

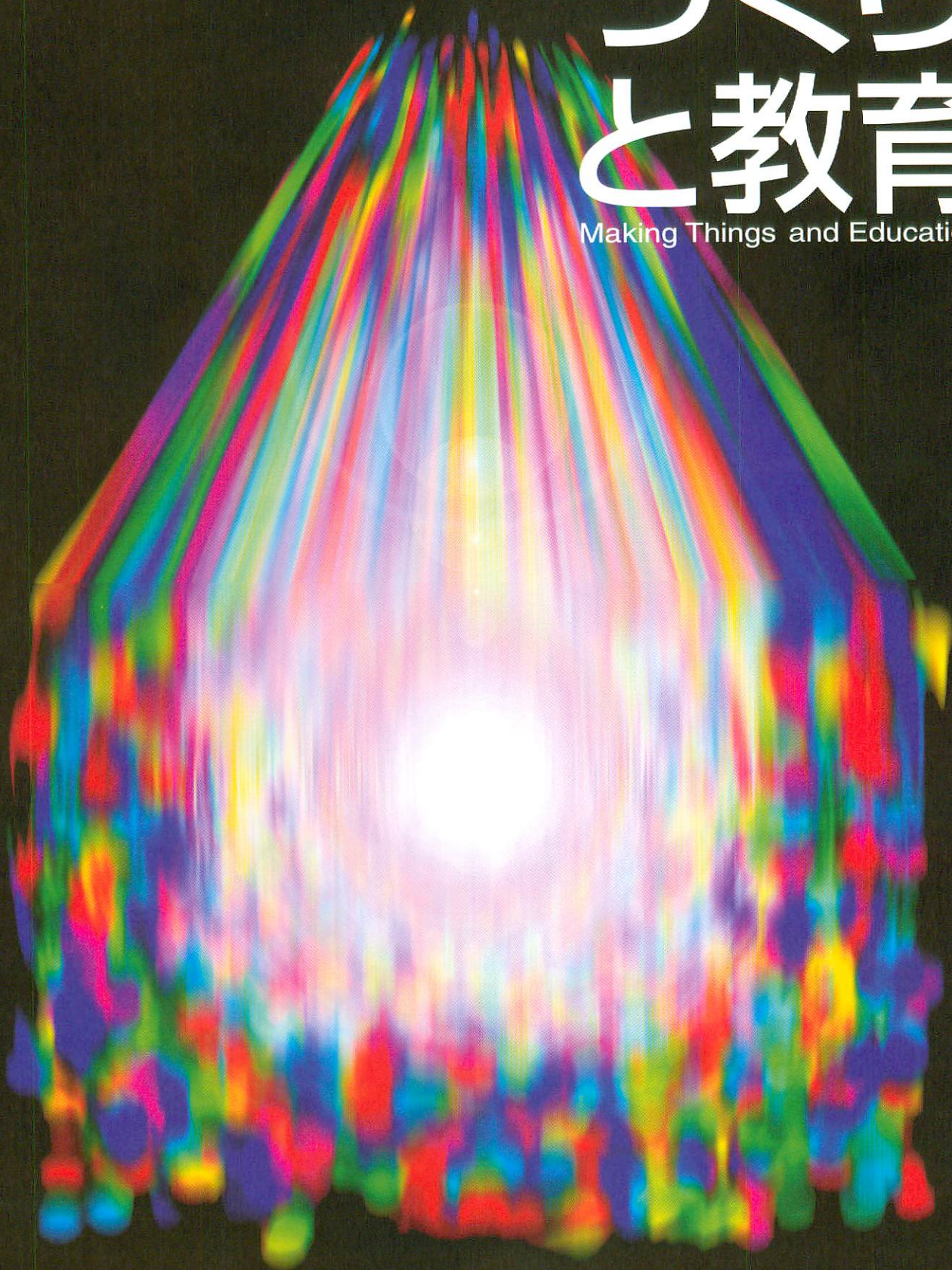


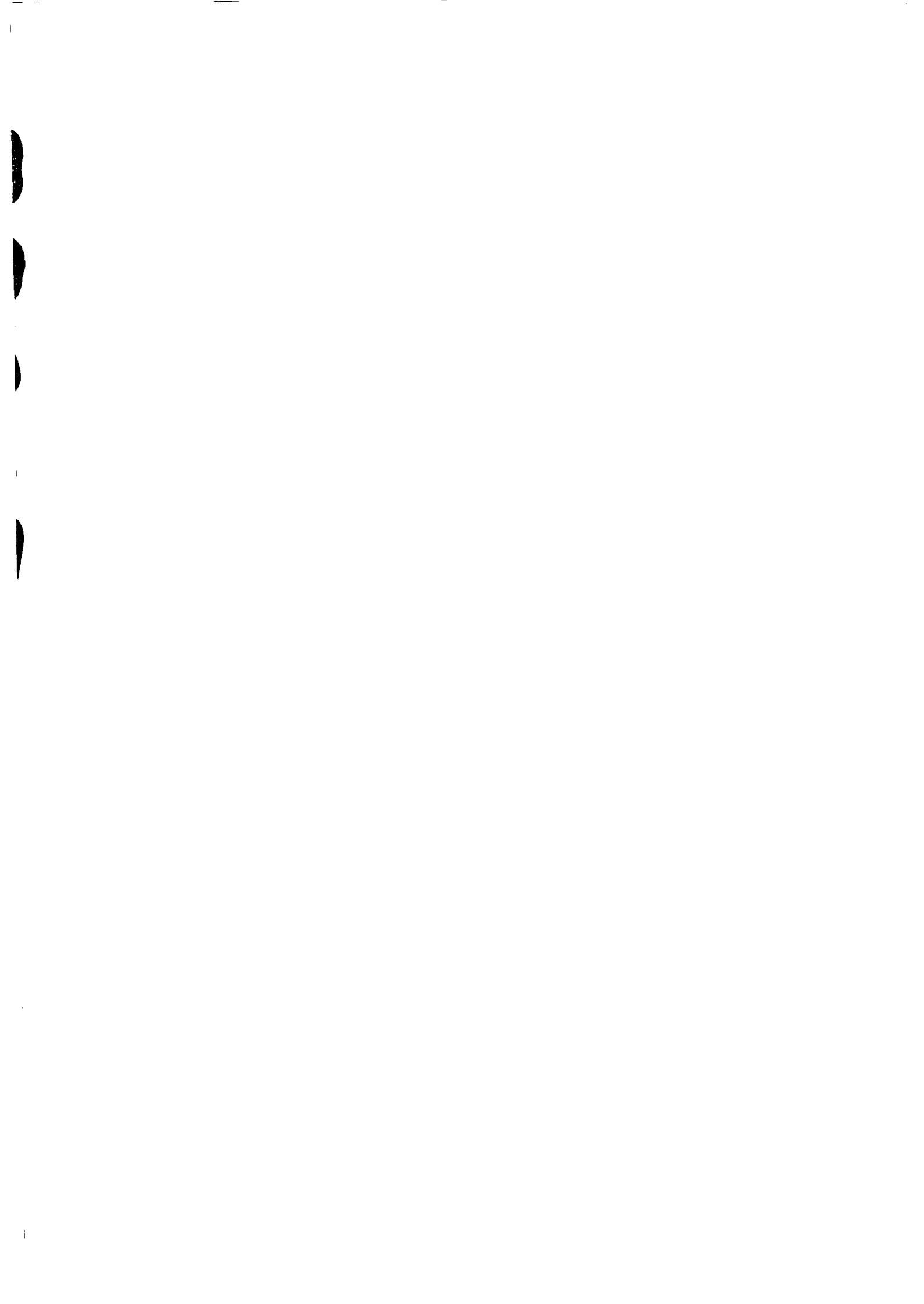
愛知教育大学
Aichi University of Education

もの づくり と教育

自然との対話
現代技術の体感
世界の人々との交流
Dialogue with Nature
Experiencing Today's
Technology
Exchange among the
Peoples of the World

Making Things and Education





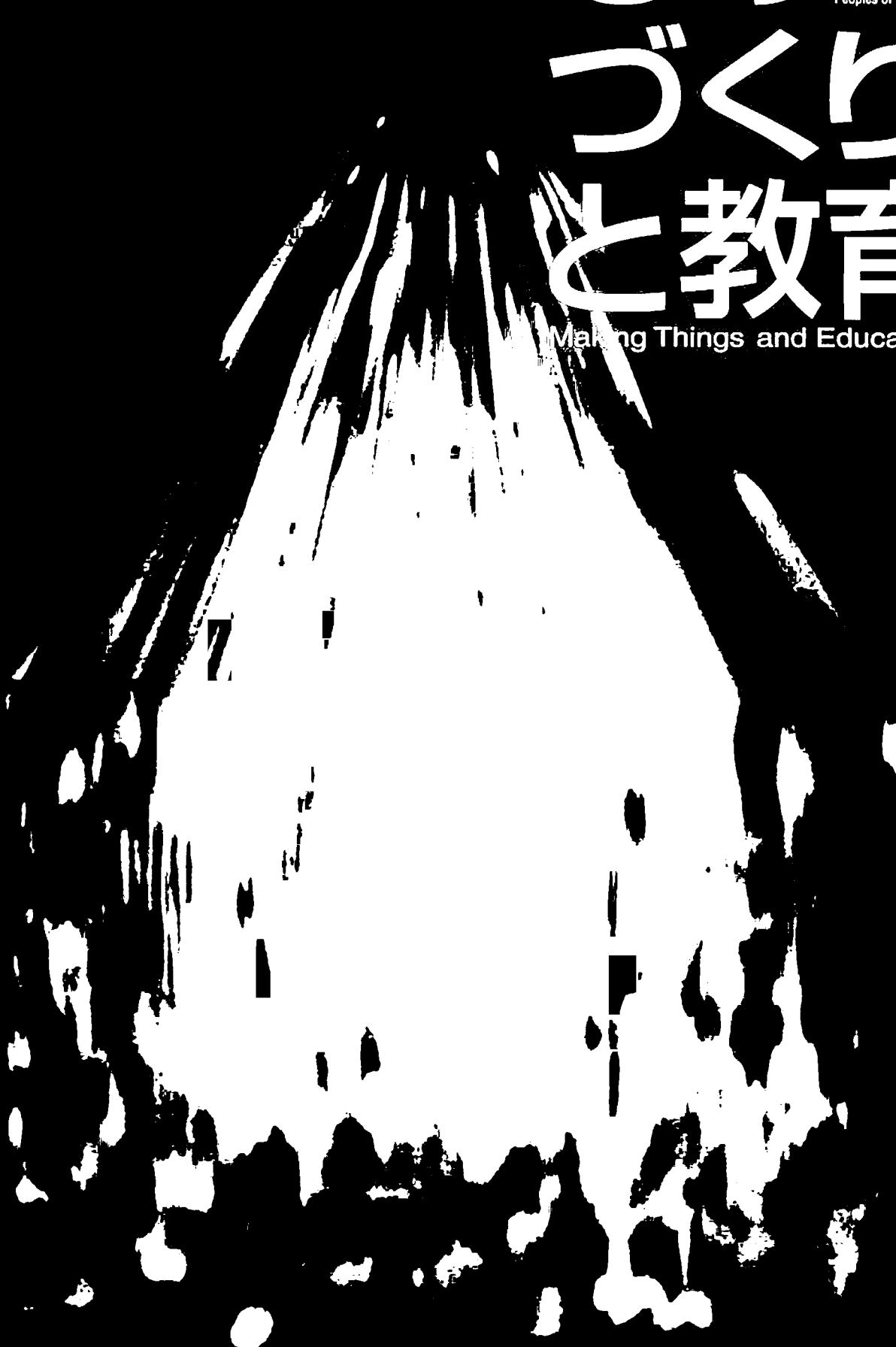


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Final Report

愛知万博市民プロジェクト「ものづくりと教育」の実施と成果 Performance and Accomplishment of "Making Things and Education" in Citizen's Project of The 2005 World Exposition in Aichi, Japan

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1. はじめに Introduction

2005年日本国際博覧会（略称：愛知万博、愛称：愛・地球博）が2005年3月25日（金）から9月25日（日）までの185日間、名古屋東部丘陵の長久手会場と瀬戸会場で開催された。我が国では大阪万博以来35年ぶりで、約121ヶ国・4国際機関の参加、そして約2,200万人の入場者があった。当初の推定では入場者1,800万人であったので、大きくこの数字を上回った。

愛知万博のテーマは「自然の叡智」で、新しい文化・文明の創造をめざして開催されたが、愛知教育大学では、愛知県が我が国でも有数の製造業（ものづくり）の盛んな地域で、また、本学が教育に関わる教育・研究を行う大学であることを加味して、これらにちなんだ「ものづくりと教育」イベントを企画し、「自然との対話」、「現代技術の体感」、「世界の人々との交流」をスローガンに掲げ、市民プロジェクトとして実施することになった。

ここでは、このイベントの出発となるプレイベントから、愛知万博での実際のイベント、そしてその後のポストイベントについて紹介したい。

The 2005 World Exposition (abbr. EXPO 2005) was held at Nagakute Site and Seto Site located in the hills east of Nagoya for 185 days from March 25 (Friday), 2005 to September 25 (Sunday), 2005. It was the second world exposition after the last one held in Osaka 35 years ago. About 121 nations and 4 international organizations participated and about 22 million visitors came to see the exposition. While the projected number of visitors before opening was 18 million, the actual visitors exceeded this anticipation considerably.

The main theme of EXPO 2005 was "Nature's Wisdom," targeting at creating new culture and civilization. Since Aichi Prefecture is major industrial area in Japan where manufacturing is quite active and Aichi University of Education conducts education and research regarding education, a series of events for "Making Things and Education" was planned and carried out as Citizen's Project, combining these factors under the slogans of "Dialogue with Nature," "Experiencing Today's Technology" and "Exchange among the Peoples of the World."

Here, we would like to present the pre-event which marked the opening of the whole program and the actual events held on the site as well as the post-event.

2. イベント実施の経緯 Background of the event

愛知万博への参加については、約1年半前、2003年12月に最初の準備を始めた。市民プロジェクトを始めとして愛知万博でのイベント開催のチャンスは幾つかあったが、我々のこれまでの経験や実現可能性、愛知万博の趣旨・特色との整合性を検討して、最終的に市民プロジェクトで実施することを決定した。そして、市民プロジェクトとしての目的・目標、内容と方法等に準拠しながら、「ものづくりと教育」の全体像ならびに具体的活動を創造していった。このため、愛知万博担当部局ならびに担当者との会議をほぼ毎月1回行った。一方、このイベントに協力をいただく各方面（関係機関、組織、会社、学外関係者、学内職員・教員等）の方々との話し合いを随時行ったが、全体会議については約1年前の2004年8月と半年前の2005年1月に2回行った。

The initial preparation for EXPO 2005 started in December, 2003. Although there were several possibilities of hosting events at EXPO 2005, we have finally decided to take part in Citizen's Project after investigating the conformity of our past experience and feasibility with the purpose and features of EXPO 2005. In accordance with the purpose, objective, content and procedure defined as Citizen's Project, the entire image and specific programs of "Making Things and Education" were constructed. A liaison meeting with the section/persons in charge of EXPO 2005 was held monthly. Meanwhile, meetings with various quarters (relevant institutions, organizations, companies, outside collaborators, administrative staff and faculty members of Aichi University of Education) were held as needed, with two plenary sessions in August 2004, one year before the exposition and in January 2005, six months before the exposition.

3. プレイベント Pre-event

愛知万博での「ものづくりと教育」イベントに先立ち、2004年10月11日（月・祝）には豊田スタジアムで開催された『とよたモノづくりフェスタ』（主催：豊田市他）の「わくわくワールド」で、上記「ものづくりと教育」のプレイベントを実施した。

そこでは、愛知万博の予行練習も兼ねて間伐材を使ったファイルボックス、貯金箱、パズル、丸太タグ等の部材を提供して、参加者に製作していただいた。用意した240人分（セット）は、午前10時から午後4時の間ですべて終了した。参加者は、子ども・大人、女性・男性の区別なく、また、楽しく作業をしていただいた。

このプレイベントの実施により、愛知万博でのイベント実施に向けて、数々の情報を得ることができた。

そこでの様子を、写真1、写真2に示す。

Prior to a series of events for "Making Things and Education" at EXPO 2005, a pre-event was implemented in "Waku-Waku World" of Toyota Manufacturing Festa organized jointly by Toyota city and others and held at Toyota Stadium on October 11 (Monday, National holiday), 2004.

In this event, materials for a file box using thinned wood, a coin bank, a puzzle and log tags and others were provided and participants were invited to manufacturing practice. It also served as a rehearsal of the exposition. The 240 sets of material were prepared, all of which were consumed from 10 a.m. to 4 p.m. All participants had fun irrespective of age or sex.

By implementing this pre-event, basic information and data were obtained for holding an event at EXPO 2005.

Photo 1 and Photo 2 show the scenes of this pre-event.



写真1 間伐材を使ったパズル作り
Photo 1 Making a puzzle with thinned wood



写真2 「ものづくりと教育」コーナーの様子
Photo 2 Scene of the site for "Making Things and Education"

4. 愛知万博での実施日程と内容 Program details of the events at Expo 2005

「ものづくりと教育」の実施時期は、7月25日(月)～31日(日)の1週間で、午前10時から午後4時～4時30分であった。日程ならびに時間帯は、万博事務局の配慮により、本学の希望通りに設定していただいた。季節としては真夏であるが、イベントへの参加者の年齢層や来場者の動向を勘案すると、大変良い時期であった。

会場は、25日(月)～27日(水)が瀬戸会場の海上広場で、28日(木)～31日(日)が同じ瀬戸会場の市民パビリオンである。市民プロジェクト事務局によると、本プロジェクトの期間中、海上広場には1日約10,000人、市民パビリオンには1日約5,000人の見学者が訪れたそうである。この中で、「ものづくりと教育」イベントに参加し、直接ものづくりを楽しんだ人数は、約1,500名に上った。各日の実施内容は、次の通りである。

"Making Things and Education" was carried out during a week from July 25 (Monday) to 31 (Sunday), from 10 a.m. to 4:30 p.m. With regard to the order of the day and the period of time, our original plan was generously accepted by the Secretariat. Although it is midsummer, it was a favorable opportunity in view of the age group of prospective participants and trend in visitors.

The venue was Kaisho Plaza in Seto Site from 25 (Monday) to 27 (Wednesday) and Civic Pavilion in the same Seto Site from 28 (Thursday) to 31 (Sunday). According to the Secretariat of Citizen's Project, there were about ten thousand visitors in Kaisho Plaza and about five thousand visitors in Civic Pavilion daily during the project period. Among these visitors, about one thousand five hundred people participated in a series of events for "Making Things and Education" and enjoyed hands-on manufacturing. The details of daily event are as follows:

4.1 各日の内容 Details of daily event

①第1日(7月25日(月)) The 1st day, July 25 (Monday)

7月25日(月)は、ものづくりワークショップとして、午前10時から午後5時まで、間伐材を使った木製品の製作を行った。題材は、丸太タグ、パズル、貯金箱、ファイルボックス、うちわ、癒しの音等である。最初の日であり緊張感の中で始まったが、多くの来場者により休む時間もないくらいに大忙しであった。なお、協力参加として、銀粘土によるアクセサリコーナーを1週間にわたって設けた。

その日の様子を、写真3、写真4、写真5に示す。

On July 25 (Monday), Making Things Workshop featured making wood products using thinned wood from 10 a.m. to 5 p.m. Major products include log tags, puzzles, money boxes, file boxes,

fan and healing chimes. Since it was the first day, the program started in somewhat strained atmosphere. However, we had a busy day receiving many participants without intermission. An accessory workshop using silver art clay is added for a week as our cooperating partner.

Photo 3, Photo 4 and Photo 5 show the scenes of the day.



写真3 貯金箱の製作
Photo 3 Making a money box



写真4 ファイルボックスの製作
Photo 4 Making a file box



写真5 銀粘土によるアクセサリー制作
Photo 5 Making an accessory with silver art clay

②第2日（7月26日(火)） The 2nd day, July 26 (Tuesday)

7月26日(火)は、午前10時から午後5時まで、ものづくりワークショップ：低温融解金属を使ったキーホルダーの製作、LED（Light-Emitting Diode）を使った照明機器、電池のいない電灯の製作を行った。この日は、台風が近づいていたため、風が強かったが、月曜日の夕方からその対策を講じていたため無事に遂行することができた。昼からはその影響が少なくなり、多くの参加者で賑わった。

その日の様子を、写真6、写真7に示す。

On July 26 (Tuesday), key rings using low-temperature fusion metal, LED lights and manually-powered flashlights were products of Making Things Workshop of this day. The workshop was held from 10 a.m. to 5 p.m. As a typhoon was approaching, it was a windy day but the event finished without any problems as we took measures against this Monday evening. In the afternoon, the impact of the typhoon was weakened and we received more participants.

Photo 6 and Photo 7 show the scenes of the day.



写真6 キーホルダーの製作
Photo 6 Making a key ring



写真7 LEDを使った照明機器の製作
Photo 7 Making a LED light

③第3日（7月27日(水)） The 3rd day, July 27 (Wednesday)

7月27日(水)は、中学生によるものづくり技術の発信として、ロボットの製作を題材に午前11時から午後2時まで行った。その前後の午前10時～11時、午後2時から5時までは、25

日と26日と同じものづくりワークショップとして、間伐材を使った木製品の製作、LEDを使った照明機器・電池のいらない電灯の製作、低温融解金属を使ったキーホルダーの製作を行った。ロボットの製作の際には、子ども環境サミット2005（UNEP：国連環境計画主催）で来日した海外の子どもや大人を招待してもものづくりの楽しさを味わっていただいた。

その日の様子を、写真8、写真9に示す。

On July 27 (Wednesday) of July, junior high school students joined the program to present their manufacturing techniques in robot manufacturing from 11 a.m. to 2 p.m. The same Making Things Workshops as on 25 or 26 were implemented before and after this event, from 10 to 11 a.m. and 2 to 5 p.m., covering works using thinned wood, LED lights, manually-powered flashlights and key rings using low-temperature fusion metal. International participants who visited Japan to attend Children's World Summit for the Environment 2005 (hosted by UNEP, United Nations Environment Program) were also invited to this program and shared the joy of making things with us.

Photo 8 and Photo 9 show the scenes of the day.



写真8 中学生によるロボットの製作

Photo 8 Robot manufacturing by junior high school students



写真9 海外からの参加者による製作

Photo 9 Making things by overseas participants

④第4日（7月28日（木）） The 4th day, July 28 (Thursday)

7月28日（木）は、CAD（設計・製図）ソフトウェアを使ったものづくりコンテストを午前10時から12時と午後2時から4時までの2回実施した。午前と午後のコンテストで使用したソフトウェアは異なるため、課題ならびに出来上りを評価する審査委員は異なる方にお願

いた。審査委員には、米国、香港等、海外からの招待者も含まれている。審査では、最優秀賞を本学の学長から授与していただき、続いて優秀賞、特別賞等をソフトウェア制作会社、販売会社から授与していただいた。

その日の様子を、写真10、写真11に示す。

なお、この市民パビリオンでのイベント期間中、“現代技術の体感”コーナーとして、レーザー加工機とNC機械の製作会社に参加をお願いし、木材とプラスチックに最新機器を使っているキャラクター等の加工を行っていただいた。

On July 28 (Thursday), two Making Things Contests were conducted from 10 a.m. to noon and from 2 to 4 p.m., applying CAD (design/drawing) software. As different software was used for the morning contest and the afternoon one, different judges were selected in order to evaluate the assignment and the finish. The Judges include international participants invited from U.S.A., Hong Kong and others. Best Work Prize was awarded by the president of Aichi University of Education, then Excellent Work Prize, Special Prize and others were awarded by the software company and the sales companies, respectively.

Photo 10 and Photo 11 show the scenes of the day.

During this event at Civic Pavilion, we asked manufacturers of laser processing machinery and NC machinery to join us and to demonstrate the processing technique of the most advanced machines through shaping well-known characters with wood and plastic.



写真10 CADコンテストの風景
Photo 10 Scene in the CAD contest

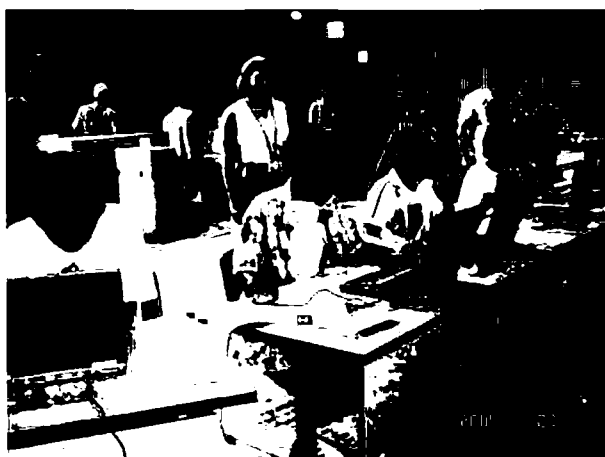


写真11 生徒の競技中の様子
Photo 11 Students during the competition

⑤第5日（7月29日(金)）The 5th day, July 29 (Friday)

7月29日(金)は、間伐材を使ったものづくりコンテストを午前10時から12時と午後1時30分から3時30分までの2回実施した。午前は子どもと保護者、午後は中学生の参加者であるため、課題ならびに審査方法を異なるように設定した。また、出来上りを評価する審査委員には、間伐材に関わる組織、行政機関、団体、学校の先生等、異なる立場の方をお願いした。審査では、最優秀賞を本学の学長から授与していただき、続いて優秀賞、特別賞等を各々の部署の方から授与していただいた。

なお、コンテストの空き時間を利用して、ものづくりワークショップとして、間伐材を使った木製品の製作、LEDを使った照明機器・電池のいらぬ電灯の製作、低温融解金属を使ったキーホルダーの製作を行った。

その日の様子を、写真12、写真13に示す。

Another Making Things Contest using thinned wood was held twice, from 10 a.m. to noon and from 1:30 to 3:30 p.m. on July 29. As the intended participants are different: children and their guardians in the morning and junior high school students in the afternoon, different task and different judgment method were prepared. Judges were chosen from the relevant sectors such as the organization related with thinned wood, local authority, various institutions and schools, each representing different viewpoint. Best Work Prize was awarded by the president of Aichi University of Education, followed by Excellent Work Prize, Special Prize and others were awarded by the respective partners.

During the waiting time of the contest, Making Things Workshop were offered, making wood products with thinned wood, manufacturing LED lights, manually-powered lights and key rings using low temperature fusion metal.

Photo 12 and Photo 13 show the scenes of the day.



写真12 間伐材コンテスト（子どもと保護者）の風景

Photo 12 Scene in the contest using thinned wood (children and their guardians)



写真13 間伐材コンテスト（中学生）の風景

Photo 13 Scene in the contest using thinned wood (junior high school students)

⑥第6日（7月30日(土)）The 6th day, July 30 (Saturday)

7月30日(土)は、インターナショナル・フォーラムとして、世界9カ国10名の参加による「ものづくりと教育」の交流を行った。テーマは、各国とも共通に「ものづくりと教育(Making Things and Education)」で、出席者の氏名と国、そして副タイトル（有する場合は、下の通りである。

- 1) Dr. Clarence H. Preitz (カナダ) (Canada)
- 2) Mr. The Augustin Kouadio (コートジボワール) (Cote d'Ivoire)
- 3) Mr. Mario Alfredo Majano Guerrero (エルサルバドル) (El Salvador)
- 4) Ms. Sahar Mahmoud Mohamed Abouzid (エジプト) (Egypt)
---Industrial Technology Education and Making Things in Egypt
- 5) Dr. Gerd Hoepken (ドイツ) (Germany)
---Making Things-Using Methods of Technology
- 6) Mr. Elisha Ndinya Abeka (ケニア) (Kenya)
- 7) Mr. Cesar Augusto Sena Ruiz Diaz (パラグアイ) (Paraguay)
- 8) Mr. Mehmet Yazar (トルコ) (Turkey)
- 9) Dr. Richard A. Boser (米国) (U.S.A.)
---Lasers and Wood: Applications in Technology Education
- 10) Ms. Anna Sumner (米国) (U.S.A.)
---SIMP Pre-Engineering Program Making Things and Education

フォーラムの終了後には、フォーラムの発表者と会場にいる参加者と一緒に、間伐材を使った木製品の製作、LEDを使った照明機器・電池のいない電灯の製作、低温融解金属を使ったキーホルダーの製作を行った。

その日の様子を、写真14、写真15に示す。

On July 30 (Saturday), International Forum was held with 10 presenters from 9 different nations of the world to exchange views on "Making Things and Education." Presentations were made on the common theme of "Making Things and Education." Their names, countries and sub-titles (if any) are as shown above.

After the Forum, the presenters joined the workshops to make products with thinned wood, LED lights, manually-powered flashlights and key rings using low temperature fusion metal together with the participants.

Photo 14 and Photo 15 show the scenes of the day.

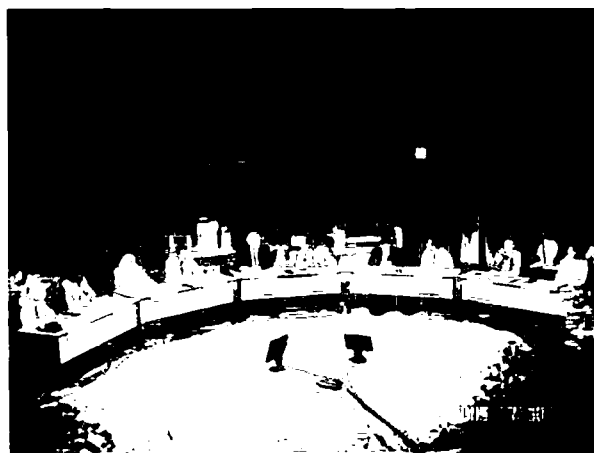


写真14 フォーラム（世界）の風景
Photo 14 International Forum (World)



写真15 アベカ（ケニア）氏の発表の様子
Photo 15 Presentation by Mr. Abeka (Kenya)

⑦第7日（7月31日（日）） The 7th day, July 31 (Sunday)

7月31日（日）は、インターナショナル・フォーラムとして、アジア7ヶ国9名の参加による「ものづくりと教育」の交流を行った。テーマは、各国とも共通に「ものづくりと教育」で、出席者の氏名と国、そして副タイトル（有する場合は、下の通りである。

- 1) Mr. Choeun Tauch（カンボジア）(Cambodia)
- 2) Dr. Jin-Soo Kim（韓国）(Korea)
- 3) Mr. Muhammad Nor Zaini Bin Jaafar（マレーシア）(Malaysia)
- 4) Dr. Hazrat Hussan（パキスタン）(Pakistan)
---Making the Knowledge to work for Organisational Excellence in TEVT
- 5) Mr. Tariq Mahmood（パキスタン）(Pakistan)
- 6) Mr. Ghulam Abbas Channa（パキスタン）(Pakistan)
- 7) Ms. Martha Farolan（フィリピン）(Philippines)
---Creativity in Education and Technology
- 8) Mr. Amin Badra（シリア）(Syria)
- 9) Dr. Chih-Yang Chao（台湾）(Taiwan)
---Design of the Liquid Cooling System with CPU

フォーラムの終了後、フォーラムの出席者と会場にいる参加者と一緒に、間伐材を使った木製品の製作、LEDを使った照明機器・電池のいらぬ電灯の製作、低温融解金属を使ったキーホルダーの製作を行った。

その日の様子を、写真16、写真17に示す。

Another International Forum took place on July 31 (Sunday) with 9 presenters from 7 Asian countries to exchange views on "Making Things and Education." As the preceding day, presentations were made on the common theme of "Making Things and Education." Their names, countries and sub-titles (if any) are as shown above.

After the Forum, the presenters joined the workshops to make products with thinned wood, LED lights, manually-powered flashlights and key rings using low temperature fusion metal together with the participants.

Photo 16 and Photo 17 show the scenes of the day.

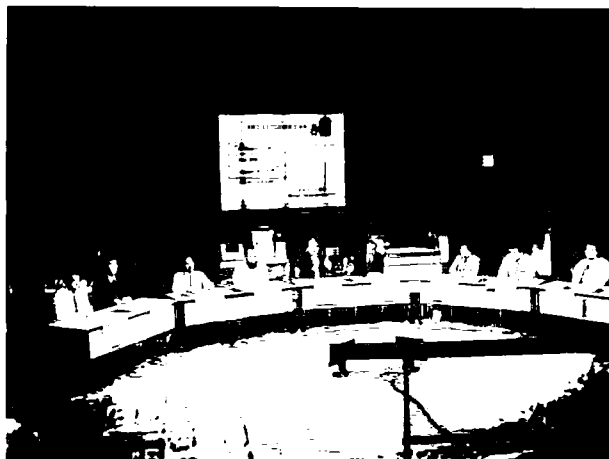


写真16 フォーラム（アジア）の風景
Photo 16 International Forum (Asia)



写真17 ジェイファ（マレーシア）氏の発表の様子
Photo 17 Presentation by Mr. Jaafar (Malaysia)

4.2 協力体制 Cooperative structure

これらのイベントに加えて、“自然との対話”では、全国森林組合連合会、愛知県ならびに愛知県森林協会、豊田市足助町木材協同組合とタイアップして間伐材に関わる資料の展示を行うと共に、当日のイベントでは使用する間伐材の一部を提供していただいた。また、上に述べたように、“現代技術の体感”では、レーザー加工機やNC機械のメーカーから、間伐材や金属、プラスチックなどの材料加工を最新機器を使つてのデモンストレーションを行っていただいた。また、“世界の人々との交流”では、国際協力機構（JICA）と日本国際協力センター（JICE）からは世界から、国際機関コロンボ計画技術者養成機構（CPSIC）からはアジアからの研修員をこのインターナショナル・フォーラムに参加できるように配慮していただいた。また、インターナショナル・フォーラムは、愛知万博・三菱パビリオンアテンダント杉山 翠（みどり）様に司会をしていただいた。

このように、本イベントの実施には、学外からいろいろな会社、組織・団体、学校の先生にお世話になった。そして、言うまでもなく、本学の教員、職員、学生には直接スタッフとしてご協力をいただいた。

In addition to the above-described events, as for "Dialogue with Nature" an exhibition of information regarding thinned wood was held in cooperation with National Forestry Cooperative Union, Aichi Prefectural Forestry Cooperative and Lumber Cooperative of Asuke-cho, Toyota city.

As mentioned above, in "Experiencing Today's Technology," manufacturers of laser processing machinery and NC machinery held a material processing demonstration of thinned wood, metal and plastic using the most advanced machines. As for "Exchange among the Peoples of the World," Japan International Cooperation Agency (JICA) and Japan International Cooperation Center (JICE) kindly arranged to send the overseas participants of their training programs to International Forum, Colombo Plan Staff College (CPSC), an international organization also joined in this effort to delegate their Asian trainees. Ms. Midori Sugiyama, an attendant of Mitsubishi Group Pavilion at EXPO 2005 supported International Forum as the master of ceremony.

External assistance such as companies, organizations and institutions as well as teachers contributed to the implementation of this event. Needless to say, cooperation of Aichi University of Education faculty, administrative staff and students led to this series of events.

5. ポストイベント Post event

愛知万博でのイベントをきっかけとして、その後「ものづくりと教育」について、多くの方面からイベントの依頼があった。ここでは、次の3つのイベントについて紹介する。また、その日の様子を、写真18、写真19、写真20に示す。

①日時：平成17年8月21日（日）午前10時～12時、午後1時～3時30分

場所：株式会社デンソー高棚工場 主催：株式会社デンソー

タイトル：デンソー夏休みモノづくりスクール「愛教大生による工作教室」

参加者：小学生と保護者 50人×2回（午前と午後）=100人

内容：間伐材によるパズルの製作

Our event at Expo triggered for further development concerning "Making Things and Education." We received requests for this event from various channels, three of which are introduced here.

Photo 18, Photo 19 and Photo 20 show the scenes of these events.

① Date: August 21 (Sunday), 2005, 10 a.m. to noon, 1 p.m. to 3:30 p.m.

Venue: Denso Corporation, Takatana Plant

Sponsored by: Denso Corporation

Title: Denso Summer Holiday Monozukuri School "Making Things Class by AUE Students"

Participated by: Elementary school pupils and their guardians, 50 participants × 2 times (morning and afternoon) = 100 participants

Content: Making puzzles using thinned wood



写真18 デンソーでのイベントの様子

Photo 18 Scene of the event at Denso

②日時：平成17年9月11日（日）午前10時～午後4時

場所：豊田スタジアム 主催：豊田商工会議所 他

タイトル：豊田産業フェスタ2005「間伐材ワークショップ」

参加者：一般 全100人

内容：矢作のせせらぎ（木製品の製作）

② Date: September 11 (Sunday), 2005, 10 a.m. to 4 p.m.

Venue: Toyota Stadium

Sponsored by: The Toyota Chamber of Commerce and Industry

Title: Toyota Industry Festa 2005 "Workshop for Thinned Wood"

Participated by: General public. Total: 100 participants

Content: Murmur of River Yahagi (Making wooden product)

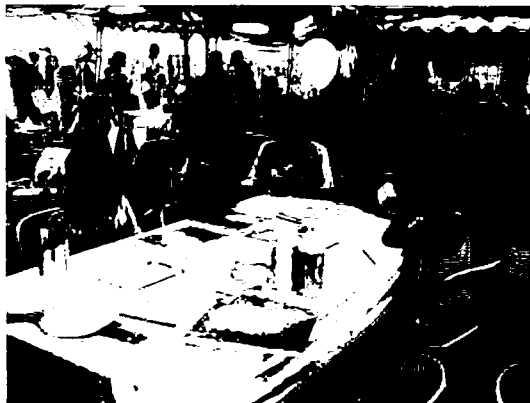


写真19 豊田市でのイベントの様子
Photo 19 Scene of the event in Toyota city

③日時：平成17年11月6日（日）午前10時～正午

場所：三好町緑と花のセンター「さんさんの郷」 主催：三好町 他

タイトル：産業フェスタみよし2005「子ども会まつり」

参加者：三好町子ども会 50人×2回=100人（1回1時間）

内容：間伐材を使ったパズルの製作

③ Date: November 6 (Sunday), 2005, 10 a.m. to noon

Venue: Green and Flower Center "Sansan-no-sato" in Miyoshi-cho

Sponsored by: Miyoshi-cho and others

Title: Industry Festa Miyoshi 2005 "Children's Club Festival"

Participated by: Members of Children's Club, 2 times (every one hour) = 100 participants

Content: Making puzzles using thinned wood



写真20 三好町でのイベントの様子
Photo 20 Scene of the event in Miyoshi-cho

6. おわりに Conclusion

愛知万博において、本学は市民プロジェクトとして「ものづくりと教育」という名称で貴重な展開の場を得た。この中で、以上に述べた盛りだくさんのイベントを計画して実施することができた。本学から愛知県、全国、世界に向けて、「ものづくりと教育」の大事さを発信し、児童・生徒、大人等に参加いただき、各イベントを盛り上げることもできた。

このことを将来、教育や研究、その他に生かしていくためには、継続的な活動が必要である。折しも、本学は文部科学省の2005年度特色GP「大学教育支援プログラム：学生の学習及び課外活動への支援の工夫改善に関するテーマ」が採択された。その中で『ものづくり教室』が提案され、そして現在鋭意実施されている。したがって、愛知万博での経験と、そこでの成果を継承して、今後さらに取り組んでいくことが可能になった。

なお、本イベントの取り組みの成果を、日本産業技術教育学会誌に報告として掲載する予定である。

A precious occasion was provided to Aichi University of Education under the title of "Making Things and Education" as Citizen's Project at EXPO 2005. All sorts of events were planned and implemented as described before, and thus we indicated the importance of "Making Things and Education" to Aichi Prefecture, overall Japan and the world through this exciting event in which pupils, students and adults participated.

It is necessary for us to follow up this program in order to reflect this experience in our education and research in the future. Just then, "University Education Support Program: Ingenuity and improvement of support for learning and extracurricular activities of university student" of Aichi University of Education was adopted by Ministry of Education, Culture, Sport, Science and Technology as the distinctive GP (Good Practice) for FY2005. In this program, "Making Things Class" was proposed and it is now implemented. Under this condition, it became possible to advance our activity further, taking over the experience at EXPO 2005 and its result.

It is scheduled that a report covering our commitment in this event will be issued on the Journal of "Japanese Society of Technology Education."

謝辞 Acknowledgment

まず始めに、このような機会を与えていただいた2005年日本国際博覧会万博協会にお礼を申し上げます。

次に、4.2で述べたように、このイベント実施においては、いろいろな関係機関、組織、会社、学外関係者、学内職員・教員等の方々約350名にお世話になりました。ここに、厚くお礼を申し上げます。

First of all, we would like to express our gratitude to Japan Association for The 2005 World Exposition for offering this precious opportunity to us.

Secondly, as described in 4.2, a special note of thanks is due to about 350 supporters including people from relevant institutions, organizations, companies, outside collaborators, administrative staff and faculty members of Aichi University of Education who worked to realize this program.

【概要 Outline】

愛知教育大学は、愛知万博市民プロジェクトにおいて「ものづくりと教育」イベントを2005年7月25日から31日までの7日間、関係機関、組織、会社、学外関係者、学内職員・教員等の協力を得て実施した。具体的内容は、間伐材、低温融解金属、LEDを使ったものづくりワークショップ、CADソフトウェア・間伐材を使用したものづくりコンテスト、世界・アジアからの参加者によるものづくり国際・フォーラムである。これらのイベントは好評を博すとともに、このことを通して、今後の「ものづくりと教育」に関わる多くの示唆を得た。

キーワード：2005年日本国際博覧会、愛知教育大学、ものづくりワークショップ、ものづくりコンテスト、国際・フォーラム

Aichi University of Education took part in the Citizen's Project of The 2005 World Exposition, Aichi, Japan from July 25 to July 31, 2005 with a series of events for "Making Things and Education" for seven days in cooperation with relevant institutions, organizations, companies, outside collaborators, administrative staff and faculty members of Aichi University of Education. Specific programs include: Making Things Workshop using thinned wood, low temperature fusion metal and LED, Making Things Contest using CAD software and thinned wood and International Forum on "Making Things and Education" by participants from the world and Asia. These events gained popularity with a large audience and many hints are suggested in terms of future "Making Things and Education."

Keywords: The 2005 World Exposition, Aichi University of Education, Making Things Workshop, Making Things Contest, International Forum

Original Articles

Lasers and Wood: Applications in Technology Education

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Introduction

Lasers are the latest technology added to the Technology Education program at Illinois State University. Although lasers are now work horses in many industries from manufacturing to health care, lasers have always evoked a science fiction or futuristic connotation that sparked the imagination – from laser light shows to StarTrek weapons and transporter devices. The utilization of lasers in technology education can capture student’s interest while emphasizing and integrating design, art, science, and technology applications. The purpose of this paper is to illustrate how laser technology can be combined with knowledge of wood and used as a tool for design and problem solving in technology education. The paper has three parts: first an overview of what makes a laser work; second, why awareness of lasers is important for technology education, and finally, sample products and the processes used to produce them.

How Lasers Work

The term LASER is an acronym for Light - Amplification by Stimulated Emission of Radiation. Lasers have a long and complex history. The original theoretical work on “stimulated emission” of light was published by Albert Einstein in 1917. It took another 50 years before Gordon Gould in 1958 outlined the design principles for a stimulated emission devise, which he termed a “laser” (Bellis, 2005). T.H. Maiman is credited with the development of the first working laser model in 1960.

Very briefly, a laser is devise for amplifying and controlling a focused beam of light (radiation). The basic components necessary are the active medium (source of radiation), a power source to stimulate the atoms in the medium to release photons, which bounce back and forth between a full mirror and a partial mirror until enough photons have been created (amplified) to emit radiation as a bright compact beam.

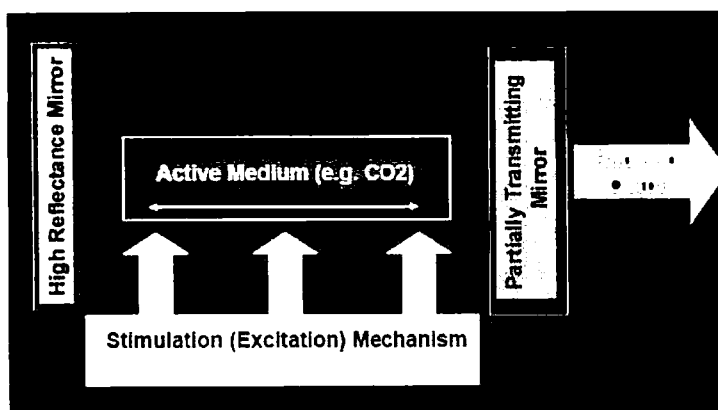


Figure 1 Basic laser components

Laser light is different from normal incandescent light due to many factors (Weschler, 2005). Laser light is monochromatic, coherent, and directional. A laser works more like a magnifying glass used to focus sunlight. Laser light is one color and one wavelength, organized into parallel waves with each photon moving in step with the other. The result is an amplified directional focused beam of light. A light bulb which is unfiltered and unfocused, projects all colors of light, each with different wavelengths, in all directions (Kross, no date). The light is therefore defused and cannot be focused to as a small spot. Light bulb light cannot be as intense as a laser without expending tremendous amounts of energy.

Laser light can be made less intense by activating a few photons or made very intense by activating many more generated photons to make a very bright compact beam (Weschler, 2005). An atom can exist in an excited state, similar to a bow when it is stretched. When the atom relaxes it emits a photon. This is similar to releasing the string of the bow and letting the arrow fly. Normally an atom will relax from its excited state anytime it feels like it. However, if another photon comes by that has the same energy as the atom in the excited state, the atom will decide to give off its photon and it joins the other. The atom is stimulated by another photon to release its photon. The excited atom emits a photon when another photon comes by. Radiation is a general term for anything that is radiated, or given off by an object. For lasers, radiation refers to the photons which are being emitted.

Types of Lasers

There are many different types of lasers. The laser medium can be a solid, gas, or liquid semiconductor (Wikipedia, no date). Lasers are commonly designated by the type of lasing material employed. Solid-state lasers have lasing material distributed in a solid matrix. Gas lasers which are helium and helium-neon, and are the most common gas lasers, have a primary output of visible red light. CO₂ lasers emit energy in the far-infrared, and are used for cutting hard materials. Excimer lasers use reactive gases, such as chlorine and fluorine, mixed with inert gases such as argon, krypton, or xenon. When electrically stimulated, a pseudo molecule (dimer) is produced. When lased, the dimer produces light in the ultraviolet range. Dye lasers use complex organic dyes, such as rhodamine 6G, in liquid solution or suspension as lasing media. They are tunable over a broad range of wavelengths. Semiconductor lasers, sometimes called diode lasers, are not solid-state lasers. These electronic devices are generally very small and use low power. They may be built into larger arrays, such as the writing source in some laser printers or CD players.

Laser Classifications and Safety

Lasers are classified into four general areas depending on the potential for causing biological damage. Lasers are classified into the following categories.

- Class 1 – These lasers cannot emit laser radiation at known hazard levels. Well known examples of Class 1 lasers include CD-ROM players and laser printers
- Class 1A. – This is a special designation that applies only to lasers that are “not intended for viewing” such as a supermarket laser scanner. The upper power limit of Class 1A. is 2.0mW.
- Class 2 – These are low-power visible lasers that emit above Class I levels but at a radiant power not above 1mW. The concept is that the human aversion reaction to bright light will protect a person. Supermarket scanners are an example of Class 2 lasers.

- Class 3A – These are intermediate-power lasers (cw: 1-5mW), which are hazardous only for intrabeam viewing. Most pen-like pointing lasers are in this class. Class 3 lasers can be an eye hazard if viewed directly.
- Class 3B – These are moderate-power lasers.
- Class 4 – These are high-power lasers (cw: 500mW. Pulsed: 10 J/cm² or the diffuse reflection limit), which are hazardous to view under any condition (directly or diffusely scattered). and are a potential fire hazard and a skin hazard. Significant controls are required of Class IV laser facilities. Class 4 lasers are used for many manufacturing applications.

It is important to understand laser classification for student safety. The lasers used for engraving and other technology education activities are Class 1 lasers that do not emit laser radiation at known hazard levels. Class 1 lasers are safe if left in their original housings and not disassembled. For additional information on laser classifications and safety see Laser Safety Training self-study guide at http://ehs.unc.edu/training/self_study/laser/.

Safety should always be a concern in a technology lab and proper instruction must be provided to students who work with lasers. However, lasers are safer than conventional cutting tools. The laser operates in a safety enclosure and will not operate if the door is open. Hence, no special personal safety equipment is needed. After relatively simple instruction on safety and material properties, students can quickly begin working with lasers. Instructors and professionals should compare laser technology to the hazards of cutting something on a band-saw, or the time, setup, equipment cost, and expertise required.

Uses of Lasers

Since 1960, laser technology has been developed for numerous industries and applications. Lasers show up in an amazing range of products and technologies. You will find them in everything from CD players and dental drills to high-speed cutting machines and measuring systems. Manufacturing and electronics applications of lasers include micro-machining, precision cutting and drilling. Lasers also have an ever increasing number of applications in construction. Laser levels are used to set elevations and grades, and create visible building lines to guide material installation. New power tools have laser pointers for more accurate cutting and layout. Also, as medical technology seeks to be less invasive, lasers are routinely used for eye surgery, blood clot removal, and a host of cosmetic surgery procedures.

Why Teach Lasers in Technology Education?

Flowers (2000b) offered many reasons why students should learn about lasers. Laser technologies are being widely implemented in a variety of industries and today's students should have an awareness of laser applications and related careers. Laser designs and applications require the application of mathematics for accurate cutting and engraving. Like CNC (Computer Numerically Controlled), lasers provide an opportunity to experience integrate design and production as students move from CAD (Computer Aided Design) to product prototype. Students can produce professional parts in short time more safely than with conventional saws and cutting tools. Because of the speed of production, rapid prototyping is possible with troubleshooting to find and fix design errors. Finally, students can produce a "take home" product quickly, something which is not common in most of today's technology education activities.

Laser Applications at Illinois State University – Process, Products, and Issues

Two years ago, Illinois State University purchased a 25 Watt CO₂ laser engraver, which engraves and cuts on wood, acrylic and plastic and will mark, but not cut, most coated metals. Although 25 watts does not sound like much power, it is focused in a very small area of about 5 thousandths of an inch, or 1/10th of a millimeter, in diameter. As such, the 25 watts generates a power density of about 1,000,000 watts or equivalent to over 16,000 60-watt light bulbs.



Figure 2 25-Watt CO₂ VersaLaser Universal Laser System Engraver with template on engraving table

How you use the laser depends upon the type of product you are producing. If you are producing a single item, like a key chain, you simply position the blank in the upper left hand corner, create your design or logo in CorelDRAW or other appropriate software, designate the appropriate settings for the type of material, and then print to the laser engraver. If you are producing multiple items, such as a six engraved pencils at a time, you must first cut out a template to correctly position the pencils for laser engraving. Once the template is produced, the pencils can be loaded into the template and engraved. The laser engraver works essentially the same way as a laser printer. A software driver for the laser must be installed; the design created in software such as CorelDRAW, and then “print” to the laser driver, which prompts you for settings for cutting, engraving, and material characteristics. As an example, a finished product of six pencils was laser engraved in less than two minutes. Total time to design and locate the text, cut the template, and engrave the pencils was about 20 minutes. The quality of cutting and engraving of this machine depends upon accurate measurement. Electronic digital calipers are used for this purpose.



Figure 3 Digital calipers used for measurement accuracy in setting up the template.

Laser machining is capable of replacing work on machines such as the band-saw or scroll-saw for cutting thin stock. The laser is safer to use than these traditional machining methods and can allow students to create products that would have been nearly impossible to build in the past.



Figure 4 Pencils placed in template ready for laser engraving.



Figure 5 Sample key chain product produced on VersaLaser engraver.



Figure 6 Veneer inlay cut on the VersaLaser. The same design was used on two different types of wood, cherry and ash, to maximize the contrast. The letters cut of one veneer fit into the other.

Laser machining in technology education can allow students who have used laser cutters to quickly go from a product idea to an actual part. Programs are available on the internet to quickly generate drawings within AutoCAD. These drawings can then be used as an outline for laser cutting. Students must practice laser safety, apply mathematical concepts, perform measurement and inspection, trouble-shoot industrial electronics and control, in order to effectively use laser technology.

The biggest obstacle for schools to introduce laser machining technology is the cost of the hardware. Also, students must gain a certain level of familiarity with these tools in order to use them effectively. Although cost may seem like a big problem, some manufacturers have advertised lasers as low as \$12,900. As an example, Ball State University used a combination of university funds from the National Science Foundation's Instrumentation and Laboratory Improvement Grant Program. If funds are not available, teachers may have to rely on field trips, videos, and partnerships with companies or with other schools that have the hardware. Ball State University students use their laser machining center to make manufacturing tools, prototypes of designs, and to mark materials. The largest use has been to make small signs, key chains, or other items with art and text engraved on a flat surface. Laser machining also offers additional options such as a three-dimensional laser scanners used to capture an object's surface geometry. However, this can be costly and time consuming compared to laser cutting parts with two-dimensional geometry (Flowers, 2000a).

Summary and Conclusion

This paper provided an overview of laser technology and illustrated how laser technology can be used as a tool for design and creative problem solving in technology education. A variety of products can be produced that challenge and motivate students to apply mathematics, science, and coordinate-based computer design. Laser activities in technology education expose students to a contemporary technology with numerous industrial applications. Students can quickly learn to produce professional looking products with a laser that would be dangerous or impossible to produce with traditional industrial machining. Laser machining is not limited to signs or key chains, but can also be applied to make design prototypes and tooling for more elaborate projects. Although the initial purchase of a laser engraver/cutter may be somewhat expensive, materials for subsequent activities are very economical. Laser machining is appropriate for technology education because it infuses contemporary technology in a way that is fun, safe, and builds knowledge and skills of integrated design and production.

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Note: I would like to thank Martin Mazur, Graduate Assistant at Illinois State University, for developing the draft of this manuscript from the original PowerPoint slides and narrative.

Methods of Technology – Methods of Technology Education – “Making Things”

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Since the beginning of technology education in Germany as a school subject in the sixties there emerged a set of specific approaches to teach technology as a subject. In most school subjects these approaches are named teaching “methods” – in German: Unterrichts-“Methoden”. To show the characteristics of technology as a school subject, a different concept for methods came into use: Unterrichts-“Verfahren”. This means teaching “procedures” in the meaning of process engineering procedures.

Methods of Technology Education

From the history of the subject (Werken: art and craft or industrial arts) the predominant procedure was the “Konstruktions- und Fertigungsaufgabe” (design and make activity). But not all aspects of technology can be covered with this procedure. So it was split into two independent parts, design exercise and making task. In the course of developing technology education, some more “procedures” evolved. The common set of “procedures” comprises the following activities (Henseler/Höpken, p. 53 ff.):

Table 1 The common set of procedures

Course of instruction	This is a method to attain limited partial aims of technology education. It is restricted to teach knowledge and skills. Examples are: How to use a power drill, computation of a series resistor for a light emitting diode.
Design activity	This method corresponds with an important technological action - designing. In the process of solving technological problems it emphasizes inventing, planning, designing and creating. Examples are: Designing a circuit board for an electronic circuit, Designing a time control (traffic light, flashing light)
Making activity	Manufacturing an object the pupils independently plan and organize the production process. Examples are: Manufacturing an electronic wiring, ...
Design and making activity	Design exercise and manufacturing can be combined. This is the original method of application of arts and crafts. It includes all stages of the planning and manufacturing process. But this means also, that only few exercises can be carried out during one term.
Technological experiment	The technological experiment can provide unknown values, which are needed in the further course of the lesson. Examples are: Determining the adhesion of various adhesives, determining the life of batteries under different loads.
Technological analysis	In a technological analysis technological object or technical facts are examined concerning their components or factors. This can be done destructive or non destructive. Examples are: Disassembling an electric iron to see

	the components of a control loop (non destructive, the iron can be re-assembled), opening the case of a power transistor (TO 3) (destructive)
Technological exploration	This is a planned and purposeful investigation of institutions outside school. Examples are: Traffic light, machines in a factory or workshop
Technological assessment	Assessment and evaluation of technology is one of the most complex methods of technology education. It takes place after each manufacturing exercise to assess and evaluate the object made. The result can be used to evaluate the pupil's standards. However technological assessment can also be a method of its own testing industrial products or even comparing types of power stations.
Project	The project is a method to enable students to solve complex tasks emerging from the reality of life. The project activities go from planning to practical realization. Characteristics of working in a project are orientation towards product and activity, interdisciplinary, orientation towards students, reference to situation and society, joint organization of learning processes. A project requires the removal of separation between school subjects and of 45-minute lessons.
Case study	In a case study, a real situation is the starting point for the learning process. After an exact analysis of the problem, several possible solutions are worked out in groups and a decision is made in the whole class. The result is compared with the real decision and assessed.
Expert inquiry	Expert inquiry is a method aiming towards reality. An Expert is invited into the classroom to answer questions about a certain, limited issue. So the students get first hand knowledge, insight, and experience.

This list of procedures shows a dilemma: some of them are part of the teaching strategies of all school subjects (e. g. course of instruction), some represent specific pedagogical approaches (e. g. project). So this set is not coherent and not stringent. Is there another way of determining a more coherent set of teaching and learning activities?

The goal of technology education is to clearly illustrate to the student the technical surrounding which are getting more and more complex. It should lead to a general technological literacy, which consists of three interactive components: factual competence, methodological competence, and assessment competence.

- The student is guided to a factual competence, by imparting to him exemplary and both structural and functional knowledge about technological subjects and processes which at the same time are transferable and objectively and subjectively significant. This incorporates getting to know technical functions, modes of action and conformity. The development of activity and skill to use technology, and effective use of matter, energy and information as well as the recognition of scientific and economic determined connections of technology.
- The student is lead to methodological competence within technology by using a way of thinking and working typical for technology in his lesson, like they appear within technology in developing-, inventing, and production processes. The path towards methodological competence corresponds with the development of creativity and the ability to co-operate and communicate in connection with technological action.

- The student is lead to an evaluation and assessment competence within the area of technological acting. by learning to assess and question critically the development, production and usage of technology under economical, ecological and social aspects. (Hartmann et al.. p. 10 f.)

Methodological competence is the key for developing teaching activities. Factual competence will be a by-product of methodological competence: evaluation and assessment competence is part of it.

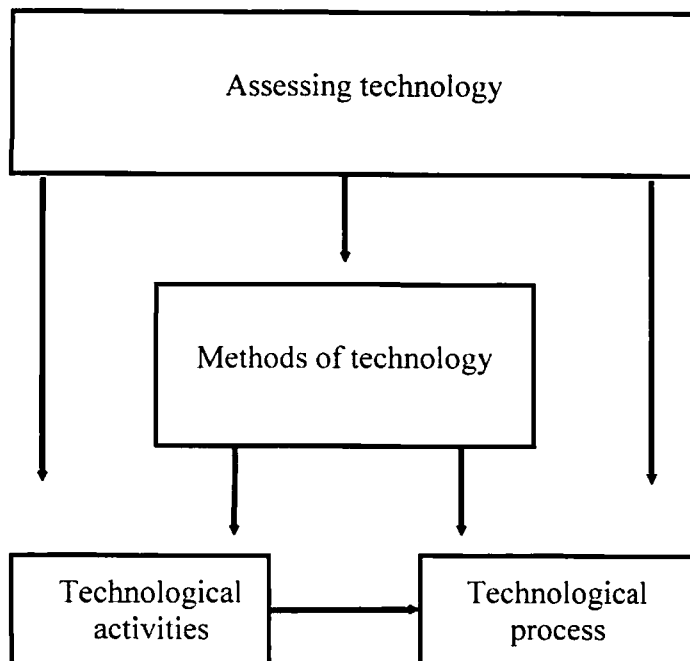


Figure 1 Content areas of technology (Henseler/Höpken, p. 33)

Technological Activities

Technological methods are embedded in general technological activities. These activities comprise the whole life of a technological product and include designing and making, but also distribution, usage, maintenance, and putting of operation.

Table 2 Technological activities

From emerging needs	Creating, controlling, manipulating, assessing need
Design	Planning, analyzing, looking for and assessing solutions, choosing, projecting, elaborating
Production	Acquisition, organizing, making, using standardized parts, assembling, testing
Distribution	Organizing, packing, storing, shipping, selling
Usage	Assembling, operating, testing function and safety, maintenance, cleaning, repair
Putting out of operation	Dismantling, scrapping, storing, recycling, ...

(Henseler/Höpken. p. 34)

In all these activities, specific technological methods are used. In today's complex technologies several methods are needed to acquire control over processes and artifacts. So methods to understand a process are eminently important.

Technological Methods

The technological methods were shown in the following Table 3.

Table 3 Technological methods

Methods of assigning and assessment	<ul style="list-style-type: none"> • Developing alternative solutions and choice of solutions according to criteria of assessment • Assessing consequences and danger using a technological system
Anticipating methods	<ul style="list-style-type: none"> • Choosing natural laws and assessing their appropriateness for achieving the objective • Anticipating a concrete solution by drawing or simulation • Assessing the function of concrete solution by a real model, by drawing, by calculations based on natural laws, by experiment, .. • Planning, organizing and representing the course of the process
Realizing methods	<ul style="list-style-type: none"> • Carrying out a process • Controlling the course of a process • Choosing and using appropriate objects, means and procedures
Simplifying/ systematizing methods	<ul style="list-style-type: none"> • Abstract and symbolic representation of systems, subsystems and their combinations • Splitting a complex system into single systems and subsystems easily to grasp • Assigning relevant quantities to systems and subsystems • Standardization
Analyzing methods	<ul style="list-style-type: none"> • Uncovering the natural laws, the system is basing on • Explaining the mode of operation by following the causal connections between relevant quantities and subsystems • Searching for errors and narrowing down errors by measuring relevant quantities at the interfaces of subsystems • Determining specifics of the object of operation, technological procedures and technological objects, assessing their appropriateness for a technological solution

(Henseler/Höpken, p. 41)

Activities and methods of technology change only very little in the course of time – they are time invariant, while technology changes. So they are subject matter with specific value. Technology education has to ensure the usage of technological activities and technological methods. Some of the methods are methods to make a process (or an artifact) understandable. So they are pedagogical per se. A good example for this sort of method is the

simplifying/systematizing methods. Abstract and symbolic representation of systems, subsystems and their combinations is a tool for many engineers today. to communicate with colleagues or for decision making.

In the following, selected technological methods are viewed, to show their appropriateness as methods for technology education.

Methods of assigning and assessment

Developing alternative solutions and choice of solutions according to criteria of assessment

It is the nature of technology that for a given problem there are always several alternative solutions. So criteria for assessing these solutions have to be made clear to select one of the possible solutions.

Assessing consequences and danger using a technological system

Every technological artifact, process, or system has effects and side effects. The balance between effects and side effects has to be assessed to make a decision about a technological system.

Anticipating methods

Choosing natural laws and assessing their appropriateness for achieving the objective

When a technological system is planned, there has to be made a choice of the basics for this system (mechanics, electronics, or pneumatics). From these basics it depends, how the balance of effects and side effects will be and how the solution will come up to expectations.

Anticipating a concrete solution by drawing or simulation

Once a solution has been taken into account, the properties of the solution will be viewed in a drawing or a computer simulation.

Assessing the function of concrete solution by a real model, by drawing, by calculations based on natural laws, by experiment.

When the anticipated solution seems to be promising, it can be further examined. A model can be made; several experiments or calculations can be done, to see whether the function of the solution is sufficient.

Planning, organizing and representing the course of the process

Once the course of the process is envisioned, the process has to be planned and organized.

Realizing methods

Carrying out a process

Of course, after planning, the process has to be carried out.

Controlling the course of a process

Control technology is one of the main areas of technology during the course of a process. The underlying control technology is technological solution (with all details and consequences) of its own.

Choosing and using appropriate objects, means, and procedures

One of the most important decisions for the effectiveness of a process is selecting the appropriate objects, mean, and procedures.

Simplifying/systematizing methods

Abstract and symbolic representation of systems, subsystems and their combinations

To carry out a complex process, it is inevitable to communicate about several ways of fulfilling the task. Since all processes are done by division of labor, systems have to be split into subsystem, but these again have to be combined.

Splitting a complex system into single systems and subsystems easily to grasp

Complex technological solutions employ many different parts basing on different fields of technology. These subsystems have to be named to enable communication between different groups of engineers.

Assigning relevant quantities to systems and subsystems

When a system has been split into subsystems, the relevant quantities have to be assigned to these subsystems.

Standardization

One of the reasons for the success of modern technology is standardization. So it is to prefer that as many parts of a system as possible are standardized.

Analyzing methods

Uncovering the natural laws, the system is basing on

A common misunderstanding is to consider technology as an application of science. Technology is a very much different field of human experience than science, but of course (like anything in human life) technology is based on science. Different solutions for a problem employ different natural laws. So it is interesting to name these laws to see the possibilities for variations or new solutions.

Explaining the mode of operation by following the causal connections between relevant quantities and subsystems

For bystanders a complex system only can be explained by uncovering the causal connection between the different parts.

Searching for errors and narrowing down errors by measuring relevant quantities at the interfaces of subsystems

One of the most important activities in modern technological product is finding errors or narrowing down them. So the rated value at every interface has to be known.

Determining specifics of the object of operation, technological procedures and technological objects, assessing their appropriateness for a technological solution

To assess every projected part of a technological solution, the specifics of all parts, all procedures have to be known.

Selecting technological methods for technology education

In technology education we find all types of technological methods: methods of assigning and assessment, anticipating methods, realizing methods, simplifying/systematizing methods, and analyzing methods. They are appropriate to structure technology lessons. The main advantage of structuring the lessons this way is to make sure that technology education has time invariant content and that it is well balanced representing all technological lessons.

Applying Methods of Technology – “Making Things”

Let us have a look at a very simple piece of woodworking, a little wooden puzzle. Do we need technology to make such a puzzle? How do we have to proceed to make it?

Let us analyze the puzzle. It consists of two identical parts. Each of them has a hole for the pieces of dowel rod of the other part to fit in. The single part of the puzzle must have been made in a way that dowel rod pieces can put into the boreholes. To explain how this has been made, we already need some technological methods. When we see the list of technological methods, we immediately find methods to solve this problem.

Some of the anticipating methods seem to be appropriate to show hidden things and how the parts are put together. But also the simplifying/systematizing methods seem to be extremely useful to explain how things work. From a systems approach e.g. the two identical parts can be seen as two subsystems. So the interfaces between them have to be identified: holes and dowel rods.

From this aspect it is also clear that the realizing methods have to be chosen carefully to secure that the parts fit into each other perfectly.

Choosing and using appropriate objects, means and procedures is part of the realizing process. Because the exact fitting is very important, In this case not a single production is considered, but a series production using jigs and other fixtures as well as semi finished products.

When we look at the table of technological methods, we see that nearly all have to be used to finish this simple looking wooden puzzle.

It is very important not only to know about the methods of technology but also to apply them solving technological problems. This is the place to emphasize on the value of practical doing, of “making things”. A hand on is the way to learn how engineers work and what technology is!

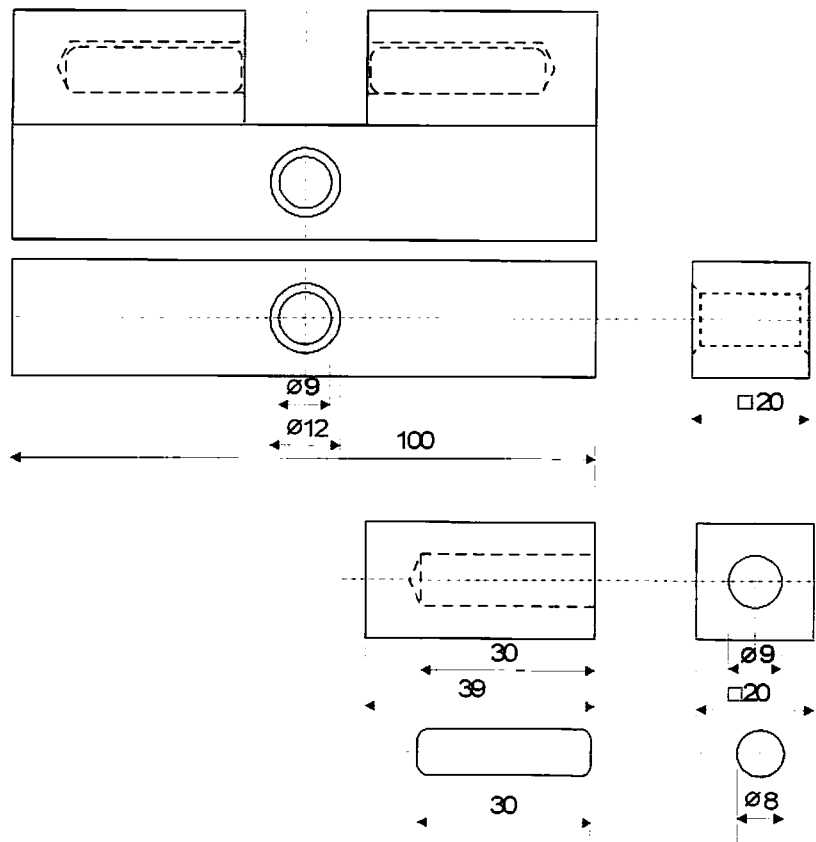


Figure 2 A puzzle

References

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Making Things in Education

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CANADA**

Introduction

Making things in education can apply to any educational activity that involves the manipulation of a material or tool process at the elementary, secondary, or tertiary level of education. These educational activities may involve the three levels of Bloom's taxonomy, the cognitive domain, the effective domain, and the psychomotor domain. It should be pointed out with emphasis that theoretically a learning activity can be placed in any domain for educational convenience. However, there is interrelatedness between the domains. For instance, a psychomotor skill cannot be taught in isolation of the other two domains. To acquire a psychomotor skill a learner must be able to think and acquire the correct attitudes toward safety of self, others, and equipment as well as develop a work ethic, etc. The ability to think is an integrated part of any skill, without the ability to think the learning process becomes meaningless.

One should be aware it is extremely difficult to pigeon-hole a learning activity into a single domain of learning because of overlap and existing shades of gray between and among the domains.

Normally educationalists related the making of things in education with the term industrial arts, which has evolved to today's technology education. Technology education places less emphasis on making things and greater emphasis on learning that involves the cognitive domain of learning with less emphasis on hands-on activities.

Makings Things – GRADES 7, 8 and 9

Initial learning activities in grades 7, 8 and 9 where the student begins the learning process to manipulate a material or a tool, hand or power that activity should be planned so the student has success with the end product. The teacher for these grades should:

1. Design a learning activity that is within the ability range of the learner.
2. Design a learning environment that is well organized with the correct equipment and learning resources, plans, references, etc., that are within the ability range of the learner.
3. Have materials that are easy to work so the learner has success working the material.
4. Provide the learner with technical information that is related to the material being used will help to expand the knowledge base of the learner.
5. Incorporate safety procedures for hand and power tools so the learner develops a wholesome attitude toward safety from the student's perspective and the perspective of the equipment and tools being used.
6. Selecting learning activities that will help to reinforce the academic disciplines offered as part of the school curriculum.

What is learned in grade 8 provides the foundation that will be expanded and reinforced in

subsequent grades of secondary school and later in the working world or at the tertiary level of education. Things to be made at this grade level should be simple, involve a number of processes that involve both hand and machine tools and permit the learner to have success in making the selected product. For instance, a product made of thinned wood the wood selected for the product should be a softwood, spruce, pine, or bass, which are easy to work by hand or machine. This will allow the learner to have success in making the product and prevent the learner from becoming discouraged. Time should be allotted for the presentation of related technical information that focuses on the material being used. To illustrate: is the wood domestic or imported; under what classification is the wood found; Is the wood open or closed grain.

At the junior/senior high school where I taught grade 7 students enrolled in Industrial Arts program of study were required to take a mandatory course in both Drafting Metal which included both sheet metal and machine metal. Grade 8 students took a mandatory course in Woodwork. Grade 9 students had the option to elect a course from one of the three areas. Class periods were an hour and a half long. Student enrollment for each course was limited to fifteen students per course by state edict. The state provided each teacher with a curriculum guide from which the teacher structured units of instruction.



Figure 1 Thinned wood product – American Black Walnut

Makings Things – GRADES 10, 11, 12

Students who elected to enroll in Industrial Arts at the Grade 10, 11 or 12 level had the option of selecting from one of the three courses available; Drafting, Metals or Woodworking as either a minor or a major. A minor took a course for two periods a week while a student enrolled as a major took the course for two periods a day five days a week for a ten periods a week. Students enrolled as either a minor or a major had free selection of the product they would make from a Chippendale mirror to a Salem chest. Time was made available for these students to work during their free periods, after school hours, and during Woodcraft Club, which was held in the evening one night a week for two hours.



Figure 2 Salem chest reproduction
Honduras mahogany
Grade 12 student

Senior high school products that were determined to be of quality by a judging team made of grade level students and the teacher were entered into a tri-state student craft fair for judging. The work of winners at this fair were placed on display in the lobby of a local bank and then sent to Dearborn, Michigan for international judging. One student had the good fortune to receive an Outstanding Achievement Award for a Queen Anne lowboy he made in Grade 12.

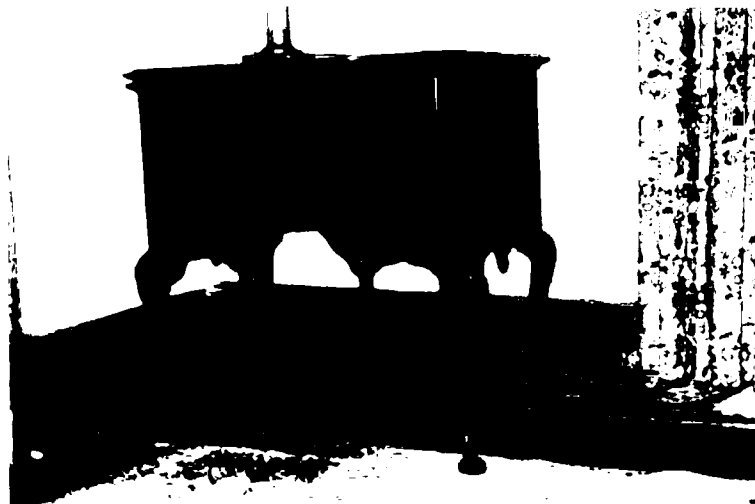


Figure 3 Queen Anne lowboy reproduction
Honduras mahogany
Outstanding Achievement Award Winner
Grade 12 student

Regardless of the grade level students enrolled in a woodwork course were taught related technical information about the woods they were using in their product and the finishing material used so that they would become more intelligent consumers and citizens who would make a contribution to society. The figures as follows are the examples of students' works.

Makings Things University-Undergraduate Students

University students enrolled in the Industrial Arts Program of Studies at the University of Alberta, Canada, were taught skill development in a materials multiple activity laboratory where Ceramics, Plastics and Woods were taught concurrently. In these three areas 105 psychomotor skills were developed. To acquire these skills the students received instruction six hours per week for twelve week or 72 hours of instruction during the term. In addition to acquiring these psychomotor skills students had to acquire skills in the other two learning domains.



Figure 4 Ceramic students making slip for slip casting
Plastic student adding catalyst to polyester resin

Prior to teaching any laboratory course the professor teaching the course was presented with a curriculum network, which illustrated the entry and exit points, a student had to achieve to successfully complete the course. Interpreting the curriculum network illustrated, the network list the processes in Plastics i.e., rotational molding, and the material, plastically, use to make a product using the rotational molder. Prior to entering the plastics area the student completed a 25-question survey to determine the student's previous knowledge of plastics and plastic processes. An area exit survey was also administered. The two scores from the surveys were compared to determine if learning had taken place. Neither score was used in compiling a grade for the area. Students had to complete all the learning activities on the curriculum network before advancing to a new area.

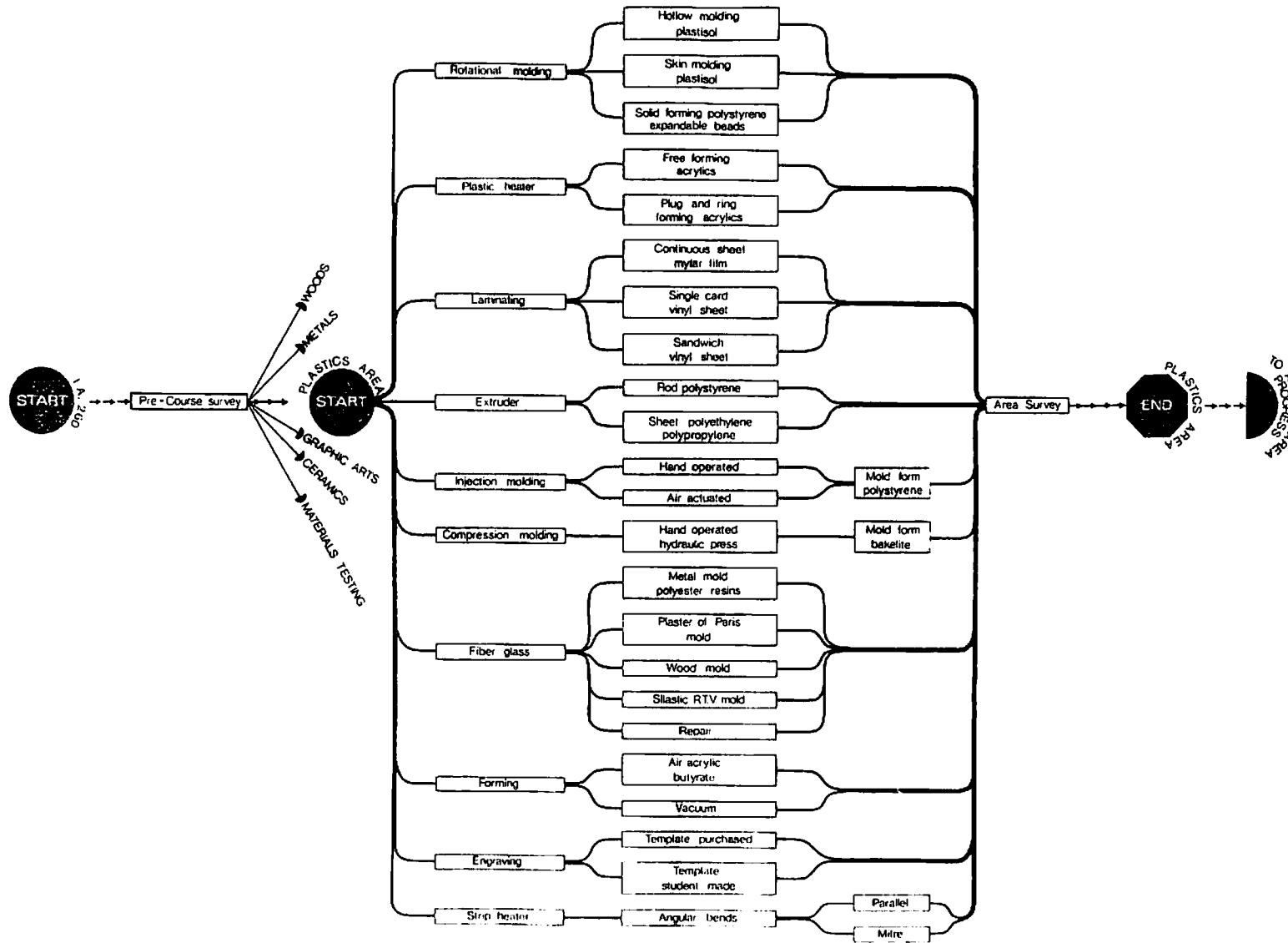


Figure 5 Plastic segment of curriculum network for beginning materials laboratory

For the beginning and advanced materials courses which I taught charts were developed which were color coded to the color of the appropriate area. Listed on the chart were the products in the area the student was to complete and outside. When a product or assignment was completed the graded was placed on the chart. This added to the competitiveness among the students to do the best of which they were capable. Marks competitiveness among the students to do the best of which they were capable. Marks were there for all students to see. In essence the chart became the grade book for each course.

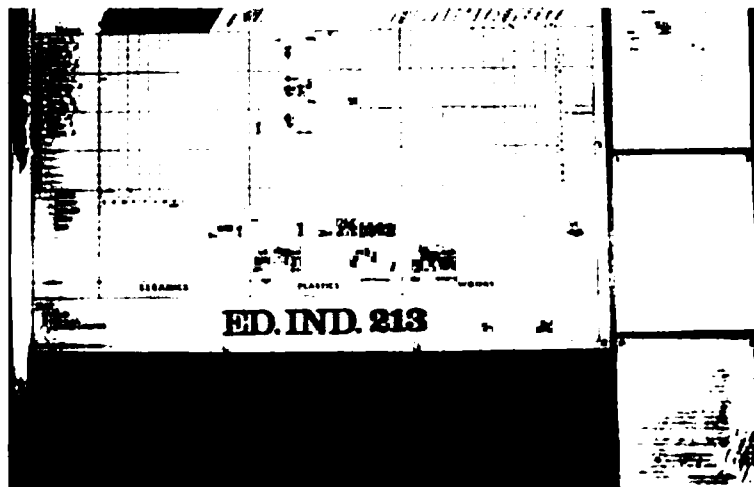


Figure 6 Chart for three areas of instruction beginning materials laboratory

From experience with these adult learners we learned we had students entering the program at the two extremes of the educational continuum. At one extreme of the continuum was the student who possessed a goodly number of the 105 psychomotor skills acquired through either informal or formal education or training. At the opposite side end of the continuum was the student who possessed a limited number of skills. To compensate for this skill differential a product matrix was developed to maximize the learning time for the student.

This matrix had three levels of experience: none, some, proficient. Each level of experience is divided into a product quadrant which began with a product a beginning students would have success in making and terminated with a product a proficient student would have success in making. (Figure 7)

The content for the materials courses was divided into 80 percent practical and 20 percent theory. The major professor for the course taught both portions of the course with the practical portion taught by the major professor with the aide of a teaching assistant.

Emphasis for both the beginning and advanced materials courses was placed on reinforcing the academic disciplines of mathematics, science, and English the language of instruction This was done so the student would develop the concept that industrial arts is not an isolated subject but was dependent on other subjects for part of its content.

Product Matrix Wood




<u>Manufacturing Process</u>	Level Of Experience		
	None	Some	Proficient
<u>Machining</u>	 <p>Level of Difficulty</p>		

Figure 7 Product matrix for woods area
Materials Laboratory

Summary

Any practical learning activity will involve the three domains of learning of Bloom's taxonomy. These learning domains must be taught as unit and not in isolation of the other.

Junior high school students, Grades 7, 8, and 9 should have success with the material used to make the product. To achieve that success the product should be of interest to the student and the material easy to work. Related technical information should be incorporated into the instructional program.

Grades 10, 11, and 12 students should have free selection of the product they want to make and be permitted enough time to complete the product. The teaching of related technical information is a must at this level of education.

University student enrolled in the Industrial Arts Program of study were taught in a multiple activity laboratory – Ceramics, Plastics, and Wood, where 105 psychomotor skills were developed over a period of 12 weeks. Students were taught six hours a week for 12 weeks. Charts were developed for materials courses and color coded to the appropriate areas of the laboratory. These charts were used for formative evaluation to show student progress.

Because of different learning experiences of entering students a three level product matrix was developed for product selection. The purpose of this matrix was to maximize the student learning time.

Making Things and Education: SIMP Pre-engineering Program

**Anna Sumner
Westside Middle School
U. S. A.**

Overview

The Society of Military Engineers (SAME) sponsors the Student Initiative Mentoring Program (SIMP) through the University of Nebraska at Omaha's Engineering Campus. SIMP is a pre-engineering program where the primary goal is to introduce middle and high school students to the Engineering and Architectural fields of study. SIMP links the students to an engineer or architect adult mentor. The teacher's role becomes one who coordinates the needs of the project and guides students.

The process of SIMP begins with brainstorming problems that exist in our world today. Based on criteria, students select an open-ended problem they want to solve. The remainder of the time is spent solving this problem in group sessions. Engineering mentors meet students on a weekly basis and guide them through the same problem solving model engineers' use. The process concludes with a competition where students present the solution to the selected problem. Students write a proposal, present their model, do an oral presentation, and field questions from the judges.

This pre-engineering program truly reflects an experience for students in the field of Technology Education. The program uses a cross-disciplinary approach and is inquiry-based. Within a safe environment, students take risks intellectually, socially and emotionally. On a daily basis students learn about the technological world they live in and how they can make it better. It reflects teamwork in the "real world." When disagreements arise on how to solve a piece of the problem, mentors introduce "Pros and Cons" and the teacher may pose decision-making strategies. Students then, as a group, decide on solutions.

The adolescent learner thrives on challenges; they love to explore new technologies. Technology use and training is infused throughout the entire year. The teacher provides students software to learn, introduces them to multimedia presentation styles and well as modeling techniques. Mentors arrange site visit to "see" how engineers are solving everyday problems. Other experts come and talk to the students about how to address solutions to their problem as well as other people to contact to further justify a solution path. These contacts take place online, by phone, or face-to-face. Students use global positioning devices (GPS), plotters, surveying equipment and aerial maps. If the students find a need for a technology with which the mentors or teacher are unfamiliar with, together we seek help. We have had assistance from other engineers, school board members, principals, and plant managers.

This program addresses the needs of all the learners in a school by providing them with the opportunity to express their knowledge yet challenges them to think critically. Most importantly, they learn how to work together as a group. Each student is responsible for a "piece" of the project. The project will not reach fruition if one person does not do their research and apply what they have learned to their part of the solution. Students figure out that in this type of group work they cannot do all the work or "slack off" and do none. No

one will come to his or her rescue. If they do a poor job on their work the entire project may fail. Just like in the “real world.”

Parents are a key element in the success of this program. They are invited to any of the work sessions, support students in their research and give the occasional nudge to keep their student on track. They help edit the proposal, proofread, gather and donate materials for our models, and attend the competition and awards ceremony.

The pre-engineering process challenges the students to think harder than they ever have and through critical thinking methods this in turn challenges their teacher. Teachers read professional journals and scan workshop offerings, continually seeking additional teaching methods for these learners. This to maximizes the student’s learning experience.

Student Initiative Mentoring Program (SIMP)

Program Goals

To provide for students a “Real World” learning environment that introduces them to the various fields of Engineering and Architecture
To generate excitement about career opportunities
To work with different problem solving models
To develop a strong understanding of teamwork and professional networking

Teamwork

Involve everyone in the project development
Assign students to tasks to suit their talents
Mentor assists in guiding students through the engineering process

The Process

Select a project

Teachers have students select a project they want to do when students select the project they have a stronger commitment to the project
Students BRAINSTORM a list of ideas
Avoid projects that are not feasible in time or capabilities
Get an idea of what the final product will be
Define project scope and timeframe to complete project

Take field trips

Possible solution sites
Manufacturing sites
Any site to enrich the student learning that pertains to the project

Visit job site under construction

This allows students to see “how” an idea/project becomes reality

Research

By themselves, in teams, with mentor(s), parents, other adult volunteers
Keep daily journals of their progress, field trips, research, etc.

Develop a solution

Problem solving

Use or learn about new resources

Teamwork – everyone has a job that affects the projects outcome

Prepare a written proposal

All components of a “real proposal” are included

CONTENT - Shall Include but Not Be Limited To:

- i . Title Page/Sheet: Including School Name, School Team Leader, Mentor Name(s)
- ii . Brief Project Description Title, Date, and List of Names and Grades of All Team Members
- iii . Project Problem Statement
- iv . Recommendations (Project Solution) and Action Plan for Implementation of Recommendations
- v . Team Organization (Chart)
- vi . Project Description (Journey Documentation)
- vii . Lessons Learned
- viii . Acknowledgments

Prepare oral presentation and display materials for competition day

Very open-ended and is up to the student team. It may include

Multimedia presentation using a SmartBoard or PowerPoint

Model of the solution

Poster boards explaining solution

Competition day

Present solution

To a panel of judges within the time limit

Answer judges questions

Attend other presentations

Evening Awards

Project on display

Listen to guest speaker

Award winners announced

Celebrate

As a team

Have a party - make team t-shirts

Review judge’s comments

Reflect on the process and how we did as a TEAM

The Pictures of the Process

1. Take field trips



2. Visit job site under construction



3. Research



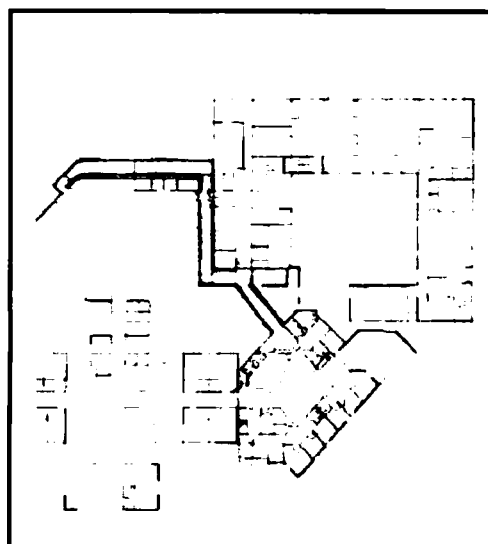
4. Develop a solution



5. Prepare a written proposal

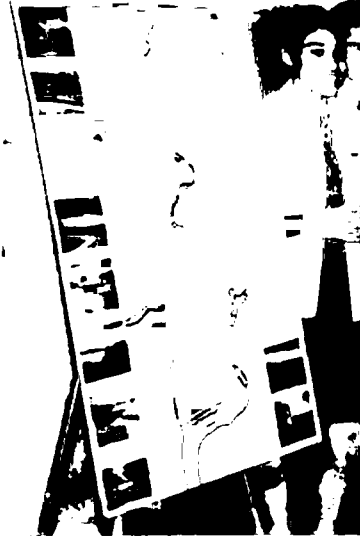
PROBLEM STATEMENT

Within the Douglas County area there are few mental health facilities. However, the need for mental health facilities has not decreased. Those who cannot afford private services or require continual care have few options. We have decided to solve this problem by creating a cost effective facility. We plan to approach this by...



Graphic/Drawing/Etc.

6. Prepare oral presentation and display materials for competition day



7. Competition day



8. Celebrate



(Anna Summer, President of ITEA 2004-2005)

Design of the Liquid Cooling System with CPU

Chih-Yang Chao, Dyi-Cheng Chen, Yi-Ren Lin
National Changhua University of Education
TAIWAN, ROC

Introduction

Motivation

Computers are now frequently used in daily lives and the calories of the electronic spare parts, such as CPU, increased while information machines like computer servers are highly performed. The most important relevant problem of computer usage is the heat dissipation, which can often explain why computers crashed with unknown reasons. Traditionally, the cooling systems use wind to dissipate heat. Once the systems are not capable to cool machines, the operating frequency of the fans increased to ensure the quantity of wind, and the sound of the operation became louder. However, increasing operation frequency of the fans is not the best solution to dissipate heat. Recently, computer market invented a liquid cooling system, which uses water to dissipate heat. The liquid cooling system will be a potential product in computer industry for it is more capable to cool and is more silent to drive. [1-6]

Purposes

The study main idea is to improve, design and integrate recent liquid cooling system products. Because the price of the heat dissipation systems are still quite expensive in computer market, we attempt to lower the cost by simplified the structure and try to design a smaller heat dissipation system, so that the system will be easy to purchase and install. The price of the new liquid cooling system will be similar to traditional ones and hoping to popularize liquid cooling system with CPU into daily lives. More users can enjoy the advanced product with low price and computers can functioned in a best situation through this system.

Range and limitation

This product mainly aims at improving the existing design on present market, looking after both good heat dissipation product originally possessed and possible manufacturing cost that need to be reformation. By doing so, customers may achieve a good balance point on price.

Therefore, the study took manufacturing steps into consideration when designing product. We also communicated with manufactures about the modified design chart, possible blind spot, and tried to finish all works such as design, change, open a mold, renovate, test, etc., in a brief time. Besides, the parts that cover in the top and bottom had to be considers whether they could be perfectly combined with the essence structure without a drop of leaking. In addition, because the materials of the top and bottom cover adopt PC plastics and product essence adopts the aluminum to push into shape, temperature that causes expand and shrink should also be considered. Hot and anti-oil consideration of PC plastic materials, how liquid could flow fluently in the essence to dissipate heat, how to choose good but cheap materials, etc., are also important factors to overcome.

Related Background Knowledge

Outline

This manufacturing project is divided into two main parts: first, manufacturing heat dissipation water tank, and second, manufacturing the liquid cooling system. The whole process including: understand the function of the whole operation with initial heat dissipation system, adhere to the steps planned, draw the sketch, group discussion and coordination, and finish the basic framework.

The first step completes the initial layout of the hardware that designed the basic structure of the liquid cooling system, modified to open the mold, and tested out the semi-finished product. Matching with the demand of the design, we modified components of the product, assembled the setup after completing, and revised by test its performance. The whole project completed at beautifying the appearance of the product.

Related designing principles

This project is divided into two parts: the manufacture of the heat dissipation water tank; second, the manufacture of liquid cooling system.

1. Manufacture of heat dissipation water tank

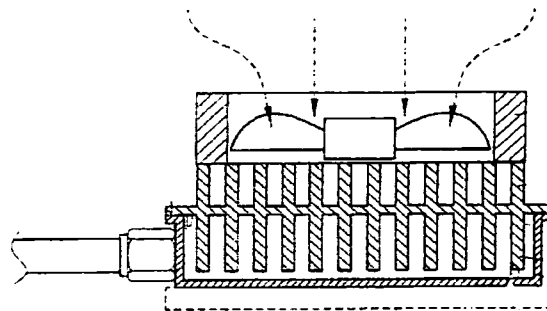


Figure 1 Heat dissipation water tank

(1) Manufacturing process of the heat dissipation water tank

- a. Body.
- b. Material: copper/aluminum.
- c. Molding tool: heat dissipation pieces.
- d. Better heat dissipation design.
- e. Edge cleaning.
- f. Surface treatment.
- g. Assembling: joint the body of the dissipation water tank and the upper cover by metal soldering.
- h. Cooperated with the assembling craft techniques of the fan and CPU to reach the better result and be more convenient to dismantle.

(2) Fan

- a. Select from the current market products.
- b. Compare the performance: quantity, pressures, and noise values.
- c. Consider the price and performance.

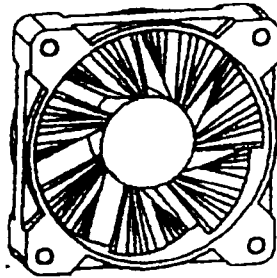


Figure 2 Fan

(3) Performance measurements

- a. Configure to measure on simulation system: in order to compare the performance of the heat dissipation water tank.
- b. Combine the measurement system and the computer.
- c. The preparation and purchase of the measurement instruments.

(4) Production

- a. Automated, reduce the manufacturing process and the cost.
- b. Preparation of the producing machines or outsourcing processes.
- c. The allocation of the related personnel: machine/ CAD design/ product assembling design.

2. Manufacture of liquid cooling system

(1) The manufacture of the heat exchanger

- a. Extrusion forming.
- b. Thin out the wall and the heat dissipation slab.
- c. Joint the spiral and the tube tightly.
- d. Deal with the connection of the joint and tube.
- e. Rest of the procedure is similar to the manufacturing of heat dissipation water tank.

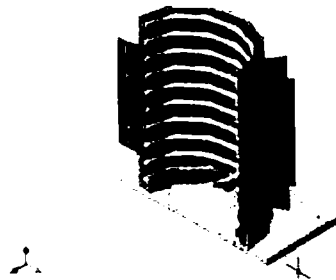


Figure 3 Heat exchanger

(2) Water pump

- a. Select from the current market products.
- b. Compare the performance: quantity, pressures, and noise values.
- c. Consider the price and performance.

- (3) Fan
 - a. Select from the current market products.
 - b. Compare the performance: quantity, pressures, and noise values.
 - c. Consider the price and performance.
- (4) Choose the piping connection.
- (5) Performance measurements
 - a. Configure to measure on imitating system: in order to compares the performance of the heat dissipation water tank.
 - b. Combine the measurement system and the computer.
 - c. The preparation and purchase of the measurement instruments.
- (6) Production
 - a. Automated, reduce the manufacturing process and the cost.
 - b. Preparation of the producing machines or outsourcing processes.
 - c. The allocation of the related personnel: machine/ CAD design/ product assembling design.

The material used in top and bottom cover is plastic. It is typically applied to the electricity and business equipment (computer components, connectors...etc.), apparatus (food processing machine, refrigerator drawer...etc.), and the transportation industry (vehicle lamp, instrument board...etc.).

The conditions of the injection molding craft are as followed. The PC material has to be hygroscopic. Suggested dry condition is about 100°C to 200°C, for 3 to 4 hours. Before processing, the moisture should be lower than 0.02%. Melting temperature is 260 to 340°C; molding tool temperature is 70 to 120°C. As to injection pressure, high injection pressure is preferred. To smaller gate, the injection speed should be lower while others can be higher.

Its chemistry and physical characteristics are as followed. The PC is a kind of non-crystal engineering material, with incredible anti-attack intensity, heat stability, luster, germ repression, and characteristics as flame retarding and anti-pollution. The otched Izod impact strength of PC is pretty high and the constringency rate is generally low to 0.1 ~ 0.2%. PC has good mechanical characteristics but worse flow ones. Therefore, the process of injecting using such kind of material is more difficult. Final expectation of the product is the base to choose PC materials. If the segments require higher anti-attack intensity, low flow rate PC will be suitable; on the contrary, high flow rate PC material and optimized the injection process. The later was adopted in our product.

Aluminum extrusion molding is a kind of aluminum material processing. It is different from aluminum casting and forging. The shape differs from the molding tool, including shaping material, wire material, tube material, bar material, and so on. Each of the cross section is consistent and can be used for extrusion molding. According to its usage, aluminum extrusion molding products can be divided into two types: general usage and industrial usage. The product in our project used the later one for it is lighter and cheaper, and with better heat dissipation.

The material of the heat dissipation water tank adopts the copper to fold the model. Copper has good intensity, ductility and anti-causticity, and is good to conduct electric and heat. It is thus viewed as a valuable business metal and the outlay is only inferior to iron and aluminum.

Copper is also called "red metal". Good conductivity of copper makes it widely used in electricity industry. Say with the unit volume, its electric conduction is only next to silver and is applied to make conducting wires and kit of electrical communication devices. The high heat conductivity of copper is also next to silver only and is used in refrigerator, vaporization machine, and heating coil...etc. Another important characteristic of copper is anti-causticity. Using copper piping can prevent mineral substance deposition when delivering water. So, copper is used in many water supply articles within deluxe bathroom equipment. cooling device, solar equipment and air condition systems. Architecture industry and automobile industry also use it for a great quantity. Therefore, using copper to make the water tank can easily absorb and take away the heat in a shortest time period. Other materials bought from the present market products. The functions are still in testing process.

Results and Illustration

Method and steps

(1) Contact with manufacturer :

Contact with manufacturer to discuss the cost and the society needs. After combining the speculation of both party, product design and produce put into practice.

(2) Consult and collect references :

To gather materials from every possible aspect, and follow the direction professor guides to do related literature review.

(3) Draft the direction and the topic of the finished product :

Select the topic of the wanting finished product and the report topic as well after reading materials collected from different resources.

(4) Discuss the heat dissipation function, modify and construct design :

By discussing with cooperate manufacturer; we concluded more economic and better heat dissipation functions to modify the liquid cooling system.

(5) The design diagram of the liquid cooling system with CPU :

The design was divided into three parts and draws each diagram.

- a. The design of injection of the top and bottom cover.
- b. The design of the aluminum extrusion molding of slab.
- c. The design of the column of heat dissipation actinium and copper plate folding piece.

(6) Discuss and modify the diagrams :

Through the drawing and design, we had basic cognition of the liquid cooling system. Then modify, redesign the diagram following what have been discussed with the manufacture before.

(7) Change related kit to fit the design :

To calculate and change the related places of the kit after making some changes of the diagram.

(8) Discuss with the manufacturer about the design variations :

Visit the cooperate manufacturers to make sure the manufacturing difficulty, practicability, etc. Then, modify the design.

(9) Appraise :

Estimate the price of the finished product and see if the product can be manufactured in an economic way.

- (10) Production: cooperate with manufacturers :
- a. The manufacture of injection of the top and bottom cover.
 - b. The manufacture of the aluminum extrusion molding of slab.
 - c. The manufacture of the column of heat dissipation.
 - d. The manufacture of the heat dissipation copper plate plait piece.
- (11) Connect each related kit and do experiment :
- Experiment the sample made by the manufacturer. The experiment items include heatproof and heatproof liquid of the fluxion, market satisfaction, etc., that can be a reference to modify the product.
- (12) The finished product :
- Complete the finished product with manufacturer through several of experiments and manufacturing.

Introduction of product appearance and operation

This product is modified and designed by the liquid cooling system of the present market but lower the cost of producing and is easy to operate. Following is the explanation of how each part operates:

- (1) Motor device: It is the main power of heat dissipation. After turn on the motor, heat dissipation liquid flows through heatproof pipe and dissipate heat.
- (2) Heat dissipation copper plate: accompanied with heat dissipation cream underneath the cooper plate, the liquid heat dissipation system can reach the best result.
- (3) Heat dissipation copper column: The internal copper column can transform the heat energy of its CPU. The motor will turn on the fan and ejects the heat.
- (4) Upper cover: Equip by the copper plate, heat dissipation liquid flow through heatproof and corrosion-proof pipe to upper cover. Fans on upper cover can eject the heat. The upper cover can also stream the liquid to reach the function of heat dissipation.
- (5) Aluminum extrusion molding slab: Heat dissipation liquid streams within the device and make use of the heat dissipation slab to increase the heat dissipation results.
- (6) Bottom cover: The main function is to connect the computer host and prevent the leakage of the liquid, and to bring back the heat liquid back to motor as a cycle.

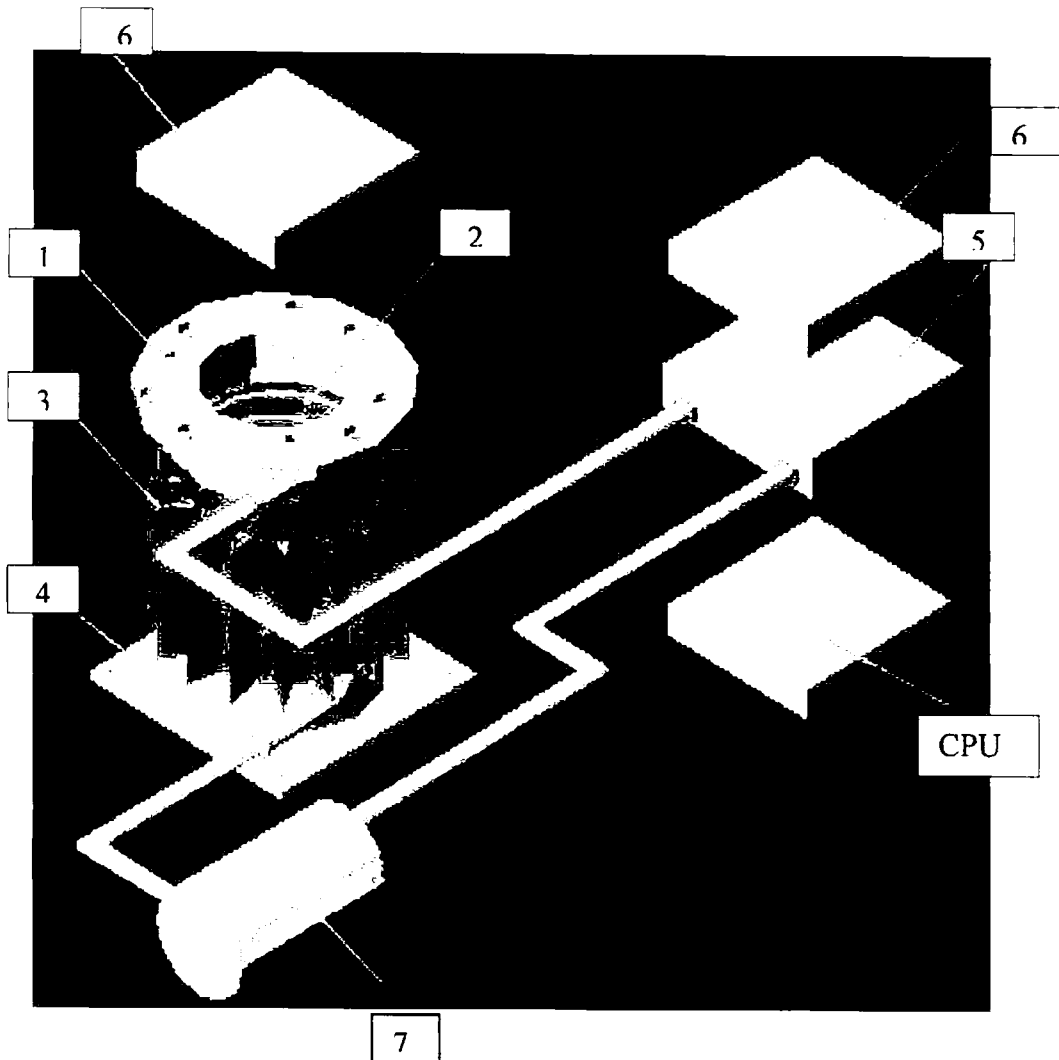


Figure 4 Appearance of finished product

- No.1: Upper cover
- No.2: Inner heat dissipation piece
- No.3: Outer heat dissipation piece
- No.4: Bottom cover
- No.5: Heat dissipation copper plate and the column
- No.6: Fan
- No.7: Motor device

Operating guide and special notice

(1) Operation of the product :

This finished product is mainly designed for large company or family with big CPU usage. The setup is simple. To operate, users only need to install the system in the host, making the computer on and it will function automatically once the motor is motivated.

(2) Special notice :

Please keep this product away from needle form things and avoid falling it off. When installing, do not touch the liquid or the system might not operate normally.

Conclusion and Suggestion

Conclusion

- (1) The present liquid cooling systems are quite expensive and with big volume. To solve such problem, our team members designed a smaller heat dissipation system.
- (2) In order to make the society use this liquid cooling system and identify its ability to dissipate heat, so we try to promote this liquid cooling system with CPU into more families. Users then can enjoy a better-functioned product and the CPU of computers and reach their best conditions.

Suggestion

- (1) The error of copper plate and assembling kit should be considered so they can be setup properly.
- (2) The liquid cooling system with CPU should be installing in computers after complete tests. so that we can avoid the difficulty of spare parts dismantling.
- (3) Additional attention to fan break down problems is needed.
- (4) Separate the circuit of each area inside the computer host to reduce any possible interference or interaction of the circuits.

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Technology Education and Making of Korean Traditional Things

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Introduction

Technology education gives opportunities for students to apply theories into reality and in the result enhance their sensitivity, expressiveness, and creativity when they perform their practical behaviors, which consist of, namely, 'making activity'. This is an important part of technology education. Technology education in Korea has been taught as a subject of 'Practical arts' in elementary school, 'Technology · Home Economics' in middle schools and 10th grade in high schools.

Making activity remains in existence in a form of traditional handicrafts in Korean history. Some of Korea's best products showing elaborate craftsmanship include a white porcelain in Yi-dynasty, daily commodities made of hand-made paper, and a wooden mask called Gagsital. These artistic handicrafts require artistic sense and technology talent for not only practicality to manage daily life but also function of practical use. Today appreciation of artistic handicrafts and brief experience are performed in various ways through instructional activities in schools. This can be, say, as a living education and good learning material.

Therefore, we introduce the process of making traditional fan in Korea and study the Technology education in middle school in relation to it in this study.

Curriculum of Technology & Home Economics of Middle School in Korea

Technology education in Korea was established and announced by the notification of the Ministry of Education in Dec. 1997. Technology · Home Economics aims at the objects of fostering spontaneous and creative Koreans who lead information era and globalization which is main mottoes of the 7th Curriculum integrating Technology · Industry and Home Economics which is operating in The 6th Curriculum into one so that students can, whether female or male, take as the National Basic Common Curriculum.

Table 1 shows the 7th Curriculum announced by the notification of the Korea Ministry of Education in Dec. 1997.

Table 1 The 7th national curriculum in Korea

Schools		Elementary School						Middle School			High School				
		Grades		1	2	3	4	5	6	7	8	9	10	11	12
Subjects															
S u b j e c t A r e a s	Korean Language	Korean Language		238	204	204	204	170	136	136	136				
	Moral Education	210	238	34	34	34	34	68	68	34	34				
	Social Studies	Mathematics		120	136	102	102	102	102	102	136	170 (Korean History 68)			
	Mathematics	Disciplined Life		136	136	136	136	136	136	102	136				
	Science	60	68	102	102	102	102	102	136	136	102				
	Practical Arts	Intelligent Life				68	68	Technology Home Economics			Elective Courses				
	Physical Education	90	102					68	102	102	102	102			
	Music	Pleasant Life		102	102	102	102	102	102	68	68				
	Fine Arts	180 204		68	68	68	68	68	34	34	34	34			
	Foreign Languages (English)	We are the first graders 80		68	68	68	68	34	34	68	34				
Optional Activities		60	68	68	68	68	68	136	136	136	204				
Extracurricular Activities		30	34	34	68	68	68	68	68	68	68	68	8 units		
Grand Total		830	850	986	986	1,088	1,088	1,156	1,156	1,156	1,224	144 units			

Technology education in Korea is carried out as a subject of Practical Course in 5-6 grade of the elementary school. on the basis of which the learner can accept the primary knowledge and function for highly industrialized society, and at the same time develop the adequate attitude and ability to elevate the quality of life by acquiring the basic knowledge need to manage home.

Technology and Home Economics in middle school consists of the basic knowledge for real life and various kinds of experiences for career research. It assigns the amount and elements of the contents. levels. allotted hours by grade, considering the learner's interest, degree of adjustment to real life, readiness for experimentation and practice of local schools. Contents of Technology and Home Economics in middle school are represented as Table 2 below.

Table 2 Contents of technology and home economics subject in middle school of Korea

grade domain	7th grade	8th grade	9th grade
comprehension of family and work	<ul style="list-style-type: none"> • Comprehension of I and family • characteristic of adolescent • Gender and relationship with the other sex • relationship with I and family 		<ul style="list-style-type: none"> • Industry and career • comprehension of industry • decision of occupation and working ethics • industrial disaster and safety
daily life technology	<ul style="list-style-type: none"> • Nourishment and diet of adolescent • nourishment of adolescent • diet of adolescent • practical basics of cooking • Technology in the future • development of technology and future • biotechnology and cultivation • Basics of drawing • how to represent things by measuring • comprehension and making of a drawing 	<ul style="list-style-type: none"> • Purchase of clothes and its management • function of clothes and appearance • purchase plan of clothes and purchase • making clothes and its recycling • clothes caring and keeping • Comprehension of machines • elements of machines • making mobile thing • Use of materials • characteristics of raw materials • design of products and manufacture 	<ul style="list-style-type: none"> • Diet management of family • choice of menu and food • preparation of diet and assessment • table manners • Electrical and electronic technology • an electric] circuit and illumination • check of electric home appliances • making electronic products
	<ul style="list-style-type: none"> • Computer and data processing • structure and principle of computer • production, storage, and distribution of data 	<ul style="list-style-type: none"> • Computer and life • application of softwares • application of Internet 	
management of resources and environments		<ul style="list-style-type: none"> • Management of resources and environments • use of resources and environments • work and time of adolescents • adolescents and their lives as one's daily life as consumers 	<ul style="list-style-type: none"> • Family life and housing • use of living space • interior environments • preservation and repair of house

Manufacture of Taekuksun Fan

Kinds of Korean fan

Korean traditional fan could be classified into 5 kinds, which are Uhsun(羽扇), Dansun(團扇), Chopsun(接扇), Pewlsun(別扇), and Taekuksun(太極扇) like (Fig. 1) shown below. Especially, Taekuk symbol of Taekuk Fan is most widely used to the traditional handicrafts.

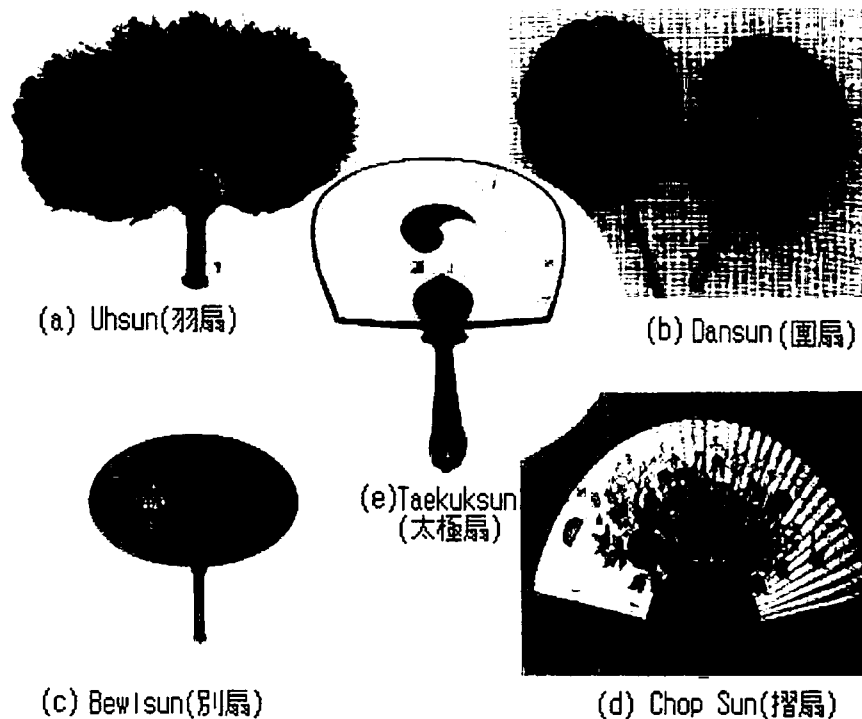


Figure 1 Korean traditional fans

Materials used

Essential raw materials for making fan are bamboo tree for its ribs and Han-Ji for its two side. Besides, paper band, paste, scissors, and knife. The characteristics of bamboo tree and Han-Ji are presented as follows.

1. Han-Ji: It is a kind of paper covering the ribs. It is made from mulberry trees only and rather thick and durable.
2. Paste: It may be replaced by common paste available in a corner stationery shop for students' making practice.
3. Bamboo tree: Bamboo tree for ribs must have no flaw as far as possible, for identical flexibility of each rib assures fan shape to maintain the original form and guarantees Han-Ji not to be off. When make the ribs, first cut the bamboo trunk in size of what you think fit. But, in this study, we used the commercial plastic material instead of bamboo.

Procedure of making fan

Procedure of making Taekuk symbol fan, by which students in middle school can make it, is introduced.

(1) Preparation of materials for fan

Purchase plastic molded rib, wooden pivot, and some stuff that are ready for class for experience study (Fig.2). Prepare drawing instruments for Taekuk symbol (Fig. 3).

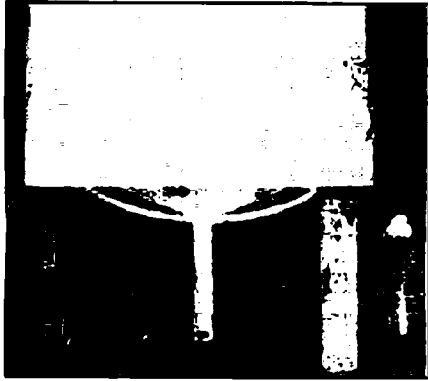


Figure 2 Materials for fan



Figure 3 Materials for Taekuk symbol

(2) Pasting Han-Ji

Paste Han-Ji to the ribs like (Fig. 4). Use the enough paste to attach Han-Ji to ribs. And rub Han-Ji and ribs together carefully for both not to hold air bubble between them and to paste them fast. And dry it enough.

(3) Cutting fan pattern

Draw a fan shape pattern on the Han-Ji and lib with a pencil and cut it into fan shape with scissor along the pattern.

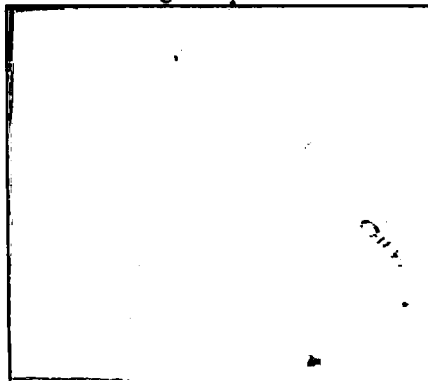


Figure 4 Pasting Han-Ji

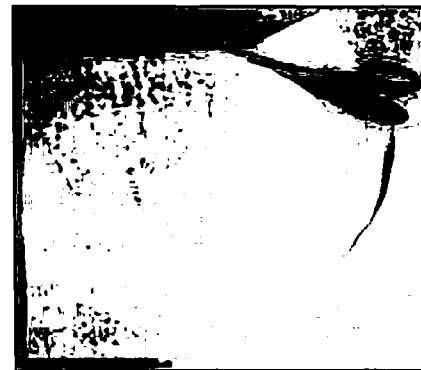


Figure 5 Cutting fan pattern

(4) Putting border (邊線)

To trim the margin of fan shape, put a border on it with pasted Han-Ji or paper band (Fig. 6).

(5) Fixing a pivot

After completion of fan shape, you can fix the pivot like (Fig. 7) Insert the fan shape into the wooden pivot and tighten the nut fixed.

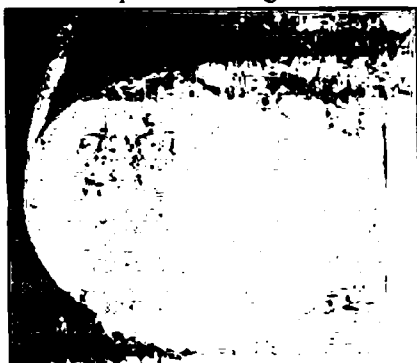


Figure 6 Putting border(邊線)

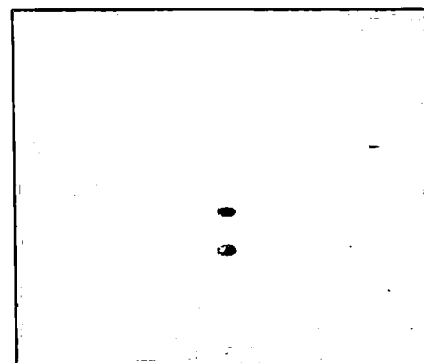


Figure 7 Fixing a pivot

(6) Drawing Taekuk symbol

It is a kind of pattern the proportion and balance of which is in harmony with each other. So you can draw it with a ruler and compass by the way which was learned in the drawing class. Also, nowadays computer is so widely used that anyone can get the proper program easily and print it in various colors. Here, we introduce how to draw Taekuk symbol with a ruler and compass by using the way of drawing in the textbook of the first grade in middle school as follows.

1. Draw a circle of an adequate size with compass on the fan side (Fig. 8).
2. Divide circular arc of the circle into 6 parts with compass. Length of every part is semi diameter of the circle (Fig. 9).
3. Draw straight lines connecting three point and center of the circle (Fig. 10).
4. Draw 3 smaller circles having the straight line as diameter (Fig. 11).
5. Paint 3 smaller circles with colors, which are one red, another blue, third yellow (Fig. 12).
6. At last, drawing Taekuk symbol is completed (Fig. 13).

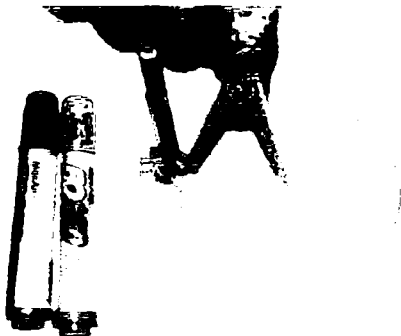


Figure 8 Drawing a circle

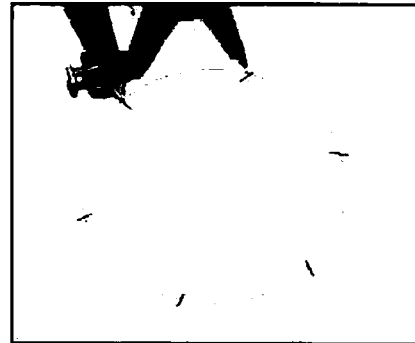


Figure 9 Dividing circular arc into 6 parts

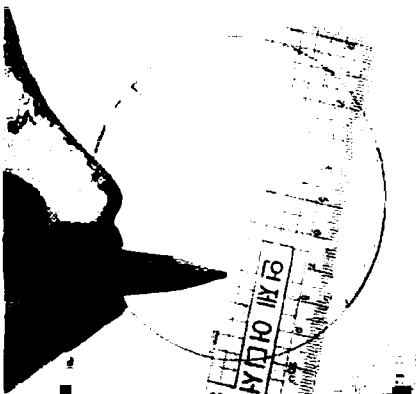


Figure 10 Dividing circle into 3 parts



Figure 11 Drawing Taekuk symbol circle



Figure 12 Painting 3 smaller circles

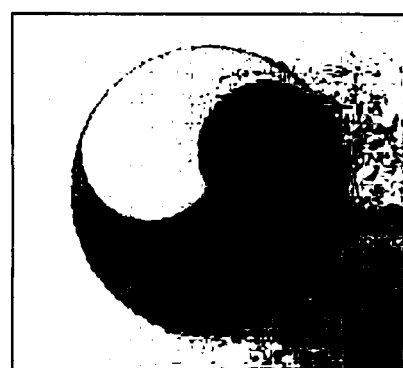


Figure 13 Completed Taekuk circle

(7) Completion of Taekuksun

If Taekuksun symbol of (Fig. 13) is pasted on the fan of (fig. 7), then, now it is finished (Fig 14).

(Fig. 15) shows various Taekuk symbol fan used in Korea.

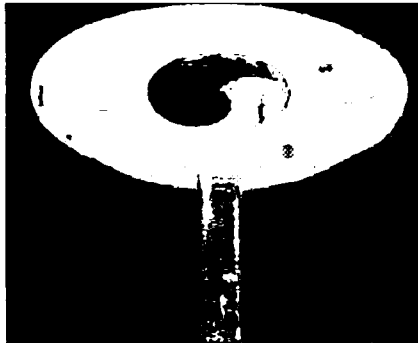


Figure 14 Finished Taekuksun



Figure 15 Various Taekuksun

Conclusion

We could get the conclusion from the point of technology education through making Taekuk symbol fan as follows:

First, unification between subjects can be possible. 'Making traditional fan' class can be used of integrating subjects in many ways. For instance, unification between a unit of drawing in Technology and a unit of artistic handicrafts in Fine Arts can be occurred. In other words, Drawing Taekuk symbol with beautiful curves and proportion can be dealt with in the unit of drawing in Technology, while making very useful fan in real life can be taught in the unit of artistic handicrafts in Fine Arts.

Second, various kinds of class plan may be designed. Self-directed learning or problem-solving learning can be well realized through manufacture of traditional fan. How to make Taekuksun introduced by this article possibly enable students to reach the process of problem solving. In the middle of the thinking of problem solving, teacher can play a role as an adviser, so that students can lead student-leading problem solving process.

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Web-Based Teaching and Learning: The CPSC Experience

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Background

The Colombo Plan Staff College (CPSC) is inter-governmental regional organization of the Asia Pacific region established under the Colombo Plan in December 1973. The main purpose of the college is to help strengthening the Technical and Vocational Education Training System of its member countries through human resource development programs, institutional capacity building, research and development and consultancy services, knowledge management, information and dissemination services and other specialized services as per trends of the region and specific needs of the member countries. Presently the college has 19 regular member countries of the Asia Pacific region.

The College conducts and arranges 20 to 25 programs annually including the regional programs geared towards the regional trends, the in-country programs to meet the specific needs of member countries and customized programs to meet the needs of the specific programs/ projects being implemented by the member countries in collaboration with donor agencies like ADB, World Bank etc. Over the past 32 years, the college has accumulated a wealth of resources in all major fields of technical and vocational education.

The college develops and implements its strategic plan in consultation with all stakeholders and sets its direction according to the regional needs and global trends. The college is presently implementing its programs under 8 major thrust areas called as CPSC RING. The detail of programs (regional and in-country only) conducted over the past five years under the 8 major thrust areas are given in the Table 1.

Table 1 The detail of programs conducted over the past five years

Major thrust area	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Computer and Internet Technologies	7	7	8	7	6
Programs and Institutional Management	5	5	5	5	4
Sustainable Development	2	1	1	1	1
Curriculum Development	3	1	3	1	2
Research and Development	2	2	1	2	1
Industry-Institution Linkages				2	
Non-Technical Skills	1	2		1	2
Global Partnership	1			1	2

It is evident from the above table, that there has been an increasing demand for conduction of Information Technology related courses and programs in the member countries over the past 5 years. Due to this persistence in IT courses, the Colombo Plan Staff College developed its capabilities and resources to undertake the web based teaching and learning programs.

This paper describes various stages of development of CPSC web based teaching and learning system. its benefits and potential as realized by CPSC, limitations and constraints faced in implementation and its future prospects in terms of policy directions of CPSC.

Planning and Designing of WB TLS

The first CPSC Web Based Teaching Learning System (WB TLS) was designed and developed in July/ August 2004. It started with signing of an MOU between the CPSC and the Philippines Technical Education and Skill Development Authority (TESDA) to train administrators of the 25 centers of excellence in Technical and Vocational Education in Philippines to make them capable of providing vision and leadership to their assigned centers.



Figure 1 CPSC-TESDA Partnership

The CPSC in consultation with TESDA authorities agreed to prepare a four training modules program spread over to 4 months in the areas of Total Quality Management, Project Management, Management of ICT Resources and Entrepreneurship Development. In view of the fact that TESDA administrators were senior and busy people, work places scattered at different places in Philippines and that they had no time to come to CPSC for four training course of one week each, it was mutually decided that CPSC would conduct the courses in a blended mode comprising off face to face and use of web based material to learn, interact, submit assignments at their work places using the world wide web.

The Colombo Plan Staff College is not a big organization in terms of its number of faculty and staff. The total number of staff from the institutional head to the lower staff such as janitors is around 40. In order to design and develop the program, the CPSC faculty and ICT staff (around 12 in number) met under the leadership of its Director General to work out the plan and strategy to develop and design the web based teaching and learning system using all in-house facilities and resources.

The CPSC team with continuous deliberations arrived at the following main elements of the web-based teaching and learning system.

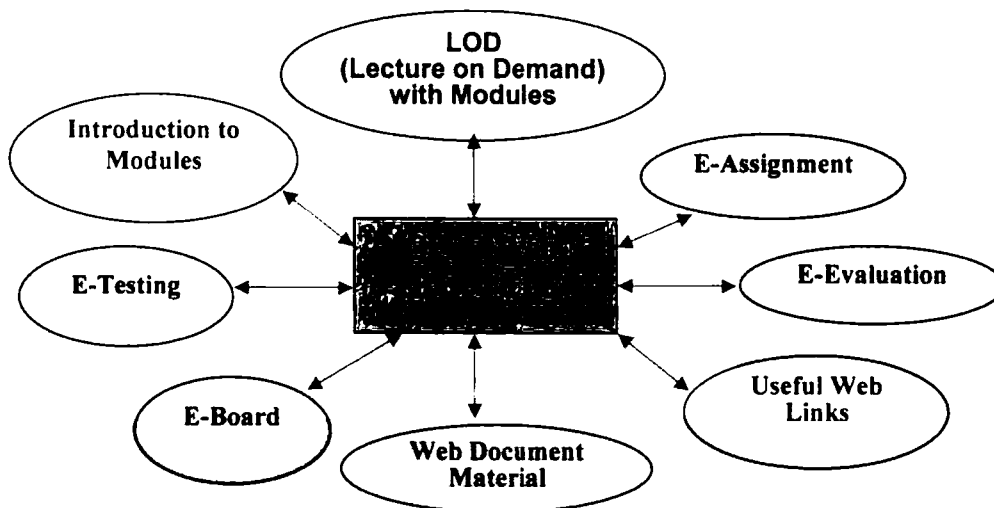


Figure 2 Main elements of WB TLS

The development and designing of the website and web documents was a team effort. The faculty and the ICT staff worked very closely to discuss the content layout, type of web documents to be prepared and links to be setup. Preparation of Lecture on Demand (LOD) or Video on Demand (VOD) was a gigantic task. To prepare and record comprehensive lectures for listening by the participants was a time consuming and difficult exercise. It required script development as per theme of presentation, power point slides development and good quality sound system. However with concerted efforts by the faculty and the ICT staff, VODs were recorded for all contents of the theme papers and were presented to the participants in the form of a complete website.

It was realized that development of theme papers and their presentation face to face is entirely different from the process of preparation of theme papers to be placed as web documents and to be presented through the pre-recorded videos on the web site. Several technical and pedagogical aspects need to be taken in to consideration in developing and designing web based teaching and learning material video recording.

Implementation of WB TLS

The real problems and benefits of any system are seen when its actual implementation begins. The first web based teaching and learning system designed by CPSC was implemented for the senior administrators of the Centers of Excellence of Technical Education and Skill Development Agency (TESDA) Philippines. They were all mostly the senior age people and had little knowledge of World Wide Web technologies, emailing and e-boarding systems. Some of them were using computer for the first time.

It was however planned to orientate all participants on the use of web based teaching learning system, its various elements like use of e-board for question and answer, use of assignment submission, taking on-line test, undertaking evaluation of the program, using reference links, listening to VODs and browsing texts and other related material. The most important of all was interaction with the teacher and among other participants using the e-board.

It was surprising and interesting to note that the administrators quickly learned the web-based teaching and learning system, its various components and their uses. They started enjoying the experience of listening and viewing online lectures carefully without any pressure of mind

at their own pace and taking their own individual learning time. They were also able to overcome language problem by constant listening to the 2 to 10-minute long lectures. Every participant got involved with concentration on the web-based lectures, thus making the CPSC lab a virtual classroom with no teacher standing in front of the class. The teacher only showed up for a while giving introduction and briefing about the topic. They were asked to raise their questions about any concept or point not clear to them using the question-answer e-board online.

The interest of the administrators aroused to such an extent that on the very first day they submitted 50 questions online for one theme only. The questions and answers were made accessible to all participants for their benefit and information. The teacher, having the administrator's power, was able to delete any irrelevant question from the list. In order to ensure the security of the Web-based teaching and learning system and ensure that only authorized persons log in to the system, every participant was properly registered, with individual ID and password issued for website access. The CPSC Web-based teaching and learning system was thus restricted and was available for use by only the authorized persons.

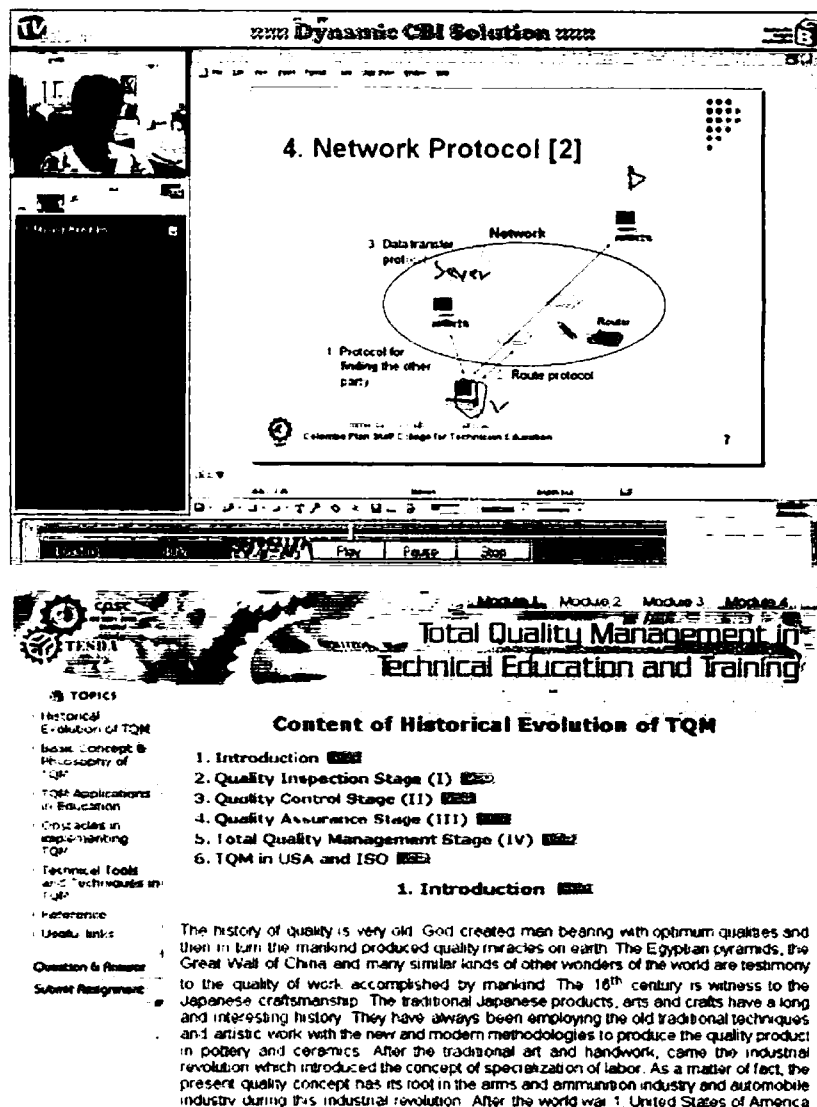


Figure 3 WB TLS Lecture screen and theme paper with VODs

Benefits and Potentials of WB TLS

The Colombo Plan Staff College has realized several benefits of the web based teaching and learning system. We can summarize them in to the following four categories:

- Pedagogical Benefits
- Education Anytime, Anywhere & At Any Age
- Cost Reduction benefits
- Benefits Specific to CPSC

Pedagogical benefits:

Some of the main pedagogical benefits realized through the CPSC's WB TLS are listed below

- *Learning at their own pace:* It has been realized that WB TLS gives the participants of different ages and different comprehension level ample time and space to work at their own pace and mental abilities.
- *Self-Directed with option of choosing contents of choice:* It has been realized that WB TLS allow the participants to choose contents of their own choice and focus more on those areas, which are of their interest and require their attention.
- *Interactivity through e-board:* Interaction with the instructor and interaction among the learners is the core of any teaching and learning process. It has been realized that WEB TLS provide opportunity to the participants to freely interact with the instructor and among themselves about their questions and answers.
- *Enhancing computer skills:* Although the teaching and learning using web based material does not require any prior knowledge or skill of computer usage, the participants through interaction wit WB TLS develop interest and learning habits using the computer and as a result enhance their computer and internet using skills.
- *Searching reference material from the Web:* In the WB TLS, the CPSC does not give any printed material to the participants and the participants are encouraged to use web search through useful links provided to them. WB TLS generates habit of web based reference research and e-library concept.
- *Conceptualized Life Long Learning:* All CPSC training programs are of fixed duration, but through the WB TLS, the learning and teaching never stops. It becomes life long learning and the participants continue in touch with WB TLS even after their formal training program period.
- *Multimedia approach to Learning:* Teaching and learning is effective and interesting when it has variety of options to use. CPSC WB TLS use multimedia approach to learning through the use of text, video, images and graphics. The teaching and learning thus become both interesting and effective.
- *Dynamic nature of contents on the Web:* The WB TLS provide facility to modify, add and delete contents of the web document thus making it dynamic to leverage new concepts. They are easy to maintain, update and make them reusable.

Education anytime, anywhere & at any age

The Web Based Teaching and Learning System provides opportunities to the participants to learn at any time at their convenience, learn at their own work place or at home without any

compulsion of coming to the classroom and learn without any age restrictions. Some of the benefits realized under this category are:

- *No geographical barrier:* The WB TLS can be accessed at any place having internet connection. The participants geographically distributed at various locations within the country can access the web site at their own place of work or at home.
- *24/7 accessibility to the website:* The WB TLS is available 24 hours of the day and 7 days a week. It allows the participants to schedule their learning at their own convenient time.
- *Increase in enrolment does not demand for any increase in the website:* The CPSC WB TLS allows enrolling as many participants as necessary without any additional uploading of web material.
- *No classroom attendance required:* The CPSC WB TLS has been designed for all interested people who can register with CPSC and use the teaching and learning material without physical attendance during the course duration.
- *No age limit in Learning:* It is the general tendency and common understanding that learning is done at the young age. The WB TLS enrolled all ages of participants who equally benefited from it irrespective of age limits.

Cost Reduction

One of the quality benefits of WB TLS is its cost reduction as a result of several cost cutting measures. Some of the cost related benefits realized are:

- *No traveling cost:* Travel is required to attend physically a learning class. It is always difficult for the participants coming from far off places to attend the class as it involves travel funds and time. The WB TLS does not require for the participants to move or travel physically.
- *No cost involved in printing and duplication of material:* In any training program, printing of multiple copies of the training material is mandatory according to the number of participants involved. Printing of good material and extra copying is cost intensive. Through Web Based TLS, the printing and duplication of material cost was reduced as all material uploaded on the web can be accessed without printing and duplication.
- *Utilization of in-house resources and replication without extra cost:* The CPSC WB TLS was developed using all the in-house resources. A group of people including web designer, programmer, multimedia artist, LAN expert and the professional faculty worked jointly to produce the material without involvement of outside expertise. Once developed, the WB TLS requires less time and efforts for its replication thus minimize the utilization of resources on the part of institution.
- *Groundwork for setting up virtual training center:* The development and implementation of WB TLS lays the foundation for development of virtual training center. The CPSC is already on its way to develop Ubiquitous Campus (U-Campus) to integrate its all web based teaching and learning courses for the benefits of participants.
- *Capturing, and disseminating tacit knowledge for future use:* One of the important benefits realized is the capturing and disseminating of tacit knowledge. In the regional or international institutions like CPSC, the people come for a specific period and leave after some time along with their knowledge and expertise. The WB TLS capture the knowledge of the people who have to leave after some time and use it later in similar programs in the future.

Benefits to CPSC

- *CPSC became a unique organization* in Asia Pacific region in the use of World Wide Web technologies in its programs: This cutting edge technology is still to be acquired by many international training organizations whereas CPSC has taken the lead in acquisition of this expertise.
- *A motivated and skilled team has been built in CPSC*: The development of WB TLS requires concerted team effort with participation of all concerned in every stage of its development. This inculcates teamwork and develops better communication among various departments of an organization.
- *Easy modification and update*: One of the basic benefits of WB TLS is updating and revising the material without much effort. The web material can constantly be updated and revised.
- *Management of Library of good VODs for use in other courses*: The development of videos/ lecture on demand (VODs/ LODs) is one major element of WB TLS. It requires good arrangements for recording, good scripts that encompass all aspects of theme, proper video display and good sound quality.

Constraints and Limitations

Education and training is effective when it is more interactive. The better teaching and learning occurs when there is considerable interaction between learner and instructor and among learners themselves. The web based teaching and learning system is worth while when it is more interactive in nature. Its inevitable expansion however, requires several logistics on the part of learner and deliverer both. Some of the constraints and limitations in making the WB TLS more effective and its smooth implementation are listed below:

- One of the major constraints in wide use of Web-based teaching and learning system is the ubiquitous access to a reasonably good speed internet connection by the learners.
- Cultural barriers may not allow web-based teaching and learning programs to become generic in nature.
- Language barriers may not allow the portability of the web-based learning programs and its outside use in other countries/ places.
- The web-based learning programs can be developed in general as well as specific subject areas. The programs developed in specific subject areas at one place may not be of similar relevance and usefulness at other places.
- In case of synchronous web-based learning program, bringing all the learners at the same time keeping in view the geographical location of learners with different time zone is difficult and hard particularly when the learners are employed somewhere.
- Network bandwidth and speed is a big question to ensure that every learner has the high speed and high bandwidth network connection. This limitation is more apparent when multimedia is being used in the e-learning program.
- Independent learning is not possible in self-directed e-learning cases where the learner to learner and learner to teacher interactions are missing.
- Self-directed learning without supervision of the instructor is either not likely to complete or complete at a much delayed time.
- In case of asynchronous e-learning, immediate communication with the instructor or other participants is not possible. Participants might have to wait for answers to key questions that may block their progress.

- Availability of the competent and skilled instructors to develop, implement and manage the e-learning program is important and essential.
- Recording lecture video is very different from lecturing and interacting face to face. It renders the lecturer robotic in facial expressions and movement and limits smooth expression.

Future of WB TLS

The Colombo Plan Staff College started its web-based teaching and learning program on the pilot scale. However it has expanded rapidly by converging its entire in-country and regional program to web based teaching and learning. These kinds of programs are bound to increase in the coming years and would require good leadership and team work at the organizational level, skilled and motivated people including web designers, programmers, network technicians, course designers and faculty along with the state of the art facilities.

The future of Web-based teaching and learning programs is bright with the following predictions in the CPSC context:

- Web-based training program would grow quickly and most probably all in-country and regional programs of CPSC would take the shape of asynchronous web-based teaching and learning programs. Hence overall structure and fabric of the way training is handled and delivered by CPSC may change.
- The Web-based learning technology will become richer and richer over time (i.e. increase in bandwidth and internet speed) and hence the CPSC participants would enjoy richness of face-to-face learning in web mode.
- The quality of the instructional design of the Web-based learning courseware would remain a very critical factor for the success of the program. However, it is predicted that with the advancement of technology, like the ongoing trend of computer-related devices becoming cheaper and cheaper, the Web-based learning courses would also become qualitative.
- More and more reference material would be available on the Internet thus replacing existing libraries to virtual libraries. It would be much easier to have access to the relevant and updated materials in a short time on the Internet to supplement Web-based learning.
- The Learning Management System (LMS) will continue to improve, making Web-based learning ever easier to manage.

Conclusion

The human resource development has always been a cost intensive activity and also a matter of concern for management of all organizations to make it effective, continuous and sustainable. Although the CPSC WB TLS real impact in the long run is yet to be established, its implementation has brought certain immediate benefits in terms of cost reduction, overcoming language barriers, management of tacit knowledge, better use of ICT resources and so on. This paper described some benefits of Web Based Teaching and Learning System as seen by CPSC under the categories of pedagogical benefits, flexibility in implementing and maintaining and cost reduction. It also described some constraints and limitations, which are important to note for the management in planning the e-learning courses.

Whatever the case may be, the web based teaching and learning would continue to grow and the educational and training institutions would continue to explore and find ways in better using these technologies in enhancing teaching and learning process. The successful

institutions would be those, which successfully leverage these new technologies and adopt new trends wisely and in a well-planned manner.

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