IEC TR 63020

Edition 1.0 2016-05

TECHNICAL REPORT

colour inside

Digital sheet music – Market, use cases, and related technologies

IEC TR 63020:2016-05(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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Digital sheet music – Market, use cases, and related technologies

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.160.01; 37.080

ISBN 978-2-8322-3287-3

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CONTENTS

FOREWORD....3
INTRODUCTION....5
1 Scope....6
2 Normative references....6
3 Terms and definitions....6
4 Overview of the sheet music market....6
4.1 Market relevance....6
4.2 Use cases for the sheet music market....7
4.3 Use cases for the digital sheet music market....8
4.4 Market structure and impact of digitization....9
5 Elements of digital sheet music infrastructure....9
5.1 General....9
5.2 Music notation markup language....10
5.2.1 General....10
5.2.2 Symbolic music representation (SMR)....10
5.2.3 Standard music description language (SMDL)....10
5.2.4 The music encoding initiative (MEI)....10
5.2.5 MusicXML....11
5.2.6 LilyPond....11
5.3 Metadata for sheet music....11
5.3.1 General....11
5.3.2 The Dublin Core metadata element set....11
5.3.3 Music metadata style guide....11
5.3.4 The music ontology....11
5.4 Musical font and font layout....12
5.4.1 General....12
5.4.2 Standard Music Font Layout (SMuFL) and compliant fonts....12
5.5 Digital rights management....12
5.6 Reflowable sheet music....12
5.7 Annotation....12
6 Conclusion....12
Bibliography....13

Figure 1 – Market structure and impact of digitization....9

Table 1 – Major use cases for sheet music....7
Table 2 – List of stakeholders....8
Table 3 – Additional use cases for digital sheet music....8

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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DIGITAL SHEET MUSIC – MARKET, USE CASES, AND RELATED TECHNOLOGIES

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The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
100/2540/DTR	100/2648/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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INTRODUCTION

Music notation was invented more than 3 000 years ago. As it was with books, the first and biggest technological change was introduced by the invention of the letterpress in the 14th century. Since then, sheet music technology has changed only insofar as the information age and the rise of digital media have changed all media. Specific applications of technology to sheet music are still in the very early stages. Various technologies and standards exist or have been proposed as standards. Some technology, such as MusicXML [3][1], succeeded in introducing the concept of interoperability and data compatibility to the industry, but most technologies provided little consideration for interoperability, compatibility with data and processes, or standardization for quality. In this context, the sheet music industry hasn't yet been able to offer mature digital sheet music to the market.

This Technical Report starts by reviewing the current industry and the use cases around sheet music. It then catalogues the technologies currently available in the area of digital sheet music. Finally, the report combines these two aspects to illustrate the huge potential to improve digital sheet music technology as well as the added value that standardization offers.

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1 Numbers in square brackets refer to the Bibliography.

DIGITAL SHEET MUSIC – MARKET, USE CASES, AND RELATED TECHNOLOGIES

1 Scope

This Technical Report (TR) provides information related to digital sheet music. It starts with a brief overview of the sheet music market and then explains the use cases for traditional sheet music as well as additional use cases for digitized sheet music (digital sheet music). Finally, it shows examples of each area of technology areas.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 10744:1997, *Information technology – Hypermedia/Time-based Structuring Language (HyTime)*

ISO/IEC 14496-23:2008, *Information technology – Coding of audio-visual objects – Part 23: Symbolic Music Representation*

ISO 8879:1986, *Information processing – Text and office systems – Standard Generalized Markup Language (SGML)*

ISO 15836:2009, *Information and documentation – The Dublin Core metadata element set*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
score
collection of musical notations of different musical instruments for a musical composition

3.2
sheet music
piece of paper, sometimes bundled in a book or booklet, with musical symbols printed on it

4 Overview of the sheet music market

4.1 Market relevance

Very little information is publicly available on the market size of the sheet music industry. According to IBISWorld, the sheet music market in the United States in 2013 was 345 M USD. There is no verified or widely-accepted market size number for the sheet music global market. Using the number for the US market, this report assumes the global market size of the sheet music industry is 500 M to 700 M USD. The musical instrument market and music playback/performance markets are closely related to the sheet music market, and they generate 16 B USD and 16,5 B USD, respectively. Sheet music, musical instruments, and playback/performance are equally important in music, but the sheet music industry is the

smallest of the three. By enhancing the value of sheet music using the latest technology, the sheet music industry has a good chance to grow.

4.2 Use cases for the sheet music market

Major use cases for sheet music are listed in Table 1. These use cases are categorized into three groups, i.e. authoring, distribution, and consumption.

Table 1 – Major use cases for sheet music

Category	Use case label	Use case details
Authoring	Compose	Compose songs. Compositions can be as simple as a one bar jingle for advertisement to full-scale orchestral compositions. Traditional composers typically use pen and manuscript paper along with musical instruments while composing. However, composing on computers (desktop music) has also become common.
	Arrange	Arrange songs. “Composing” usually refers to creating an original musical work. On the other hand, “arranging” is to transform original music into other forms, such as creating variations, adding/subtracting parts for different sets of instruments, as well as the changing of the musical style. Arrangers and composers have the same requirements for sheet music.
	Engraving	Composers and arrangers cannot necessarily create playable sheet music. Their handwriting can be hard to read and the layouts of notes and bars won’t always consider playability. Musical engravers turn the musical works of composers and arrangers into commercially-viable and musically-playable sheet music.
Distribution	Print	Printing music commercially. Traditional music publishers use a variety of paper sizes to print music. Not only have they not adopted paper size standards like letter or A4, but they haven’t even standardized on a paper size amongst themselves. While these commercial publishers use non-standard sizes that are usually bigger than letter or A4, non-commercial printing is typically done on personal printers using standard sizes: letter or A4.
	Publishing	Sheet music is published as a single piece or as a bundled book. Sheet music pieces usually come with a simple front cover. Music books sometimes contain full color photographic pages, such as a scene for a musical. The music is usually printed in black, though is sometimes in color, especially for children’s music. Publishers have their preferred musical font. Sheet music for children and beginners tend to be in larger music fonts.
	Cataloguing	Major music publishers issue regular, periodic catalogs (usually annually) for their customers. Typically, sheet music pieces listed by genre and then by name. Each entry contains the cover page image, arrangement, price, difficulty, etc. Recently, music publishers provide the same information on their websites which offer a more effective way for customers to search and find the music they want.
	Purchase / Delivery	Sheet music is typically sold at a bookstore or musical instrument shop. It is also becoming common to purchase sheet music online. Sheet music is delivered in physical form to users.
	Marketing	The sheet music market is small compared to other media markets. Therefore, sheet music marketing activity is generally inconspicuous. However, timing is very important in sheet music marketing. For example, when a song hits a top chart, or is featured in a popular movie, the sheet music should be available soon thereafter.
	Rental	Sheet music rental is common for modern classical pieces, where the number of copies to be sold will not meet a commercially viable number.
	Rights management	Copyright plays a major part in rights management for sheet music. Beside those laws and regulations enforced by governments, there are other rights based on private contracts, such as marketing territory issues. Both legal and private contracts should be considered in sheet music businesses.
Consumption	Perform	Performers play sheet music. Sometimes sheet music is rearranged or photocopied for smooth performance. For example, a photocopy of the next page might be added next to a page to avoid a busy page turn. Photocopying can also be used to enlarge the music for easier reading. Finally, printed or copied pages from a book are also used for easier handling.

Category	Use case label	Use case details
	Annotate	Several kinds of annotations are popular. String instrument players write bowing (up/down bow), piano and string players write fingering (which finger to use to play the note), and special annotations for the speed or volume. Annotation is also used for educational purposes for music teachers to give direction to students.
	Photocopy	Making photocopies is a major use case for sheet music since the invention of the photocopier. It could be illegal in certain conditions.
	Search	Search is an essential action for performers in order to achieve other use cases. Performers search for their desired sheet music by category, arrangement, difficulty, etc.
	Teach	Sheet music is used as teaching material. Teachers pick up etudes and musical pieces that match students' needs.
	Study / Analyze	Sheet music is used for performance and practice. It is not only used for performing with a musical instrument, but also for analyzing and studying music without an instrument.

Table 2 shows a list of direct and indirect stakeholders involved in these use cases.

Table 2 – List of stakeholders

Category	User examples
Authoring	Composer Arranger Engraver
Distribution	Publisher
Consumption	Performer Teacher Student

4.3 Use cases for the digital sheet music market

Use cases for sheet music are also applicable to digital sheet. However, there are several use cases that apply only to digital sheet music because of their dynamic nature. Table 3 shows these additional use cases for digital sheet music.

Table 3 – Additional use cases for digital sheet music

Category	Use case label	Use case details
Consumption	Playback	Some digital sheet music display devices may also have playback capability. The digital sheet music can play the melody and/or the accompaniment. Users play the digital sheet music and listen to the melody as a guide, or play along with the accompaniment.
	Record	Some digital sheet music display devices may also have recording capability. Users record their performance for later review, or send the performance data via network to teachers.
	Visualize	Recorded performances can be used as source data for visualization.
	Assessment	Recorded performances can be used as source data for assessment. Since digital sheet music stores performance data along with visual representation, it is possible for the system to assess the performance against the stored performance data.

To achieve these extended use cases, service providers and application software manufacturers are also considered stakeholders of digital sheet music use cases.

4.4 Market structure and impact of digitization

Figure 1 shows the conventional sheet music market structure on the left side, and the effect of digitization of sheet music on the right side. It illustrates that sheet music goes through three phases: authoring, distribution, and consumption. In the conventional sheet music market, the physical entity, the sheet music itself, has to be physically transferred through the structure. Therefore, once sheet music reaches the consumption market; the information usually cannot go back to previous phases of authoring and distribution.

With the digitization of sheet music, this structure changes, as seen on the right side of Figure 1. With digital sheet music, the basic information flow does not change. However, there are three changes in the market. First, with the help of information technology, operations in each phase are performed more effectively. Second, to provide the information technology, new entrants, such as platform service provider or application manufacturer enter into the market. Lastly, because of digitization, the structure does not need to rely on the physical transportation of goods. This will bring other possibilities for the information flow. With digitization, the performer and teacher can become another information source for the publisher. This means that usage for digital sheet music will expand.

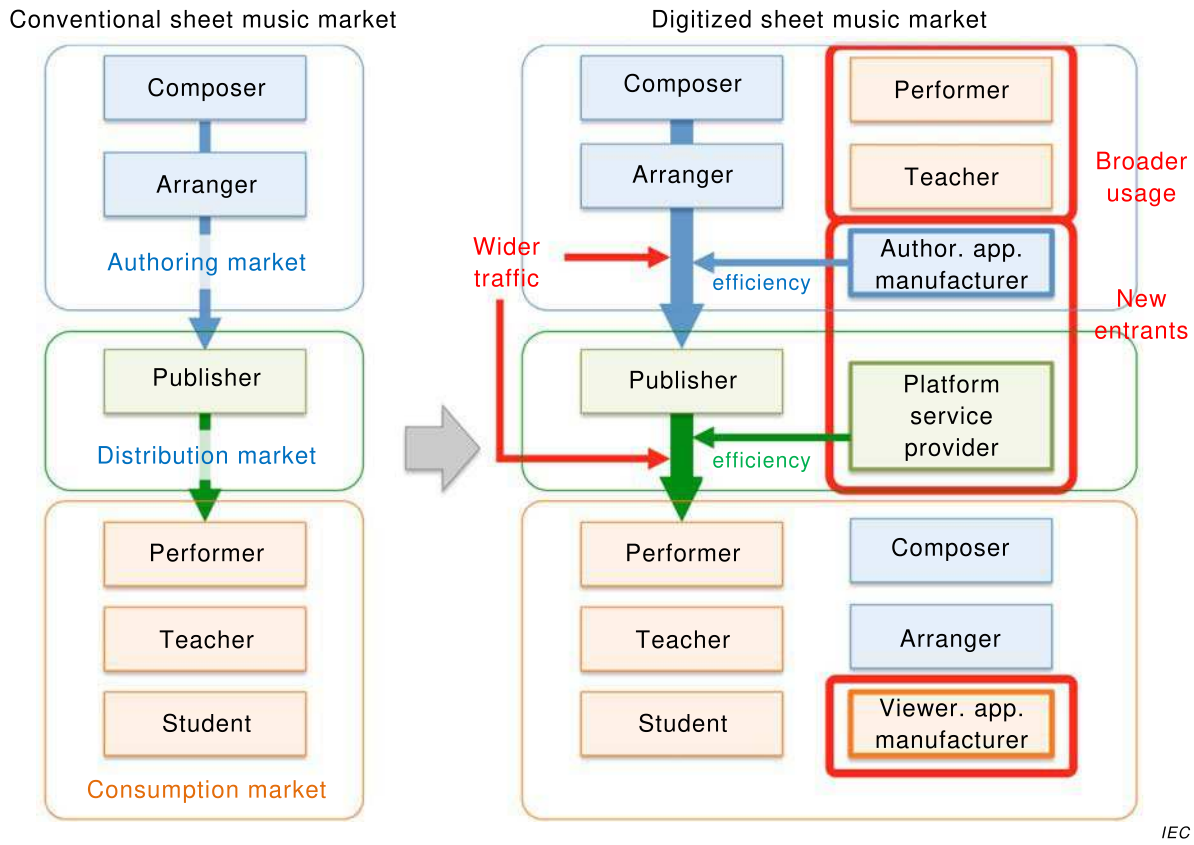

Figure 1 – Market structure and impact of digitization

5 Elements of digital sheet music infrastructure

5.1 General

To achieve use cases for digital sheet music, various technologies have been proposed and some implemented. In this clause, those technology elements are listed and categorized.

Some technology elements are published as international standards, and others are either treated as defacto standards, or simply implemented as standalone solutions. Most technology elements listed here are actively used and maintained, with some exceptions. Technology elements are often combined to achieve use cases or used as a foundation for other technology elements.

5.2 Music notation markup language

5.2.1 General

For many years, sheet music has been hand-written by engravers. These days, music notation software is used to engrave sheet music. As of this writing, music notation software, such as Finale[2] from MakeMusic Inc. and Sibelius[3] from Avid Technology, Inc. is widely used to engrave sheet music, especially in the commercial domain. The biggest departure from hand-written engraving to software engraving is the separation of data and presentation. Although all modern engraving software has a GUI (graphical user interface) and WYSIWYG (what you see is what you get) user interface, data and presentation are clearly separated in the software. To achieve use cases for digital sheet music, it is imperative to be able to use the music data separately from its presentation. Following is a list of major music notation data formats.

5.2.2 Symbolic music representation (SMR)

ISO/IEC 14496-23 specifies Symbolic Music Representation (SMR). Symbolic music representation specifies Symbolic Music Extensible Format (SM-XF), Symbolic Music Formatting Language (SM-FL), and Symbolic Music Synchronization Information (SM-SI). SM-XF is an XML-based language used to encode musical scores. It supports not only musical notations but also lyrics. SM-FL is an XML-based language used to define the rendering rules to be applied to the SM-XF format. SM-SI is a binary format describing the synchronization information between the SMR elements and the other audiovisual elements.

As of this writing, the I-MAESTRO project [1] is the only implementation of ISO/IEC 14496-23 SMR.

5.2.3 Standard music description language (SMDL)

Standard Music Description Language (SMDL) [2] defines an architecture for the representation of music information, either alone or in conjunction with text, graphics, or other information needed for publishing or business purposes. SMDL is a “HyTime” application. It conforms to ISO/IEC 10744 (Hypermedia / Time-based structuring language (“HyTime”)), as well as to ISO 8879 (Standard generalized markup language). The primary aim of SMDL is to permit application-neutral interchange of many genres of music.

As of this writing, no commercial product implementing SMDL can be found.

5.2.4 The music encoding initiative (MEI)

The Music Encoding Initiative (MEI) [5] is a community-driven initiative to define XML-based digital symbolic representation of music notation documents. The goal of MEI is to define a set of rules to record music notation documents so that the information contained in them may be searched, retrieved, displayed, and exchanged in a platform-independent manner.

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2 Finale is the trade name of a product supplied by MakeMusic Inc.

3 Sibelius is the trade name of a product supplied by Avid Technology, Inc.

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MEI is developed and maintained by Perry Roland of the University of Virginia. As of this writing, MEI has been used for many academic projects, but no commercial implementation exists.

5.2.5 MusicXML

MusicXML is a widely used music notation format. It was designed for sharing sheet music files between applications, and for archiving sheet music files for use in the future.

As of this writing (Jan. 11th, 2015), 185 commercial musical applications support MusicXML.

5.2.6 LilyPond

LilyPond [3] is a music-engraving program devoted to producing sheet music of the highest possible quality. It is managed as a part of the GNU (GNU's Not Unix) project. Unlike other music-engraving programs, LilyPond depends on a text-based data input file. The input file is not XML-based as other music notation markup languages are. It has a special syntax like a programing language.

5.3 Metadata for sheet music

5.3.1 General

Similarly to other media, metadata is important for sheet music. Sheet music metadata are used to classify sheet music by, for example, genre, arrangement, or difficulty. Following is a list of metadata-related specifications from various domains. None of the listed specifications can support all use cases for sheet music, but the concepts might be useful.

5.3.2 The Dublin Core metadata element set

The Dublin Core®[4] metadata element set is a vocabulary of fifteen properties for use in resource description, see ISO 15836. The element set includes title, creator, subject, description, publisher, contributor, date, type, format, identifier, source, language, relation, coverage, and rights.

5.3.3 Music metadata style guide

The digital supply chain and operations workgroup at the music business association published the music metadata style guide (version 2) [6]. The style guide was created to assist in harmonizing the consistency of standards across digital music retailers with respect to how music is listed, ingested and managed by establishing a common set of metadata guidelines.

5.3.4 The music ontology

The music ontology [7][5] provides a vocabulary for publishing and linking a wide range of music-related data on the Web. The music ontology is built on the resource description framework (RDF) model, which enables data to be described as "triples": subject, predicate and object.

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4 Dublin Core is the trademark of a product supplied by Dublin Core Organization.

This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

5 http://musicontology.com

5.4 Musical font and font layout

5.4.1 General

Music notation requires many musical symbols. Like letter fonts, there are many variations in musical fonts.

5.4.2 Standard Music Font Layout (SMuFL) and compliant fonts

SMuFL [8] is a specification that provides a standard way of mapping a variety of musical symbols required by conventional musical notation. Without such standardization, musical notation software use different encoding schemes for each musical symbol and musical notation data cannot be reused in other software. The SMuFL specification is published and maintained by Steinberg Media Technologies GmbH. The Bravura font is an SMuFL-compliant font provided by Steinberg.

5.5 Digital rights management

Rights protection, namely, copy protection, is an important issue in sheet music publishing. In conventionally-printed sheet music, most sheet music has no protection implemented, and some modern sheet music has copy-evident patterns using halftone screens to prevent photocopying of the original sheet music. Since making a copy is easier with digital media, various copy protection methods are used in digital sheet music. In the past, using proprietary technologies like streaming instead of downloading sometimes protects digital rights, or by limiting the number of times a user can print. Recently though, a method known as “soft DRM” or “Social DRM” has become popular. With Soft DRM, publishers watermark the digital contents with the customer’s information. For example, it is common to imprint the customer’s identification information at the bottom of sheet music.

5.6 Reflowable sheet music

Digital sheet music may be displayed on various devices that have different screen geometries. Similar to the hyphenation rules in text publishing, music notation shall be presented in musical context, such as musical notes in one bar should be displayed together. To support this requirement, digital sheet music may need to be reflowable (layout-adaptive).

5.7 Annotation

Annotation is a major use case in music. Performers may write personal notes on sheet music. Bowed musical instrument (for example Violin) players write up/down bowing along with notes. In physical sheet music, annotation is as simple as pen and paper. However, in digital sheet music, annotation not only requires methods and interfaces to let performers modify the digital sheet music, but also may need to be aware of reflowable contents. Otherwise, annotated information may be placed at an inappropriate location after the reflow process takes place.

6 Conclusion

The sheet music market has a long history, and, as shown in this report, is a sizable market. While small, the digital sheet music market does exist. However, despite the fact that various technologies have been introduced to enhance sheet music use cases in many ways, digital sheet music is not yet used in any major music scene. This report shows that standardizing those technologies and applying them to the sheet music market may contribute to the growth of digital sheet music by adding new use cases to traditional sheet music.

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch