

---



---

Development of Training Manual for Maintenance of Radio and Digital Versatile Disc Player  
Mechanical Sub-System for Electronics Craftsmen

By

**Ajunwa Joseph<sup>1</sup>, Raymond Emmanuel<sup>1</sup>, Usman Abraham Usman<sup>2</sup> & Samuel Ayande Owodunni<sup>1</sup>**

1. Department of Industrial and Technology Education,  
Federal University of Technology, Minna-Niger State

2. Department of Electrical and Electronics Engineering,  
Federal University of Technology, Minna-Niger State

Email: [ajunwajoe@gmail.com](mailto:ajunwajoe@gmail.com)

---



---

### ABSTRACT

*The aim of the study was to develop a training manual for maintenance of Radio and Digital Versatile Disc (R and DVD) Player for electronics craftsmen. One research question and one hypothesis guided the study. The study was Research and Development (R&D) research and employed the Wheeler's model. The study covers North-Central States of Nigeria. The population for the study was 58 respondents which consist of 32 electronics teachers in the 15 accredited science and technical colleges offering electronics trade and 26 master craftsmen with the NDE States head offices in North-Central States. The instrument used for data collection was questionnaire. Data collected was analyzed using mean for research question and t-test for the hypothesis. Emerging findings revealed that the R and DVD player contents consists of operational tasks, learning objectives, skills for replacing faulty components, teaching requirements and tools and materials required for maintenance of mechanical sub-system. Recommendation made include R and DVD player maintenance training module should be included in craftsmen training programme in Nigeria, consequently the developed draft training manual should be adopted and used for training and retraining of craftsmen in the maintenance of R and DVD player.*

**Keywords:** Radio and DVD player, Mechanical Sub-system, Maintenance, Electronics Craftsman, Training manual and Development.

### INTRODUCTION

Effect of globalization is felt in every facet of life endeavour. This effect has today led to the evolution of new equipment/devices. In the field of electronics before now we use to know the transistor radio as one of the earliest form of electronics communication. However today as time progresses we have the R and DVD player. R and DVD player is a dual function electronics equipment that receives radio waves and converts the information carried by the radio waves to a usable form and also decodes information that is encoded onto DVD optical disc produced under the DVD-Video and DVD-Audio technical standards (Rudersdorfer, 2013 and Robert, 2015). The device is a single electronic equipment that consists of the Radio sub-system and DVD system. This device because of its multi-dimensional function and expansion on the analogue aspect of the Video Home System (VHS) and the non-linear aspect of the Laser Disc by adding improved

picture quality, surround sound effect and multiple audio tracks in addition to incorporated radio receiver system has found application in every home today.

The DVD systems is responsible mainly for reproducing the 'video and the audio' information encoded onto the DVD optical disc. R and DVD player consists of power, audio, video and mechanical sub-systems (Advameg, 2016). The power sub-system provides the Direct Voltage that operates the other sub-systems whereas the video and audio sub-systems reproduce the video and audio information contained on the DVD optical disc. Furthermore, during media production, picture and sound are digitally encoded onto the DVD optical disc in the form of grooves and pits (Life's Good Service Centre, 2007). To watch or listen to the video or sound contained on optical disc as the case maybe, R and DVD player requires a device that can read these data called the Laser assembly. The Laser assembly produces a beam having wavelength of about 505 nanometres or 630 nanometre that is focused into a tube containing reflective mirrors electronically designed to allow binary (0 or 1) data stored on an optical disc to be decoded (Rouse, 2016). The circuit that decodes and process the audio information is referred to as the audio sub-system whereas the video sub-system decodes and processes video signal. The mechanical sub-system on the other hand is a logically assembled plastic and metallic interacting components and associated drivers performing motional function designed to achieve disc intake, ejection and playback function.

Additionally, The Mechanical Drive System is made up of a (i) motor that holds the optical disc in place with the aid of a spindle that suspends the optical disc allowing it to spin freely whenever the motor rotates, (ii) Optical System that is fastened to the mechanism that reads the data from the disc and transmits it to the electronics printed circuit board to be converted into binary code and an (iii) Electronics Printed Board which is an assembly of electronics components that help to convert the data being read into a usable format (Zandbergen, 2016 and Uicker, Pennock and Shigley, 2003). Some components that make up the mechanical sub-system are Printed Circuit Board transistors, diodes chip, resistors chip, gears and motors. These components are responsible for the entire motional functions of disc intake, ejection, non-linear tracking and playback operations. In the cause of performing these functions the mechanical sub-system and other sub system components failure is inevitable. As such, in order to keep the R and DVD player in good working condition and increase its life span as well as fix it when it fails there is a need for Maintenance.

Maintenance is defined as the action taken to preserve, restore or keep an item in good working condition (Ogbuanya, 2009). It is a deliberate action plan aimed at ensuring that an item functions continuously and properly to the owners satisfaction. Types of maintenance conducted on R and DVD player mechanical sub-system general could be in various forms such as lubricating it moving parts/gears, troubleshooting and replacement of damaged or burnt components, repairing faults, dusting (Ohanu, 2012). The importance of maintenance include; better conservation of equipment or machine and increased life expectancy of such equipment, thereby eliminating premature replacement of equipment, tools or machinery; equipment downtimes is decreased and the number of major repairs that would have resulted is reduced; it reduces e-waste generation rate by increasing the gadget life span (Goldwasser, 2011). The fragile nature of the mechanical sub-system of the R and DVD player requires constant maintenance to

be conducted on the equipment because components such as gears and motors liable are ware out or develop fault when in continuous use. The consequences of operational failure of these components may be total disc rotation failure, no picture output, no sound, no sound and picture or inability of the laser to pick. Nevertheless, whatever be the nature of fault that the R and DVD player may develop, correcting the fault requires the services of the Craftsman.

Craftsmen in Nigeria education system are graduates of technical college who are trained in a given occupation (Federal Ministry of Education (FME), 2003). Those graduates who studied electronics trade are called electronics craftsmen. The objectives of the electronics trade programme is to produce craftsmen who will possess adequate practical skills and knowledge in carrying out installation, maintenance and repairs of electronic gadgets such as radio, television and satellite for self or paid employment (National Business and Technical Examination Board, 2007). Today, due to technological advancement, trend in the society arising from invention of new electronic gadgets, skills acquired by technical college students at graduation is no longer adequate for employment (Ohanu, 2012). However, because of the need to fill the gap in skills acquired and skills required for industrial age employment the National Directorate of Employment (NDE), Industrial Training Funds were established to train and retrain craftsmen. The implementation of these programmes requires a training manual.

Training manual is a guide and plan that specifies a number of elements essential to teaching and learning (Aliyu, 2013). The content of a worth-while training manual basically specifies; operational tasks, learning objectives, requirement for implementing the objectives and tool/equipment resources that are required to accomplish an operation (C-STEmp, 2016 and Aliyu, 2013). From the foregoing therefore, training manual in the context of the study refers to a compilation of planned contents which specifies; operational tasks, learning objectives for accomplishing identified tasks, tools/materials, and instructional criterion that serve as a guide in teaching the procedures required to carry out maintenance on radio, video, audio, power and mechanical sub-systems of R and DVD player. The benefits of training manual as an instructional guide are enormous among which are; reduces learning difficulty and training time for new trainees, it ensures training continuity, it ensure consistency in training, it makes easy to find out procedure that are in place to handle respective situations or task, above all it ensure that training is based on skills required (Vorster, 2011). The realization of these benefits is hinged on quality of training manual development.

Development is the act or systematic process of using scientific and technical knowledge to build an idea or material (Merriam-Webster, 2017). From the foregoing development in the context of this study refer to the process of building an organised document called manual. There are several models of development of training manual such as ADDIE model, Tyler's model, Dick and Carey's model, Wheeler's model (Aliyu, 2013). Among these models, the Wheeler (1980) model was found to be most appropriate and was adopted in developing the draft manual. This model consists of five stages namely: stating aims and objectives, selection of learning experience, selection of teaching content, organisation and integration of learning experience and teaching content and evaluation. Wheeler's approach involve analysing the learning outcome and stating the objectives, selecting and sequencing material that will enhance learning experience, selection of teaching content, building learning outcome, materials and contents into a structure and

evaluation (UKessay, 2017). The evaluation process appraises the appropriateness of the teaching content and material in enhancing the desired learning outcome. The appraisal process usually involves subject matter experts to determine the appropriateness of the content of the draft manual. Subject matter experts that were used to assess the draft manual developed are master craftsmen and electronics teachers. Master craftsmen are holders of Advance National Technical Certificate whereas technical teachers are engineers, technologists and technicians that teach electronics trade at technical schools. These stakeholders appraised the draft manual developed to be used training and retraining of electronics craftsmen.

Despite the importance of training manual to the implementation of the training and retraining programme of craftsmen and women, it is established that there is no such manual on Radio and DVD player maintenance that could be used for training and retraining electronics craftsmen at various craft training centres in order to enhance their employability and improve service delivery (Chukwuedo and Ainetor, 2015). Consequently, this has made many electronics craftsmen to be redundant because they lack skills to service modern electronics equipment (R and DVD player inclusive) (Chukwuedo and Ainetor, 2015). Since most R and DVD player that are not repaired are disposed into the environment, e-waste that constitutes environmental and human hazards is on the increase. Equipping electronics craftsmen with the needed technical requirement to carryout maintenance on Radio and Digital Versatile Disc player will not only help in ensuring continuous usage of DVD player but will also ensure production of competent craftsmen for gainful or paid employment. Thus leading to societal development and curbing various societal menaces. It is against this background that the development of training manual for maintenance of Radio and Digital Versatile Disc player for electronics craftsmen becomes necessary.

### ***Aim and Objective of the Study***

The specific objective of the study is to develop a training manual for maintenance of Radio and Versatile Disc player for electronics craftsmen and women training in the contents of;

- i) Mechanical sub-system.

### ***Research Question***

The following research question was formulated to guide the study;

- i) What is the appropriateness of maintenance contents for training craftsmen for the Mechanical sub-system of the Radio and DVD player?

### ***Hypothesis***

HO<sub>1</sub>: There is no significant difference among electronics teachers and master craftsmen regarding maintenance contents of Radio and DVD player mechanical sub-system.

## **METHODOLOGY**

The study was Research and Development (R&D) research and employed the Wheeler's model. The study covers North-Central States of Nigeria. The population for the study was 58 persons which consist of 32 electronics teachers in the 15 accredited science and technical colleges offering electronics trade and 26 master craftsmen with the NDE in North-Central States. All the

electronics teachers and master craftsmen were used for the study. The instrument used for the collection of data was questionnaire. The specific activity carried out in line with the Wheeler's steps that led to the draft manual involved conducting job analysis of R and DVD player craftsmen which led to identification of job tasks which was translated into the objectives that are required to carry out the maintenance of mechanical sub-system. After which analysis of each of the objective was done using Task Analysis to reveal the teaching contents and tools and materials that will enhance the desired learning experience. Thereafter the objective, teaching content, and tools/materials were organised into a draft manual format. The content of the draft manual for mechanical sub-system was translated into questionnaire for three experts to evaluate the appropriateness of the contents. A Four Point Rating Scale questionnaire that employed a response options of Highly Appropriate (HA) = 4, Appropriate (A) = 3, Highly Not Appropriate (HNA) = 2 and Not Appropriate (NA) = 1 was the instrument use for data collection. Data collected were analysed using mean statistics for research questions and t-test for hypotheses. For determining which item is appropriate for inclusion in the draft manual a threshold mean of 2.50 in relative to the 4-point rating scale was set as decision rule.

## RESULTS

Appropriateness of maintenance contents for training craftsmen for Mechanical sub-system of the Radio and DVD player.

**Table 1a:** Mean and Standard Deviation on the Appropriateness of Maintenance Tasks for the Mechanical Sub-system of Radio and DVD Player

S/N	Task Description for Radio Sub-system of Radio and DVD Player	$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	$\bar{X}_t$	Decision
1	Verifying DC supply	3.56	0.50	3.08	0.79	3.03	Appropriate
2	Verifying functioning of DC motors	3.56	0.50	3.35	0.89	3.47	Appropriate
3	Verifying functioning of tray and gears	3.56	0.50	3.35	0.89	3.47	Appropriate
4	Replacing DC supply stage components	3.00	0.50	3.00	0.63	3.00	Appropriate
5	Replacing DC motors	2.94	0.84	3.23	0.65	3.07	Appropriate
6	Replacing tray and gears	3.91	0.29	3.27	0.45	3.62	Appropriate
7	DC supply stage teaching requirement	3.72	0.45	3.81	0.40	3.76	Appropriate
8	DC motors stage teaching requirement	3.53	0.76	3.12	0.65	3.34	Appropriate
9	Tray and gears stage teaching requirement	3.81	0.53	3.50	0.70	3.67	Appropriate
10	Tools/materials requirements for maintenance of Radio sub-system	3.78	0.55	3.08	1.01	3.47	Appropriate
<b>Grand Mean</b>		<b>3.54</b>	<b>0.54</b>	<b>3.27</b>	<b>0.71</b>	<b>3.39</b>	

Table 1a present the mean scores of maintenance tasks for training craftsmen for mechanical sub-system of the Radio and DVD player. The average mean ratings of the items revealed that all the items means are high since their means range from 3.00 and above. Among the items, numbers 7, 9 and 6 with mean 3.76, 3.67 and 3.62 are highest. This result shows that the respondents agreed with all the items to be maintenance tasks for training craftsmen for mechanical sub-system.

**Table 1b:** Mean and Standard Deviation on the Appropriateness of Maintenance Performance Objectives for the Mechanical Sub-system of Radio and DVD Player

S/N	Objectives Description for Mechanical Sub-system of Radio and DVD Player	$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	$\bar{X}_t$	Decision
<b>Craftsmen should be able to:</b>							
<b>Verifying DC supply</b>							
11	Test continuity of the DC voltage feeder cable to the laser conveyor motor (sled motor)	3.56	0.56	3.65	0.48	3.60	Appropriate
12	Measure the feeder voltage to the laser conveyor motor (sled motor)	3.31	0.78	3.81	0.40	3.53	Appropriate
13	Test continuity of the DC voltage feeder cable to the tilt motor	3.72	0.58	3.62	0.49	3.67	Appropriate
14	Measure the tilt motor (that raises the one end of the laser platform) feeder voltage	3.72	0.58	3.50	0.76	3.62	Appropriate
15	Test continuity of the DC feeder to playback motor	3.75	0.44	3.31	0.73	3.55	Appropriate
16	Measure the feeder voltage to playback motor	3.47	0.76	3.31	0.67	3.40	Appropriate
<b>Verifying functioning of DC motors</b>							
17	Test coils of the laser conveyor motor	3.88	0.33	3.23	0.65	3.59	Appropriate
18	Test coils of the tilt motor	3.66	0.54	3.19	0.93	3.45	Appropriate
19	Test coils of the sled motor	3.22	0.49	3.81	0.40	3.48	Appropriate
<b>Verifying functioning of tray and gears</b>							
20	Set laser assembly conveyor gears	3.09	0.92	3.65	0.48	3.34	Appropriate
21	Set the ejection gears	3.66	0.48	3.08	0.74	3.40	Appropriate
22	Detach playback disc sit platform	3.28	0.58	3.31	0.47	3.29	Appropriate
23	Detach tilt motor pulley	3.41	0.49	3.49	0.50	3.43	Appropriate
24	Set the gear of tray loader	3.56	0.50	3.50	0.51	3.53	Appropriate
25	Test open and close contacts of ejection switch	3.88	0.49	3.62	0.49	3.76	Appropriate
<b>Grand Mean</b>		<b>3.54</b>	<b>0.57</b>	<b>3.47</b>	<b>0.58</b>	<b>3.51</b>	

Table 1b has the mean scores of the maintenance objectives for training craftsmen for mechanical sub-system of the Radio and DVD player. As shown, all the items mean ratings are above 2.50 threshold mean. The average means showed that items number 25, 13, 14, 11, 17, 15 and 24 with means 3.76, 3.67, 3.62, 3.60, 3.59 and 3.53 respectively are highest. This result shows that these items are the objectives for the identified tasks required for training craftsmen for mechanical sub-system.

**Table 1c:** Mean and Standard Deviation on the Appropriateness of Maintenance Requirements for Replacing Faulty Mechanical Sub-system Components for the Radio and DVD Player

S/N	Replacing components for Radio Sub-system of Radio and DVD Player	$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	$\bar{X}_t$	Decision
<b>Craftsmen should be able to:</b>							
<b>DC supply stage</b>							
26	Replace the DC voltage feeder cable to the laser conveyor motor (sled motor)	3.28	0.88	3.35	0.62	3.31	Appropriate
27	replace the DC voltage feeder cable to the tilt motor	3.31	0.78	3.62	0.49	3.45	Appropriate

S/N	Replacing components for Radio Sub-system of Radio and DVD Player	$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	$\bar{X}_t$	Decision
28	Replace the DC feeder to playback motor	2.81	0.59	3.81	0.40	3.26	Appropriate
29	Measuring voltage of feeder cable to playback motor	3.16	0.36	3.35	0.84	3.24	Appropriate
<b>DC motors stage</b>							
30	Mount and solder laser conveyor motor	3.00	0.35	3.62	0.49	3.28	Appropriate
31	Mount and solder the tilt motor	3.22	0.42	3.35	0.48	3.28	Appropriate
32	Mount and solder sled motor	3.22	0.42	3.46	0.50	3.33	Appropriate
<b>Tray and gears</b>							
33	Replace laser assembly conveyor gears	3.59	0.71	3.15	0.78	3.40	Appropriate
34	Replace the ejection gears	3.75	0.44	3.23	0.76	3.52	Appropriate
35	Replace the playback disc sit platform	3.25	0.67	3.54	0.64	3.38	Appropriate
36	Replace the tilt motor pulley	3.31	1.17	3.00	0.84	3.17	Appropriate
37	Replace the gear of tray loader	3.28	0.58	3.46	0.50	3.36	Appropriate
38	Replace ejection switch	3.63	0.75	3.08	0.68	3.38	Appropriate
<b>Grand Mean</b>		<b>3.29</b>	<b>0.62</b>	<b>3.39</b>	<b>0.62</b>	<b>3.34</b>	

Table 1c present the mean scores of the requirement for replacing mechanical sub-system components of the Radio and DVD player. As revealed, all the items mean ratings are above 2.50 threshold mean. The average means revealed that the means of the items ranges from 3.17 to 3.52. This result shows that these items are the maintenance requirement for replacing mechanical sub-system components

**Table 1d:** Mean and Standard Deviation on the Appropriateness of Maintenance Teaching Requirements for the Mechanical Sub-system of Radio and DVD Player

S/N	Teaching Requirements for Mechanical Sub-system of Radio and DVD Player	$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	$\bar{X}_t$	Decision
<b>DC supply stage teaching requirement</b>							
39	Continuity test for DC voltage feeder cable to the laser conveyor motor sled, tilt and playback motor	3.06	0.80	3.46	0.50	3.24	Appropriate
40	Measuring the feeder voltage to the laser conveyor motor sled, tilt and playback motor	3.09	0.81	3.42	0.57	3.24	Appropriate
<b>DC motors stage teaching requirement</b>							
41	Armature resistance coils test for sled, tilt and playback motor	3.53	0.76	3.12	0.65	3.34	
		3.53	0.71	3.12	0.76	3.34	Appropriate
<b>Tray and gears stage teaching requirement</b>							
42	Setting laser assembly conveyor and ejection gears	3.22	0.97	3.27	0.87	3.24	Appropriate
43	Detachment of playback disc sit platform	3.84	0.36	3.38	0.49	3.64	Appropriate
44	Detachment of tilt motor pulley	3.28	0.63	3.65	0.48	3.45	Appropriate
45	Engaging the gear of tray loader	3.72	0.58	3.23	0.76	3.50	Appropriate
46	Testing open and close contacts of ejection switch	2.97	0.47	3.81	0.40	3.34	Appropriate
<b>Grand Mean</b>		<b>3.02</b>	<b>0.61</b>	<b>3.05</b>	<b>0.55</b>	<b>3.03</b>	

Table 1d presents the mean analysis of the electronics teachers and master craftsmen response regarding maintenance teaching requirement for training craftsmen for mechanical sub-

system of the Radio and DVD player. As evidenced, all the items average mean rating is above the 2.5 cutoff mean. All the items mean range between 3.24 and 3.64. This shows that the items have high means. As such these items are maintenance teaching requirement for training craftsmen for mechanical sub-system.

**Table 1e:** Mean and Standard Deviation on the Appropriateness of Maintenance Tools/Materials Requirements for the Mechanical Sub-system of Radio and DVD Player

S/N	Tools/Materials Requirements for Maintenance of Radio Sub-system of Radio and DVD Player	$\bar{X}_1$	SD <sub>1</sub>	$\bar{X}_2$	SD <sub>2</sub>	$\bar{X}_t$	Decision
47	Multimetre	3.75	0.44	3.31	0.47	3.55	Appropriate
48	Long nose plier	3.31	0.78	3.35	0.68	3.33	Appropriate
49	Sets of star/flat screw driver	3.22	0.90	3.62	0.49	3.40	Appropriate
50	Precision tools	3.16	0.72	3.08	0.74	3.12	Appropriate
51	Brush	3.03	0.78	3.35	0.48	3.17	Appropriate
52	Picker	3.50	0.88	3.12	0.58	3.33	Appropriate
53	Soldering iron	3.09	0.92	3.46	0.50	3.26	Appropriate
54	Lead sucker	3.62	0.49	3.15	0.67	3.16	Appropriate
55	Bench lamp	2.75	0.95	3.65	0.62	3.15	Appropriate
56	Gum	3.59	0.66	2.88	0.76	3.28	Appropriate
57	Razor blade	3.28	0.77	3.19	0.63	3.24	Appropriate
58	Blower	2.75	0.56	3.15	0.78	2.93	Appropriate
59	Flat file	2.84	0.72	3.54	0.58	3.16	Appropriate
60	Magnifying lens	3.50	0.88	3.31	0.83	3.41	Appropriate
	<b>Grand Mean</b>	<b>3.24</b>	<b>0.75</b>	<b>3.30</b>	<b>0.63</b>	<b>3.25</b>	

Table 1e present the mean scores for maintenance tools/materials requires for training craftsmen on mechanical sub-system of the Radio and DVD player. The respondents mean ratings revealed that all the items means are above 2.50 cutoff mean. The items with the highest means are item number 47, 60, 49, 48 and 52 with 3.55, 3.41, 3.40, 3.33 and 3.33 respectively. This result shows that these items are maintenance tools/materials requires for training craftsmen on mechanical sub-system.

**Table 2:** t-test Analysis of Maintenance Contents of Radio and DVD Player Mechanical Sub-system

S/N	Contents for Training Craftsmen for the Audio Sub-system	Group	N	Mean Difference	t- calc.	df.	t- tab	Decision
1	Maintenance Tasks for the Mechanical Sub-system	Electronics Teachers	32	1.35	0.90	56	2.01	Not Sign.
		Master Craftsmen	26	1.35				
2	Maintenance Objectives for the Mechanical Sub-system	Electronics Teachers	32	1.11	0.57	56	2.01	Not Sign.



S/N	Contents for Training Craftsmen for the Audio Sub-system	Group	N	Mean Difference	t-calc.	df.	t-tab	Decision
3	Maintenance Requirements for Replacing Mechanical Sub-system Components	Master Craftsmen	26	1.11	-0.64	56	2.01	Not Sign.
		Electronics Teachers	32	-1.18				
		Master Craftsmen	26	-1.18				
4	Maintenance Teaching Requirements for the Mechanical Sub-system	Electronics Teachers	32	-0.62	-0.52	56	2.01	Not Sign.
		Master Craftsmen	26	-0.62				
		Electronics Teachers	32	-0.74				
5	Maintenance Tools/Materials Requirements for the Mechanical Sub-system	Electronics Teachers	32	-0.74	-0.32	56	2.01	Not Sign.
		Master Craftsmen	26	-0.74				
		t-Total						

Presented in Table 2 is the t-test analysis of the maintenance contents for training craftsmen for mechanical sub-system of the Radio and DVD player. The table revealed calculated t-test value for maintenance; task, objectives, requirement for replacing components, teaching content and tools/materials for mechanical sub-system to be 0.90, 0.57, -0.64, -0.52 and -0.32 respectively. This result shows that there is no significant difference for all the manual components for video sub-system since the t-calculated values are less compared to 2.01 critical value at  $0.05\alpha$  df56. Likewise since -0.01 calculated t-total is less than 2.01 table value at  $0.05\alpha$  df56, the null hypothesis is therefore accepted thus, there is no significant difference among the responses of electronics teachers and master craftsmen regarding maintenance contents for mechanical sub-system for the Radio and DVD player.

## FINDINGS

1. Finding on the appropriateness of maintenance contents for training craftsmen for the Mechanical sub-system of Radio and DVD player revealed 10 maintenance tasks, 15 maintenance objectives, 13 maintenance requirement for replacing components, 8 teaching components and 14 tools/materials for maintenance of mechanical sub-system which are as follows:
  - i Maintenance tasks for mechanical sub-system are; verifying DC supply, verifying functioning of DC motors, verifying functioning of tray and gears, replacing DC supply stage components, replacing DC motors, replacing tray and gears, DC supply stage teaching requirement, DC motors stage teaching requirement, tray and gears stage teaching requirement and tools/materials requirements for maintenance of Radio sub-system.

- ii Maintenance objectives for mechanical sub-system are craftsmen should be able to; test continuity of the DC voltage feeder cable to the laser conveyor motor (sled motor), measure the feeder voltage to the laser conveyor motor (sled motor), test continuity of the DC voltage feeder cable to the tilt motor, measure the tilt motor (that raises the one end of the laser platform) feeder voltage, test continuity of the DC feeder to playback motor, measure the feeder voltage to playback motor, test coils of the laser conveyor motor, test coils of the tilt motor, test coils of the sled motor, test open and close contacts of ejection switch, set the ejection gears, detach playback disc sit platform, detach tilt motor pulley, set the gear of tray loader and set laser assembly conveyor gears.
  - iii Maintenance requirement for replacing mechanical sub-system components are craftsmen should be able to; replace the DC voltage feeder cable to the laser conveyor motor (sled motor), replace the DC voltage feeder cable to the tilt motor, replace the DC feeder to playback motor, measuring voltage of feeder cable to playback motor, mount and solder laser conveyor motor, mount and solder the tilt motor, mount and solder sled motor, replace laser assembly conveyor gears, replace the ejection gears, replace the playback disc sit platform, replace the tilt motor pulley, replace the gear of tray loader and replace ejection switch.
  - iv Maintenance teaching component for mechanical sub-system are; continuity test for DC voltage feeder cable to the laser conveyor motor sled, tilt and playback motor, measuring the feeder voltage to the laser conveyor motor sled, tilt and playback motor, armature resistance coils test for sled, tilt and playback motor, setting laser assembly conveyor and ejection gears, detachment of playback disc sit platform, detachment of tilt motor pulley, engaging the gear of tray loader and testing open and close contacts of ejection switch.
  - v Maintenance tools/materials for mechanical sub-system are; multimeter, long nose plier, sets of star/flat screw driver, precision tools, brush, picker, soldering iron, lead sucker, bench lamp, gum, razor blade, blower, flat file and magnifying lens.
2. There was no significant difference among the responses of electronics teachers and master craftsmen regarding maintenance contents for mechanical sub-system for the Radio and DVD player.

## DISCUSSION OF FINDINGS

Contained in Table 1a, 1b, 1c, 1d and 1e are the maintenance contents for training craftsmen for mechanical sub-system for the Radio and DVD player. Specifically, the established maintenance contents for training craftsmen for the mechanical sub-system are; mechanical sub-system maintenance tasks, mechanical sub-system maintenance objectives, replacing mechanical sub-system components, mechanical sub-system teaching content and tools/materials required for maintenance of mechanical sub-system. These contents are in consonance with the C-STemp (2016) contents of craftsmen training manual. Finding on maintenance tasks for mechanical sub-system presented in Table 1a are; verifying DC supply, verifying functioning of DC motors, verifying functioning of tray and gears, replacing DC supply stage components, replacing DC motors, replacing tray and gears, DC supply stage teaching requirement, DC motors stage teaching requirement, tray and gears stage teaching requirement and tools/materials

requirements for maintenance of mechanical sub-system. The mechanical sub-system basically consists of electronics printed board, optical system assembly and mechanical disc drive assembly (Advameg, 2016). Conducting maintenance on the mechanical sub-system therefore translates to the ability of the craftsmen to verifying functions and replacing identified faulty components that made up these stages. In this light, the mechanical sub-system maintenance tasks were therefore built in line with Advameg (2013) identified stages of the mechanical sub-system.

Furthermore, finding on maintenance objectives for mechanical sub-system contained in Table 1b are craftsmen should be able to; test continuity of the DC voltage feeder cable to the laser conveyor motor (sled motor), measure the feeder voltage to the laser conveyor motor (sled motor), test continuity of the DC voltage feeder cable to the tilt motor, measure the tilt motor (that raises the one end of the laser platform) feeder voltage, test continuity of the DC feeder to playback motor amongst others. According to Abdullahi (2015) objectives are statement of specific behavioural change expected of craftsmen after training. For a demonstrable behavioural change to be achieved, it is required that training on mechanical sub-system be based on the components that made up the identified stages of mechanical sub-system. In this regard, result on mechanical sub-system maintenance objectives presented in Table 1b were built in line with Advameg (2016) identified stages of the mechanical sub-system circuit components. Similarly contained in Table 1c are maintenance requirement for replacing mechanical sub-system components. The finding revealed that the requirement for replacing mechanical sub-system components amongst others are craftsmen should be able to; replace the DC voltage feeder cable to the laser conveyor motor (sled motor), replace the DC voltage feeder cable to the tilt motor, replace the DC feeder to playback motor, measuring voltage of feeder cable to playback motor, mount and solder laser conveyor motor. To accomplish maintenance on the mechanical sub-system successfully, Padelford (1984) advocate that it is required that craftsmen should possess in addition to cognitive knowledge, physical skill that will enable them de-solder, replace and solder identified faulty component. In line with Padelford advocacy, the requirement for replacing mechanical sub-system components was hence built to enable craftsmen not just acquire knowledge of the operation and functions of the radio sub-system components but also acquire manual and motor skill that will enable them accomplish a repair section.

On the other hand, finding on teaching component for audio sub-system presented in Table 1d are; continuity test for DC voltage feeder cable to the laser conveyor motor sled, tilt and playback motor, measuring the feeder voltage to the laser conveyor motor sled, tilt and playback motor, armature resistance coils test for sled, tilt and playback motor, setting laser assembly conveyor and ejection gears. For a manual to be used for training Wheeler (1980) maintained that the manual must prescribe steps in which the objectives content will be implemented or taught (Wheeler, 1980). In line with Wheelers declaration, the knowledge and physical skills craftsmen required to successfully carryout maintenance on the mechanical sub-system were hence translated to teachable units. Whereas finding on mechanical sub-system maintenance tools/materials presented in Table 1e revealed that the tools/materials for the maintenance of mechanical sub-system are; multimeter, long nose plier, sets of star/flat screw driver, precision tools, brush, picker, soldering iron, lead sucker, bench lamp, gum, razor blade, blower, flat file and magnifying lens. This result is in consonance with Chukwuedo and Ainetor (2015)

maintenance materials for DVD Home Theatre. Chukwuedo and Ainetor identified some maintenance materials to include plier, screw drivers, soldering iron. This indicates that this finding are tools needed to carryout maintenance on the mechanical sub-system. In similar vein, t-test analysis of the maintenance contents for training craftsmen for mechanical sub-system for the Radio and DVD player presented in Table 2 revealed calculated t-test value for mechanical sub-system maintenance task, mechanical sub-system maintenance objectives, requirement for replacing mechanical sub-system components, mechanical sub-system maintenance teaching content and tools/materials for mechanical sub-system to be 0.90, 0.57, -0.64, -0.52 and -0.32 respectively. This result shows that there is no significant difference for all the manual components for video sub-system since the t-calculated values are less compared to 2.01 critical value at  $0.05\alpha$  df56. Likewise since -0.01 calculated t-total is less than 2.01 table value at  $0.05\alpha$  df56, the null hypothesis is therefore accepted thus, there is no significant difference among the responses of electronics teachers and master craftsmen regarding maintenance contents for mechanical sub-system. This result therefore confirmed that both respondents unanimously agreed that findings in Table 1a, 1b, 1c, 1d and 1e are the maintenance contents for training craftsmen for mechanical sub-system for the Radio and DVD player.

## CONCLUSION

Following the nation's quest to becoming one of the industrialised nations of the world, production of skilled manpower that will take up the technological challenges of the nation becomes necessary. In this regard, there is increase demand on development of skill competency based training manual, thus the need for the study. Emerging results from the study provides maintenance task, maintenance objective, teaching content and maintenance tools/materials required for training craftsmen in the maintenance of mechanical sub-system of the Radio and DVD player.

## RECOMMENDATION

1. The National Directorate of Employment and other craftsman training centres should include Radio and DVD player maintenance training module into electronics programme, consequently the developed draft training manual should be adopted and used for training and retraining of craftsmen in the maintenance of R and DVD player.
2. Through public sensitization programmes such as seminars, master craftsmen, technical teachers and craftsmen, technicians should be enlightened and encouraged to use the draft Radio and DVD player training manual as a guide for selection of training tools, training and retraining of craftsmen/artisans or as self-instructional guide for carrying out maintenance on Radio and DVD player.

## REFERENCES

- Abdullahi, M. (2015). *An introduction to aspects of educational technology*. Kano: Gidan Dabino Publishers.
- Advameg Inc. (2016). Digital Versatile Disc Player operations. Retrieved November 8, 2016 from [www.madehow.com/](http://www.madehow.com/)

- Aliyu, A. A. (2013). Development of self-instructional manual for sand casting technology in the polytechnics in North-Central states of Nigeria. Retrieved on April 23, 2017 from <http://www.unn.edu.ng>
- Chukwuedo, S.O., & Ainetor A.U. (2015). Corrective maintenance skills requirements in DVD home theatre for integration into technical college curriculum. *Problems of Education in the 21<sup>st</sup> Century*, 66, 7-17.
- C-STEmp. (2016). Construction skills training and empowerment project (Electrical installation and maintenance training manual). C-STEmp training booklet for NDE electrical craftsmanship programme.
- Federal Ministry of Education (FME). (2003). Education Sector Status Report. Retrieved from [planipolis.iiep.unesco.org.pdf](http://planipolis.iiep.unesco.org.pdf)
- Goldwasser, S. M. (2011). Notes on the Troubleshooting and Repair of Television Sets. Version 3.30 (17-Nov-09).
- Life's Good Services Centre. (2007). Training manual: BHloo blu-ray player. Retrieved on March 12, 2016 from Life's Good website: [www.LGCSAcademy.com](http://www.LGCSAcademy.com)
- Merriam-Webster. (2017). Definition of development. Retrieved on 11 April, 2017 from <http://www.merriam-webster.com/dictionary/development>.
- National Business and Technical Examination Board. (2007). *National Technical and Business Certificate Syllabus*. Reviewed Edition.
- Ogbuanya, T. C. (2009). *Energy and technology of home appliances*. Enugu: Cheston Limited.
- Ohanu, I. B. (2012). Maintenance practices required for Liquid Crystal Display (LCD) television by electronics technicians in Anambra State. A Master's Thesis submitted to the department of vocational and teacher education, university of Nigeria, Nsukka.
- Padelford, H. E. (1984). A conceptual model of the psychomotor. *Journal of Industrial education*, 20 (2), 22 -30.
- Robert, C. (2015). Computer Extraordinaire: History of DVD. Retrieved on the October 21, 2016 from [www.miqrogroove.com/writing/history-of-dvd/](http://www.miqrogroove.com/writing/history-of-dvd/)
- Rouse, M. (2016). Definition: blue laser. Retrieved on June 3, 2016 from [whatis.techtarget.com/definition/blue-laser](http://whatis.techtarget.com/definition/blue-laser)
- Rudersdorfer, R. (2013). *Radio receiver technology: Principles, architectures and applications*. Hoboken: John Wiley and Sons.
- Uicker, J. J., Pennock, G.R. & Shegley, J. E. (2003). *Theory of machines and mechanisms*. New York: Oxford University Press.
- UKessays. (2017). A continuum of curriculum development models. Retrieved on 14 April, 2017 from <http://www.ukessays.com.html>
- Vorster, S. (2011). Virtual productivity solution: Key benefits of a standard operating procedures manual. Retrieved on April 5, 2016 from [virtualproductivitiesolutions.co/za](http://virtualproductivitiesolutions.co/za)
- Wheeler, D.K. (1980). *Curriculum Process*. London: Hodder and Stoughton.
- Zandbergen, P. (2016). What is an optical drive?-Definition, Types and function. Retrieved November 15, 2016 from [study.com/academy/lesson/what-is-an-optical-drive-definition-types-function.html](http://study.com/academy/lesson/what-is-an-optical-drive-definition-types-function.html)

**DRAFT RADIO AND DIGITAL VERSATILE DISC PLAYER MAINTENANCE TRAINING MANUAL****UNIT 5: MECHANICAL SUB-SYSTEM MAINTENANCE CONTENTS**

**Unit 5 Aim:** The unit provides:

1. Outline for verifying DC supply
2. Outline for verifying functioning of DC motors
3. Outline for verifying functioning of tray and gears
4. Steps for replacing DC supply stage components
5. Steps for replacing DC motors
6. Steps for replacing tray and gears
7. Specification for DC supply stage teaching requirement
8. Specification for DC motors stage teaching requirement
9. Specification for tray and gears stage teaching requirement
10. Specify tools/materials requirements for maintenance of Radio sub-system

**Unit 5: Mechanical Sub-System Maintenance Contents**

S/N	TASK	LEARNING OUTCOME		CONTENT	TOOLS
		PERFORMANCE OBJECTIVE	FAULTY COMPONENTS REPLACEMENT CRITERION		
		Craftsmen should be able to:	Craftsmen should be able to:		
1.	Verifying DC supply	1. Test continuity of the DC voltage feeder cable to the laser conveyor motor (sled motor)  2. Measure the feeder voltage to the laser conveyor motor (sled motor)  3. Test continuity of the DC voltage feeder cable to the tilt motor 4. Measure the tilt motor (that raises the one end of the laser platform) feeder voltage 5. Test continuity of the DC feeder to playback motor	1. Replace the DC voltage feeder cable to the laser conveyor motor (sled motor)  2. Replace the DC voltage feeder cable to the tilt motor  3. Replace the DC feeder to playback motor  4. Measuring voltage of feeder cable to playback motor	1. Continuity test for DC voltage feeder cable to the laser conveyor motor sled, tilt and playback motor 2. Measuring the feeder voltage to the laser conveyor motor sled, tilt and playback motor	1. Multimeter  2. Long nose plier  3. Sets of star/flat screw driver 4. Precision tools  5. Brush

S/N	TASK	LEARNING OUTCOME		CONTENT	TOOLS
		PERFORMANCE OBJECTIVE	FAULTY COMPONENTS REPLACEMENT CRITERION		
		Craftsmen should be able to:	Craftsmen should be able to:		
		6. Measure the feeder voltage to playback motor			6. Picker
2.	Verifying functioning of DC motors	1. Test coils of the laser conveyor motor	1. Mount and solder laser conveyor motor	1. Armature resistance coils test for sled, tilt and playback motor	7. Soldering iron
3.	Verifying functioning of tray and gears	2. Test coils of the tilt motor	2. Mount and solder the tilt motor		8. Lead sucker
		3. Test coils of the sled motor	3. Mount and solder sled motor		9. Bench lamp
		1. Set laser assembly conveyor gears	1. Replace laser assembly conveyor gears	1. Setting laser assembly conveyor and ejection gears	10. Gum
		2. Set the ejection gears	2. Replace the ejection gears	2. Detachment of playback disc sit platform	11. Razor blade
		3. Detach playback disc sit platform	3. Replace the playback disc sit platform	3. Detachment of tilt motor pulley	12. Blower
		4. Detach tilt motor pulley	4. Replace the tilt motor pulley	4. Engaging the gear of tray loader	13. Flat file
		5. Set the gear of tray loader	5. Replace the gear of tray loader	5. Testing open and close contacts of ejection switch	14. Magnifying lens
		6. Test open and close contacts of ejection switch	6. Replace ejection switch		