery of each type of report.	CEO	
6	Obtain feedback on the quality and timeliness of delivery of each report and review and improve the template for each type of report.	CEO	
7	Each reader to continue to create additional actions to progress the strategy.		

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Education Opens the Doors to the Future [65]
Martin Ivelinov Slavol and Jordan Vaskov Jordanov

Objective E: To establish effective marketing and promotion, technology transfer and diffusion, legal, Intellectual Property (IP) and commercialisation alliances and networks.

Strategy 7E: Promote and market the E&T, Skills and Careers activities of the organisations in the NWC Project network including raising the importance of welding and image of welding as a career.

Action – What		By Whom	When
1	Investigate the types of welding related programmes and projects which exist globally for individuals and organisations as related to the promotion and marketing of the E&T, Skills and Careers activities and the raising of the image and importance of welding, and make decisions on which activities could be introduced into your country.	CEO	
2	Form a working group to create the plan for the marketing and promotion of the existing and future E&T, Skills and Careers model, plans and activities in the country.	CEO	
3	Arrange a programme of events both live and virtually, covering the different regions of the country, informing people of the overall NWC E&T, Skills and Careers model, plans and individual activities.	CEO	
4	Select, train and provide the appropriate resources for each person presenting at each event.	CEO	
5	Compile an invitation to each event including the objectives and programme as well as a questionnaire for completion by each event attendee.	CEO	
6	Target "champions' to attend the events to cover industry sectors, research organisations, E&T organisations, government departments, quangos, employer associations, unions, funding agencies, amongst others.	CEO	
7	Hold the events and compile a confidential report on each event including findings.	CEO	
8	Send out a questionnaire on a personalised and confidential basis to individuals who could not attend a workshop, follow up with telephone or site discussions to finalise responses from these individuals.	CEO	
9	Put all reports, completed questionnaires, notes on all communications, contact details of all contacts into a data base.	CEO	
10	Consolidate all reports of marketing and promotional events, including feedback and recommendations, to help improve the NWC E&T, Skills and Careers plan.	CEO	
11	Each reader to continue to create additional actions to progress the strategy.		

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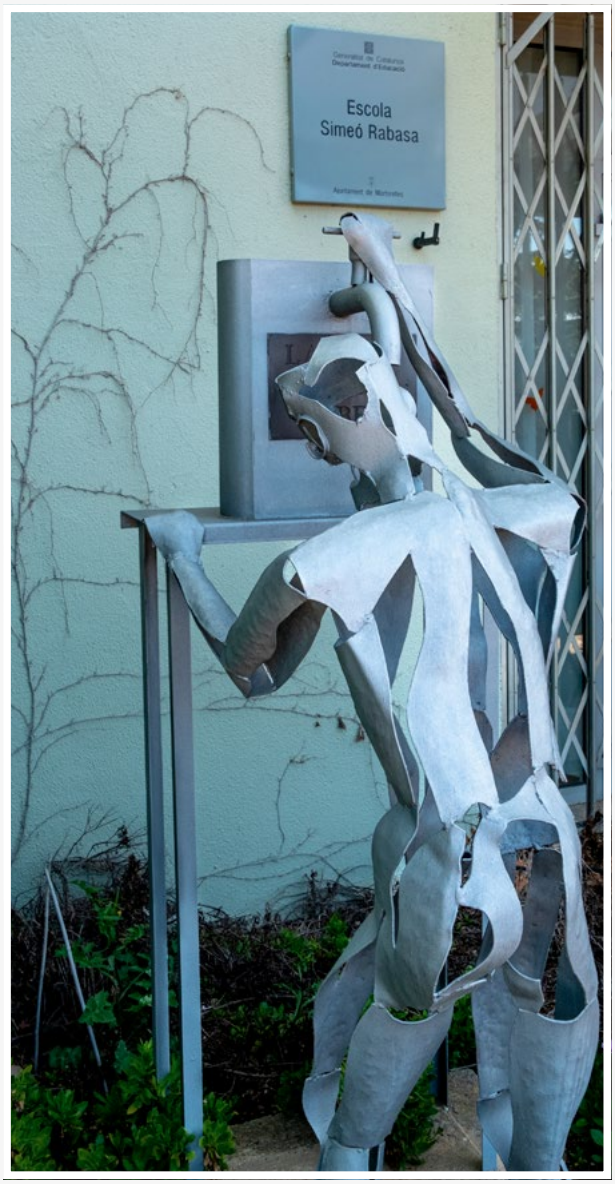
  Since 1996, the sculpture has been fittingly located outside the entrance to the Simeó Rabasa School at Martorelles (Barcelona) where both his son and nephew (the model for the child) studied, and later also his two sons. It has become somewhat of a tradition for teachers from this school to organise visits to Ricard's workshop to get their students to know one of the trades in town [65].



Spring of Knowledge
Ricard Mira

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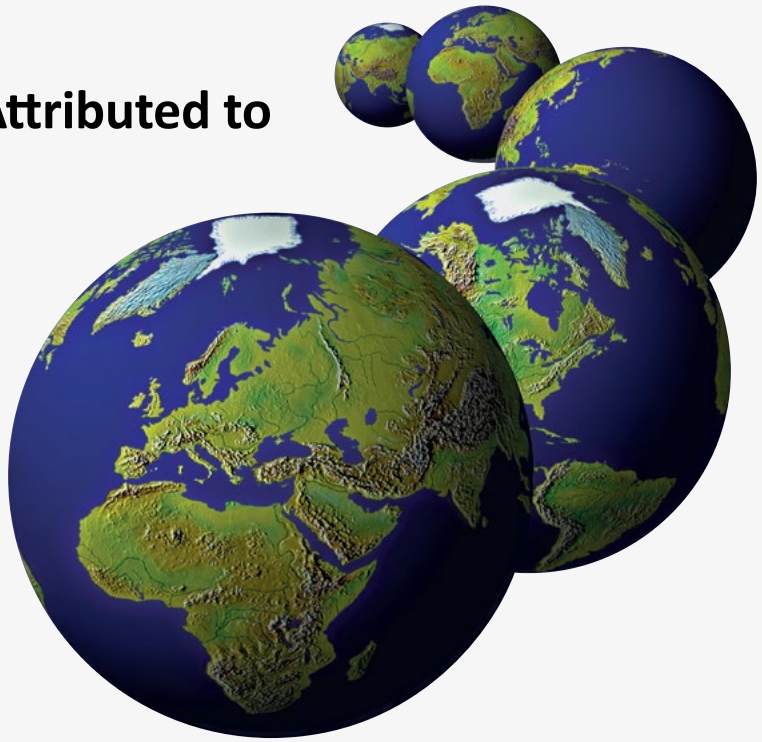

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  - The report provides **guidance**, including **practical ideas and recommendations**, on how a country's welding industry can improve its national welding capability and simultaneously progress targeted UN Sustainable Development Goals (SDGs).
  - It can be **downloaded free of charge** https://iiwelding.org/iiw-jointothefuture/iiw-and-sustainable-development/
  - Simply using the Find text link, locate all text referencing education and training, in particular, pages in the sections shown below.
  - **Short Report,** Page 12, Section 11, Industry Sectoral Projects (ISPs) which can be used to identify E&T needs.
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- EWF-570 EWF Special courses – Manual Metal Arc (MMA) – Diver Welder.
- EWF-628 EWF Special Course – Personnel with the Responsibility For Heat Treatment of Welded Joints.
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Part 8: Acronyms

AISC American Institute of Steel Construction
AM Additive Manufacturing
AMPP The Association for Materials Protection and Performance
ANB Authorised Nominated Body
ANBCC Authorised Nominated Body for Company Certification
API American Petroleum Institute
AR Augmented Reality
ASM American Society for Metals
ASME American Society of Mechanical Engineers
AS/NZS Australian/ New Zealand Standard
ATB Approved Training Body
ATF Accredited Testing Facilities
AWF Asian Welding Federation
AWFTE Association for Welding, Fabrication, Training and Education.
AWS American Welding Society
BTEC Business and Technician Education Council
BWS Bulgarian Welding Society
CE European Conformity
CEO Chief Executive Officer
CIDA Canadian International Development Agency
CIDCA China International Development Cooperation Agency
CITB Construction Industry Training Board
CGLI City and Guilds of London Institute
CPD Continuing Professional Development
CRC-MWJ Cooperative Research Centre for Materials Welding and Joining
CRC-WS Cooperative Research Centre for Welded Structures
CSA Canadian Standards Association
CSWIP Certification Scheme for Personnel
CWB Canadian Welding Bureau
CWI Certified Welding Inspector
DIN German Institute for Standardisation
DIST Department of Industry, Science & Tourism
DTI Department of Trade and Industry, UK
DVS German Welding Society
EAL Excellence Achievement & Learning Awards
ECITB Engineering Construction Industry Training Board
EN European Norm
EnvWC Environmental Welding Coordinator
E&T Education and Training
EU European Union
EURADA European Association of Development Agencies
EWF European Welding Federation
EWI Edison Welding Institute
FCDO UK Foreign, Commonwealth & Development Office (UK)
GIZ German Development Cooperation
GN Guidance Note
HEIAA Heavy Engineering Industry Action Agenda
HERA Heavy Engineering Research Association
IAB International Authorisation Board
IAEA International Atomic Energy Agency
ICIP Industry Cooperative Innovation Program
ICNDT The International Committee for Non-Destructive Testing
IfATE Institute for Apprenticeships and Technical Education
IIW International Institute of Welding
ILO International Labour Organisation
IP Intellectual Property
ISG Industry Specific Group
ISO International Organisation for Standardization
ISP Industry Sectoral Project
IWE International Welding Engineer
IWIP International Welding Inspection Personnel
IWP International Welding Practitioner
IWS International Welding Specialist
IW International Welder

IWT International Welding Technologist
IWSD International Welded Structures Designer
JICA Japan International Cooperation Agency
JWES Japanese Welding Engineering Society
KPI Key Performance Indicator
NACE National Association of Colleges and Employers
NDE Non-Destructive Examination
NDNP National Diffusion Networks Project
NDT Non-Destructive Testing
NSIRC National Structural Integrity Research Centre
NSW New South Wales
NWC National Welding Capability
OECD Organisation for Economic Co-operation and Development
QCWC Quality Control Welding Coordinator
OH&S Occupational Health and Safety
OH&SWC Occupational Health and Safety Welding Coordinator
PPE Personal Protective Equipment
Q&C Qualification and Certification
R&D Research and Development
RWC Responsible Welding Coordinator
SAFCTF South African Fabrication and Construction Training Trust Fund
SAIW Southern African Institute of Welding
SAQCC South African Qualification and Certification Committee
SCWI Senior Certified Welding Inspector
SDG Sustainable Development Goal
SENSE Schools Excelling through National Skill standards Education
SIRF Structural Integrity Research Foundation
SMART Save Money And Re-engineer with Technology
SME Small and Medium Enterprise
SASSDA Southern Africa Stainless Steel Development Association
SWOT Strengths, Weaknesses, Opportunities and Threats
TAFE Technical and Further Education
TD Technology Diffusion
TSC Technology Support Centre
TWI The Welding Institute
TWIIN TWI Innovation Network
UN United Nations
UNDP United Nations Development Programme
UNESCO United Nations Educational, Scientific and Cultural Organization
UNICEF United Nations Children's Fund
UNIDO United Nations Industrial Development Organisation
UNCTAD UN Conference on Trade and Development
USAID United States Agency for International Development
VET Vocational Education and Training
VWTS Virtual Welding Training Systems
VR Virtual Reality
WC Welding Coordinator
WCT Welding Coordination Team
WEMCO Welding Equipment Manufacturers Committee
WRCC Welding Research & Collaboration Colloquium
WTIA Welding Technology Institute of Australia

https://open.unicef.org/unicef-acronyms

IIW Vision, Mission and Core Values

Vision

The leading global welding community linking industry, research and education

Mission

Advance welding and joining through a worldwide network

Core Values

IIW is committed to the advancement of welding and joining for a safer and sustainable world

IIW operates based on mutual respect for diversity, culture and languages

Joining to the future