LilyPond

A kottaszedő program

Esszé

A LilyPond fejlesztőcsapata

Ez az esszé a LilyPond 2.24.3 automatikus kottaszedési mechanizmusmába nyújt mélyebb betekintést.

A teljes dokumentáció a `https://lilypond.org/` honlapon található.

A LilyPond 2.24.3 verziójához

Tartalomjegyzék

1 A kottaszedés

Ez az esszé leírja, miért született a LilyPond, és hogyan képes ilyen gyönyörű kottákat előállítani.

1.1 A LilyPond története

Mielőtt a LilyPondot koncerteken használt csodaszép kották szedésére kezdtük volna használni, mielőtt zenetudományi dokumentumok zenei idézeteit vagy akár egyszerű dallamokat le lehetett volna vele kottázni, mielőtt szerte a világon a felhasználók széles körben kezdték volna használni, vagy ez az esszé megszületett volna, a LilyPond története egy kérdéssel kezdődött:

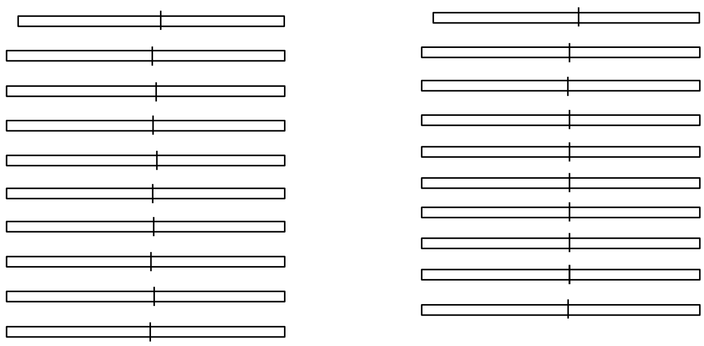
> Miért nem adják vissza a számítógép által szedett kották a kézzel szedett kották szépségét és kiegyensúlyozottságát?

Erre többnyire választ kaphatunk, ha górcső alá vesszük a következő két kottát. Az első példa egy gondosan kézzel szedett kotta 1950-ből, a második egy modern, számítógéppel szedett kiadás.

J. S. Bach első, csellóra írt szólószvitjének két kiadása hangról hangra megegyezik, mégis megjelenésükben merőben különbözőek, különösen, ha kinyomtatjuk és megszokott távolságból szemléljük őket. Próbáljuk meg mindkét kottapéldát elolvasni, illetve játszani belőlük, és meg fogjuk állapítani, hogy a kézzel szedett kotta használata kellemesebb. Folyékonysága és dinamikája egy élő, lélegző zenemű érzetét kelti, miközben az újabb kiadás hidegnek és mechanikusnak hat.

Nehéz egyből észrevenni, miben rejlik a különbség a kották között. Az új kotta első ránézésre rendezett és pontos, talán még „jobb” is, mivel számítógéphez illőbb és egységes a megjelenése. Ez gondolkodóba ejtett minket egy időre. Javítani akartunk a számítógép által szedett kottaképen, de ehhez előbb rá kellett jönnünk, mi volt a gond vele.

A válasz az új kotta precíz, matematikai pontosságú egyformaságában rejlik. Keressük csak meg minden sor közepén az ütemvonalakat: a kézzel szedett változatban az ütemvonalak elhelyezkedése természetes módon változik, míg a számítógép szinte pontosan egymás alá, középre szedte őket. Ezt mutatja be a következő egyszerűsített ábra, melyen a kézzel (balra), ill. a komputerrel szedett változat (jobbra) elrendezése látható:



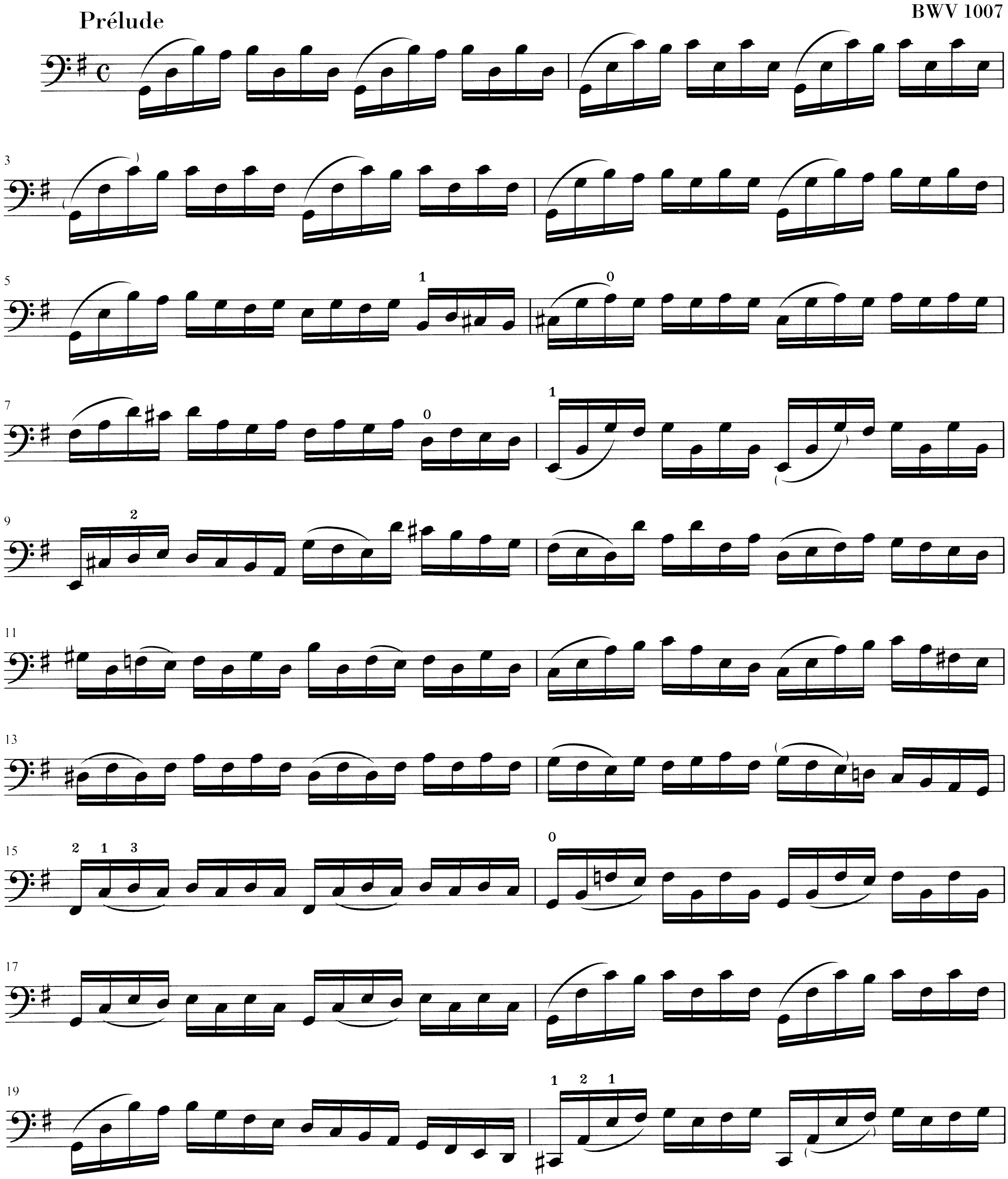
A számítógép által előállított szedésben még az egyes kottafejek is függőlegesen egymáshoz lettek igazítva, ami azt az érzetet kelti, mintha a dallamvonal eltűnne egy szimbólumokból álló merev rács mögött.

További különbségek is vannak: a kézzel szedett változat függőleges vonalai erősebbek, a kötőívek szorosabban tapadnak a kottafejekhez, és a gerendák szögeiben is nagyobb változatosság figyelhető meg. Noha az ilyen részletes elemzés szőrszálhasogatásnak tűnhet, végeredménye egy olyan kotta, ami egyszerűbben olvasható. A számítógépes kottában minden sor szinte egyforma, és ha a zenész egy pillanatra máshová tekint, hamar elveszítheti a tájékozódást az oldalon.

A LilyPond megalkotásának célja az volt, hogy kiküszöböljük a többi kottaszedő szoftver szépséghibáit, és segítségével olyan kottákat lehessen előállítani, melyek szépsége a legigényesebb kézzel szedett kottákéval vetélkedik.

Bärenreiter BA 320, ©1950:

Henle no. 666, ©2000:



1.2 A kottaszedés fortélyai

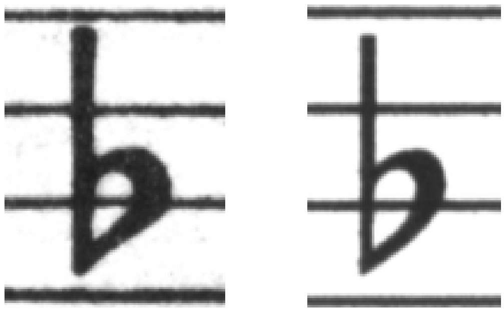
A zeneművek nyomdai előkészítését *kottaszedésnek* nevezik. Ez a kifejezés a kották nyomtatásának hagyományos, kézi módszerére utal.[1] Ez a folyamat még a 20. században első felében is úgy nézett ki, hogy a kotta elemeit kivágták, majd tükrözve belemélyesztették egy cink- vagy ónlemezbe. A lemezre ezután festéket hordtak fel, és a festék a bemélyedésekben maradt. A lemez a papírra rányomva a kotta képét adta. A metszést teljesen kézzel végezték, és bárminemű javítás nagyon körülményes volt, így a kottakép elsőre tökéletes kellett, hogy legyen. A kottaszedés tudománya nagyon különleges szakma, ahol a kézművesnek körülbelül öt éves képzést kellett elvégeznie, mielőtt a mester címet kérvényezhette. További öt év volt szükséges ahhoz, hogy a szakma minden csínját-bínját valóban magáénak tudhassa.

A LilyPond megalkotását azok a kézzel szedett kották inspirálták, amelyeket a 20. század közepe felé az európai kottakiadók (többek között Bärenreiter, Duhem, Durand, Hofmeister, Peters és Schott) hoztak forgalomba. Munkásságukat bizonyos szempontból a hagyományos kottaszedés csúcsának lehet tekinteni. Kiadványaik tanulmányozásával rengeteget tanultunk arról, mik az ismertetőjelei egy szép tipográfiájú kottának, és milyen szempontokat szeretnénk a LilyPonddal utánozni.

A kottában használt betűtípusok

A lenti ábra jól mutatja a különbséget egy hagyományosan és egy számítógép által szedett kottaelem közt. A bal oldali képen egy beszkennelt b módosítójel látható egy kézi Bärenreiter kiadásból, míg a jobb oldali ugyanennek a zeneműnek 2000-ben kiadott változatából származik. Noha mindkét képet ugyanolyan árnyalatú tintával nyomtatták, a régebbi verzió sötétebb: a kottasorok vonalai vastagabbak, és a Bärenreiter b-je gömbölyded, majdhogynem érzékien kerek. A jobb oldali kép vonalai ezzel szemben vékonyabbak, elrendezése szögletes, sarkai élesek.

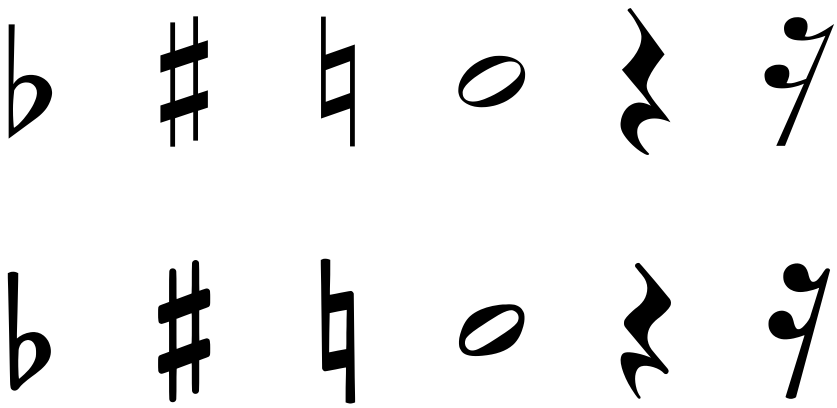
[1] A régi idők nyomdászai különböző technikákat próbáltak ki, mint például a kézzel metszett fa nyomóformák (nyomódúc), a mozgatható betű- és nyomóelemek, illetve a gravírozott vékony fémlemezek. A mozgatható betű- és nyomóelemekkel való szedésnek megvolt az az előnye, hogy gyorsan bele lehetett javítani és egyszerűen lehetett szöveget is beleilleszteni. De csak a fémlemezre végzett hangjegymetszés tette lehetővé a hibátlan elrendezést és az új kottaelemek gyors bevezetését. Végül ez utóbbi technika lett a szabvány, és még a 20. század elején is ez volt a helyzet, pár korálkönyv és daloskönyv kivételével, ahol a sablonelemek használatát annak gazdaságossága és gyorsasága indokolta.



Bärenreiter (1950) Henle (2000)

Amikor úgy döntöttük, hogy írunk egy kottaszedő programot, nem volt olyan, szabad felhasználású zenei betűtípus, ami jól passzolt volna kedvenc kottáink elegáns kottaképéhez. Ezen felbuzdulva megalkottunk egy zenei szimbólumokból álló betűtípust, amely a kézzel szedett kották szemrevaló kinézetét veszi alapul. A betűtípus megtervezése során szerzett tapasztalatok nélkül soha nem ismertük volna fel, milyen csúnyák is azok a betűtípusok, amiket eleinte csodáltunk.

Lent két zenei betűkészletre láthatunk példát: a felső a Sibelius alapbeállítású készlete (*Opus*), az alsó a LilyPondé.

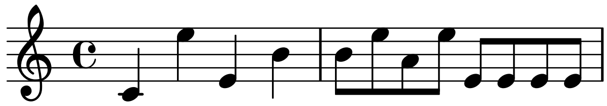


A LilyPond kottaelemei vastagabbak, valamint vastagságuk konzisztensebb, ami miatt jóval egyszerűbb az olvasásuk. A vonalaknak, mint például a negyed szünet szárnyai, nem hegyes végük van, hanem finoman legömbölyített. Ennek oka, hogy a hegyes végek a hagyományos nyomóformán nagyon törékenyek, és a használat közben gyorsan elkopnak. Összefoglalva, a jelkészlet teltségét gondosan össze kell hangolni a vonalak (gerendák, ívek) vastagságával, hogy erős, mégis kiegyensúlyozott összképet kapjunk.

Vegyük észre továbbá, hogy a félkotta feje nem ellipszis, hanem enyhén rombusz alakú. A b módosítójel függőleges szára felfelé némileg kiszélesedik. A keresztet és a feloldójelet egyszerűbb távolról megkülönböztetni, mert ferde vonalaiknak eltérő a dőlésszöge, illetve függőleges vonalaik különböző vastagságúak.

Optikai kiegyenlítettség

A kották vízszintes elrendezésénél a mindenkori hangjegy hosszúságának kell visszatükröződnie. Amint a fenti Bach-szvit példáján már megfigyelhettük, sok modern kottánál a hangjegyek hosszának ábrázolása a matematikai precizitás felé törekszik, ami nem túl szép eredményhez vezet. A következő példában bemutatjuk Önöknek ugyanazt a motívumot kétszer: először matematikai pontossággal, másodszor ugyanezt kijavítva. Melyik példa tetszik Önnek jobban?

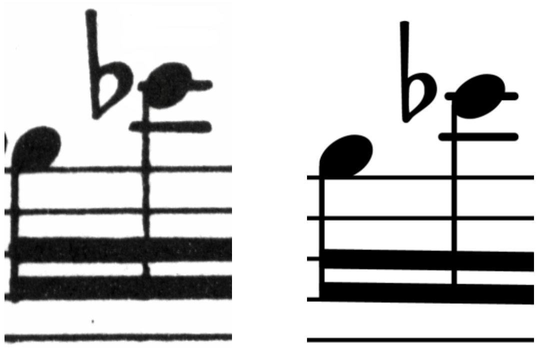


Ezen kottarészlet egyforma hosszúságú hangjegyeket használ. A hangjegyek közti távolságnak tükröznie kellene ezt. Sajnos a szemünk becsap: nem csak az egymást követő kottafejek távolságát kell figyelembe kell venni, hanem a szárukat is. Tehát egymás után következő fölfelé-lefelé szárú hangjegyeket kicsit távolabb kell helyezni egymástól, míg a lefelé-fölfelé kombináció szűkebb távolságot kíván, és az egész még függ a hangjegyek függőleges pozíciójától. Az alsó példa ezeket a korrektúraelveket tükrözi. Ellenben a felső példán a hangjegyek alsó-felső irányba váltakozása olyan érzetet kelt, mintha összegubancolódtak volna. Az alsó példa ezeket a szabályokat tükrözi. Ellenben a felső példa az olvasó szemében olyan érzetett kelt, mintha alulfölül a kottafejek egy csomóban lennének. Egy kottaszedő mester ezt a beosztást úgy igazítaná el, hogy annak az olvasása kellemes legyen.

A Lilypond beosztásért felelős algoritmusa úgy kalkulál, hogy az ütemvonalat is figyelembe veszi, ami miatt az utolsó hangjegy a fenti példában több helyet kap, ezért nem kelti a zsúfoltság hatását. Egy szár lent nem szorulna erre a beosztásra.

Pótvonalak

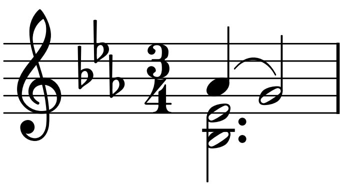
A pót- (esetleg: segéd-) vonalak mindig kihívás elé állítják a tipográfiát: miattuk nehezebb a hangjegyeket sűrűn elrendezni és a hangmagasságot egy gyors pillantással meg kell tudni állapítani. A lentebb található példában láthatjuk, hogy a pótvonalnak vastagabbnak kell lennie mint egy normál kottavonalnak és egy tanult kottaszedő a pótvonalat lerövidíti azért, hogy a módosító jeleknek maradjon hely. Ezt a tulajdonságot mi beleépítettük a Lilypondba.



Optikai nagyság

A kottákat különböző méretben nyomják. Eredetileg ehhez különböző méretű kliséket gyártottak, ami egyben azt jelenti, hogy minden klisé olyan minőségű volt, hogy a saját méretében a legideálisabb képet adja. A digitális fonttal tudjuk a hangjegyek kontúrját matematikusan felnagyítani illetve kicsinyíteni azért, hogy a tetszés szerinti méretben elő tudjuk állítani, aminek sok előnye van. Azonban kis méretben a szimbólumok túl vékonynak hatnak.

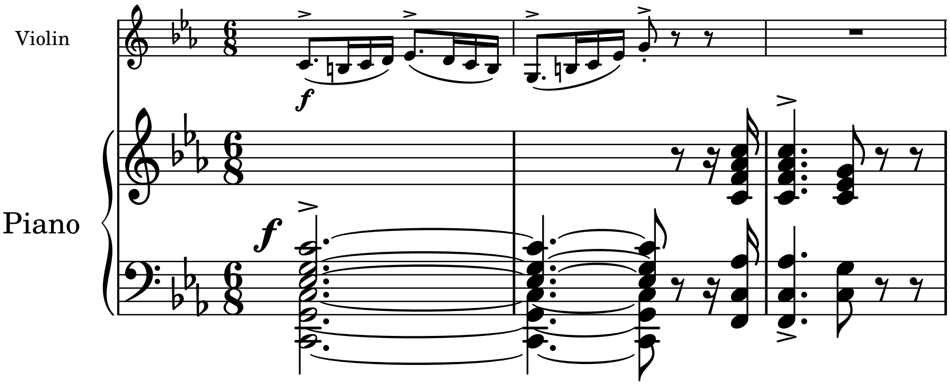
A Lilypond számára különböző vastagságú szedéstípusokat készítettünk, melyek egy bizonyos kottaméretnek felelnek meg. Az itt látható Lilypond kottaszedés 26-os méretű:



Itt ugyanazok a kották 11-es méretben, utána 236%-al nagyítva. hogy a kép pontosan abban a méretben jelenjen meg, mint az előbbi.

Kisebb méretnél a Lilypond arányosan vastagított kottavonalakat használ a kitűnő olvashatóság érdekében.

Ez teszi lehetővé különböző méretű kottasorok békés egymás mellett élését egy oldalon:



Miért szükséges ez a nagy felhajtás?

Musicians are usually more absorbed with performing than with studying the looks of a piece of music, so nitpicking typographical details may seem academic. But it is not. Sheet music is performance material: everything is done to aid the musician in letting her perform better, and anything that is unclear or unpleasant to read is a hindrance.

Traditionally engraved music uses bold symbols on heavy staff to create a strong, well-balanced look that stands out well when the music is far away from the reader: for example, if it is on a music stand. A careful distribution of white space allows music to be set very tightly without crowding symbols together. The result minimizes the number of page turns, which is a great advantage.

This is a common characteristic of typography. Layout should be pretty, not only for its own sake, but especially because it helps the reader in his task. For sheet music this is of double importance because musicians have a limited amount of attention. The less attention they need for reading, the more they can focus on playing the music. In other words, better typography translates to better performances.

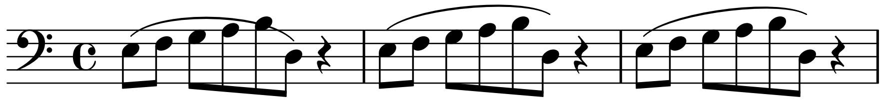
These examples demonstrate that music typography is an art that is subtle and complex, and that producing it requires considerable expertise, which musicians usually do not have. LilyPond is our effort to bring the graphical excellence of hand-engraved music to the computer age, and make it available to normal musicians. We have tuned our algorithms, font-designs, and program settings to produce prints that match the quality of the old editions we love to see and love to play from.

1.3 Az automatizált kottaszedés

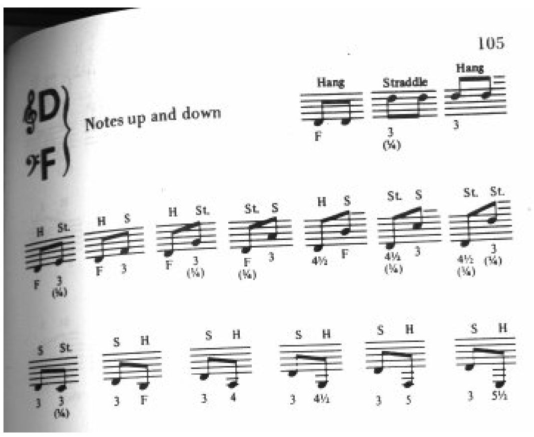
Ebben a szakaszban arról lesz szó, mi szükséges egy program megírásánál, ami az elkészült kotta szedéstükrét meghatározza. Egy módszer ami elmagyarázza a számítógépnek a szép szedéstükör ismérveit és részletesen összehasonlítja a hagyományos módon előállított kottával.

Szépségverseny

Hogyan kell hát a tipográfiát felhasználnunk? Másképpen mondva: A három egymást követő kötőívből melyiket válasszuk ki?



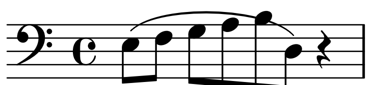
Sajnos kevés könyv állt rendelkezésünkre a kottaszedés művészetéről. Így csak ökölszabályokat állíthattunk fel és egyes példákat tudunk bemutatni. Ezek a szabályok ugyan informatívak lehetnek de túl messze távolodnak attól az algoritmustól, amit a programba beépítünk. Ahol a felhasznált irodalom által kívánt szabályokat felhasználtuk, az algoritmust nagyon sok manuális beállítás befolyásolja. Minden lehetséges esetet kielemezni nagy munka lenne és legtöbbször nem meríti ki az összes lehetőséget:



(Kép forrása: Ted Ross, *The Art of Music Engraving*)

Ahelyett, hogy megpróbálkoznánk azzal, hogy minden lehetséges esethez egy hozzá pontosan felvázolni, hogy a legtetszetősebbet ki tudja választani a szoftver. Utána felállítunk a lehetséges változatokból egy „csúnyasági ranglistát” és kiválasztjuk a legkevésbé csúnyát.

Például itt a legátó ívet 3 lehetséges pályán rajzolta fel és mindegyik változat rondaságát pontozta a program. Az első példa 15,39 pontot kapott mert az ív félbevágott egy kottafejet.

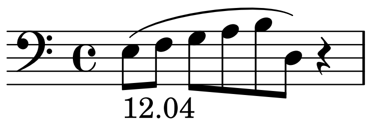


15.39

A második példa már szebb, de az ív végei nem érintik sem a kezdő sem a befejező hang bogyóját. Ebben az esetben 1,71 pontot kap a bal 9,37 pontot a jobb oldal és további két pontot mivel az ív felfelé tart miközben a dallam ereszkedik. Összesen 13,08 pont:

13.08

Az utolsó ív 10,04 pontot kap mivel jobb oldalon hagyott egy rést és 2 pontot a fent található lejtésért/emelkedésért tehát a három közül ez a legszebb.



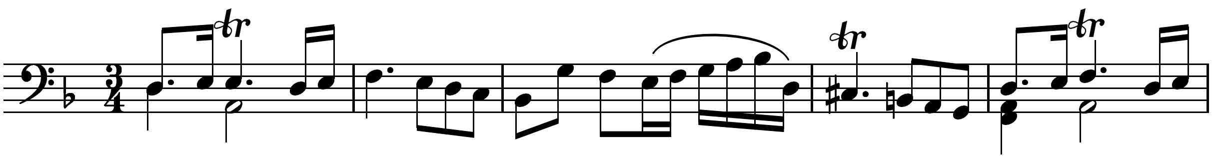
Ez a technika teljesen általános és felhasználja a program az optikai kinézet javításáért különböző ívek összekombinálásánál kötőíveknél, pontok elhelyezésénél, akkordoknál illetve sor és oldaltöréseknél. Ezeknek a döntéseknek az eredményeit össze tudjuk vetni a kézzel szedett kották kinézetével.

A minőség javítása a kottaképek összehasonlításával

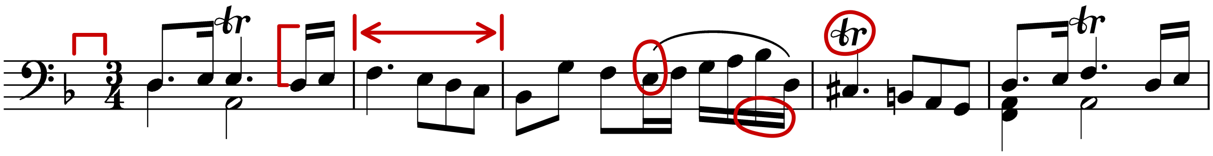
A Lilypond újabb verziói lépésről-lépésre jobbak lettek miközben folyamatosan a kézzel szedett kottákkal lettek összehasonlítva.

Itt látható egy kézzel szedett referenciapélda:

és ugyanez a sor így néz ki a Lilypond egyik régi verziójával (1.4-es verzió 2001 május):



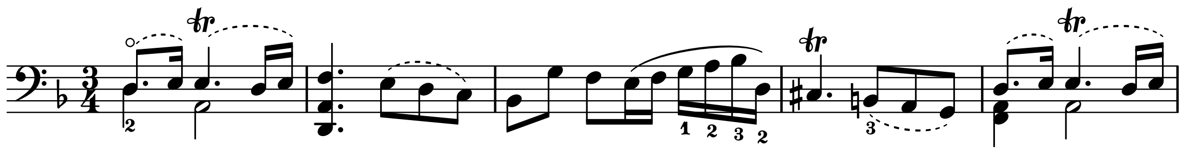
A Lilypond 1.4-es kiadása minden esetre olvashatóbb de egy részletes összevetés az eredetivel a formázás sok apró hibájára mutat rá:



- Az ütemmutató előtt nincs elég hely
- A gerendás hangjegyek szárai túl hosszúak
- A második és negyedik ütem túl keskeny
- A kötőívek idétlenek
- A trillajel túl nagy
- A szárak vékonyak

(Ezenkivül van még két hiányzó kottafej, több hiányzó közreadói megjegyzés és egy fals hangmagasság!)

Igazítva az oldalkinézeti szabályokon és a betűtípusdizájnon az újabb kiadások rendkívül sokat javultak. Hasonlítsa össze ugyanazt a referenciapéldát az aktuális Lilypond verzióval (2.24.3):

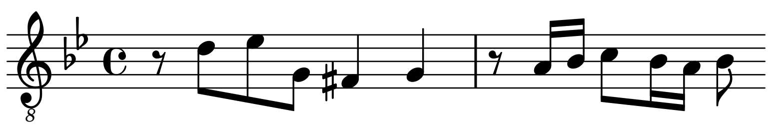


Az aktuális kiadás ugyan még nem a referencia klónja, de jobban megközelíti már a nyomdai minőséget.

Mindent szépen elrendezünk

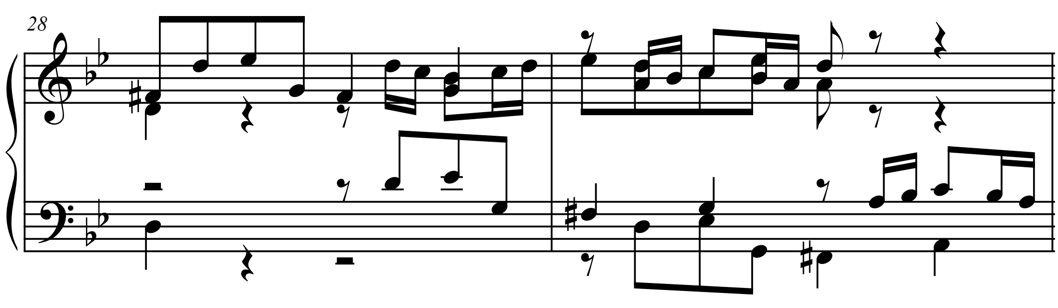
A Lilypond képességeit mérhetjük avval is, hogy összehasonlítjuk a kereskedelemben kapható programokkal. Ebben az esetben a Finale 2008-at vettük, egyike a legismertebb kottaszedő programoknak különösen Észak-Amerikában. A Sibelius a Finale fő vetélytársa, legfőképp Európában ismert.

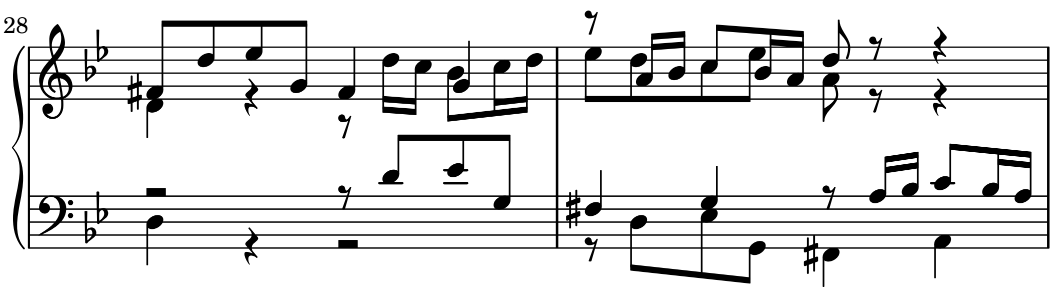
Összehasonlításunkhoz a Wohltemperiertes Clavier I. kötetének g-moll fúgáját (BWV 861) választottuk, melynek nyitótémája:



Összehasonlításunkban a darab utolsó 7 ütemét írtuk meg Finale és a Lilypond segítségével. Ez az a pont, ahol a téma háromszólamú szűkmenetben tér vissza és megy át a zárószakaszba. A Finale verziónál ellenálltunk a kísértésnek, hogy a normáltól eltérő dolgokat korrigáljuk, mivel meg akarjuk mutatni azokat a dolgokat, amit ezek a programok külön beavatkozás nélkül rendesen csinálnak meg. Az egyetlen változtatás csak a méretnél volt, hiszen hozzáigazítottuk ennek az esszének az oldalméretéhez, valamint két sorra korlátoztuk a kottát annak érdekében, hogy az összehasonlítás egyszerűbb legyen. Alapértelmezett beállításoknál a Finale két háromütemes sort és egy záró teljes szélességű, csak egy ütemet tartalmazó sort állítana elő.

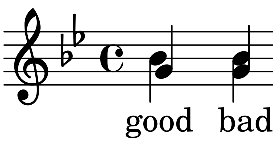
Rengeteg különbség van a két kotta között: először a Finale, majd a Lilypondé látható:





Pár hiba a teljesség igénye nélkül, amit a külön nem szerkesztett Finale szedés tartalmaz:

- A legtöbb gerenda túl messzire távolodik a kottasortól. A gerenda, ami a a rendszer közepére mutat, általában oktáv hosszúságú kellene legyen, de a kottaszedő lekurtítja azt, ha a gerendák polifónia esetén kilógnak. A Finale gerendázásért felelős egységét a programban található Patterson Beams Plugin tudja feljavítani, de ezt a lépést ennél a példánál elhagytuk.
- A Finale nem találja meg a szorosan egymáshoz illeszkedő hangjegyek helyét, ezért a kotta nehezen olvasható, főleg ha az alsó és felső szólam időlegesen helyet cserél.



- A Finale minden szünetjelet pontosan ugyanabba az állásba pozicionál. Kézzel állíthatók ugyan szükség esetén, de a program nem figyel a másik szólamra. Most ugyan nem esik egyik szólambeli hang másik szólambeli szünetre, de ez tisztán véletlen: a megírt hangmagasságokból adódik, nem a szünetek elhelyezéséből. Mondhatni, az ütközések elkerülése Bach érdeme, nem a Finalé-é.

This example is not intended to suggest that Finale cannot be used to produce publication-quality output. On the contrary, in the hands of a skilled user it can and does, but it requires skill and time. One of the fundamental differences between LilyPond and commercial scorewriters is that LilyPond hopes to reduce the amount of human intervention to an absolute minimum, while other packages try to provide an attractive interface in which to make these types of edits.

One particularly glaring omission we found from Finale is a missing flat in measure 33:

The flat symbol is required to cancel out the natural in the same measure, but Finale misses it because it occurred in a different voice. So in addition to running a beaming plug-in and checking the spacing on the noteheads and rests, the user must also check each measure for cross-voice accidentals to avoid interrupting a rehearsal over an engraving error.

If you are interested in examining these examples in more detail, the full seven-measure excerpt can be found at the end of this essay along with four different published engravings. Close examination reveals that there is some acceptable variation among the hand-engravings, but that LilyPond compares reasonably well to that acceptable range. There are still some shortcomings in the LilyPond output, for example, it appears a bit too aggressive in shortening some of the stems, so there is room for further development and fine-tuning.

Of course, typography relies on human judgment of appearance, so people cannot be replaced completely. However, much of the dull work can be automated. If LilyPond solves most of the common situations correctly, this will be a huge improvement over existing software. Over the course of years, the software can be refined to do more and more things automatically, so manual overrides are less and less necessary. Where manual adjustments are needed, LilyPond's structure has been designed with that flexibility in mind.

1.4 Building software

This section describes some of the programming decisions that we made when designing LilyPond.

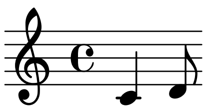
Music representation

Ideally, the input format for any high-level formatting system is an abstract description of the content. In this case, that would be the music itself. This poses a formidable problem: how can we define what music really is? Instead of trying to find an answer, we have reversed the question. We write a program capable of producing sheet music, and adjust the format to be as lean as possible. When the format can no longer be trimmed down, by definition we are left with content itself. Our program serves as a formal definition of a music document.

The syntax is also the user-interface for LilyPond, hence it is easy to type:

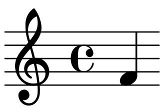
```
{
  c'4 d'8
}
```

to create a quarter note on middle C (C1) and an eighth note on the D above middle C (D1).



On a microscopic scale, such syntax is easy to use. On a larger scale, syntax also needs structure. How else can you enter complex pieces like symphonies and operas? The structure is formed by the concept of music expressions: by combining small fragments of music into larger ones, more complex music can be expressed. For example

```
f4
```

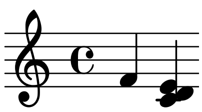


Simultaneous notes can be constructed by enclosing them with << and >>:

```
<<c4 d4 e4>>
```

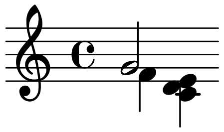
This expression is put in sequence by enclosing it in curly braces `{ ... }`:

```
{ f4 <<c4 d4 e4>> }
```



The above is also an expression, and so it may be combined again with another simultaneous expression (a half note) using <<, \\, and >>:

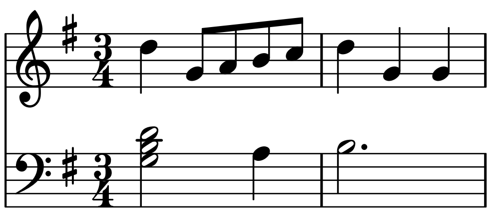
```
<< g2 \\ { f4 <<c4 d4 e4>> } >>
```



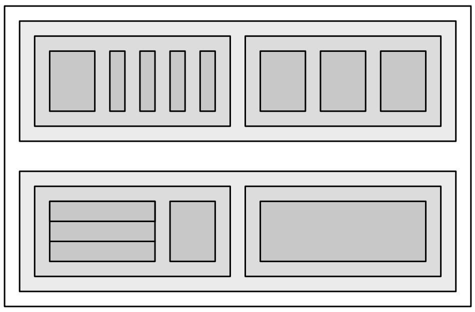
Such recursive structures can be specified neatly and formally in a context-free grammar. The parsing code is also generated from this grammar. In other words, the syntax of LilyPond is clearly and unambiguously defined.

User-interfaces and syntax are what people see and deal with most. They are partly a matter of taste, and also the subject of much discussion. Although discussions on taste do have their merit, they are not very productive. In the larger picture of LilyPond, the importance of input syntax is small: inventing neat syntax is easy, while writing decent formatting code is much harder. This is also illustrated by the line-counts for the respective components: parsing and representation take up less than 10% of the source code.

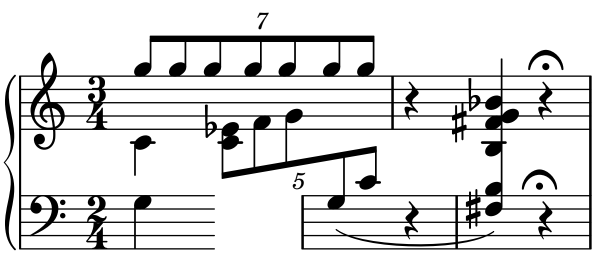
When designing the structures used in LilyPond, we made some different decisions than are apparent in other software. Consider the hierarchical nature of music notation:



In this case, there are pitches grouped into chords that belong to measures, which belong to staves. This resembles a tidy structure of nested boxes:



Unfortunately, the structure is tidy because it is based on some excessively restrictive assumptions. This becomes apparent if we consider a more complicated musical example:



In this example, staves start and stop at will, voices jump around between staves, and the staves have different time signatures. Many software packages would struggle with reproducing this example because they are built on the nested box structure. With LilyPond, on the other hand, we have tried to keep the input format and the structure as flexible as possible.

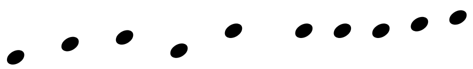
What symbols to engrave?

The formatting process decides where to place symbols. However, this can only be done once it is decided *what* symbols should be printed – in other words, what notation to use.

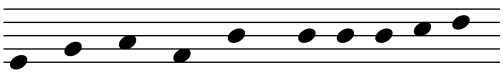
Common music notation is a system of recording music that has evolved over the past 1000 years. The form that is now in common use dates from the early Renaissance. Although the basic form (i.e., note heads on a 5-line staff) has not changed, the details still evolve to express the innovations of contemporary notation. Hence, common music notation encompasses some 500 years of music. Its applications range from monophonic melodies to monstrous counterpoints for a large orchestra.

How can we get a grip on such a seven-headed beast, and force it into the confines of a computer program? Our solution is to break up the problem of notation (as opposed to engraving, i.e., typography) into digestible and programmable chunks: every type of symbol is handled by a separate module, a so-called plug-in. Each plug-in is completely modular and independent, so each can be developed and improved separately. Such plug-ins are called `engravers`, by analogy with craftsmen who translate musical ideas to graphic symbols.

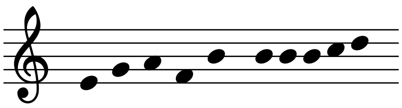
In the following example, we start out with a plug-in for note heads, the `Note_heads_engraver`.



Then a `Staff_symbol_engraver` adds the staff,



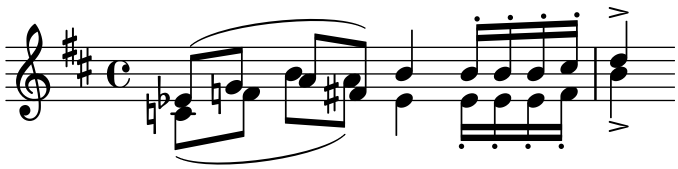
the `Clef_engraver` defines a reference point for the staff,



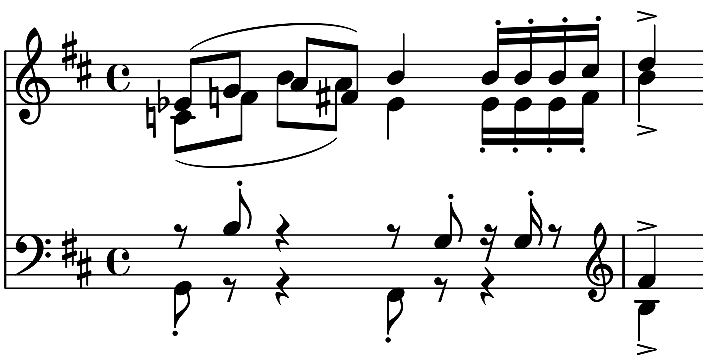
and the `Stem_engraver` adds stems.

The `Stem_engraver` is notified of any note head coming along. Every time one (or more, for a chord) note head is seen, a stem object is created and connected to the note head. By adding engravers for beams, slurs, accents, accidentals, bar lines, time signature, and key signature, we get a complete piece of notation.

This system works well for monophonic music, but what about polyphony? In polyphonic notation, many voices can share a staff.



In this situation, the accidentals and staff are shared, but the stems, slurs, beams, etc., are private to each voice. Hence, engravers should be grouped. The engravers for note heads, stems, slurs, etc., go into a group called 'Voice context', while the engravers for key, accidental, bar, etc., go into a group called 'Staff context'. In the case of polyphony, a single Staff context contains more than one Voice context. Similarly, multiple Staff contexts can be put into a single Score context. The Score context is the top level notation context.



Lásd még

Internals Reference: rész "Contexts" in *A belső működés referenciája*.

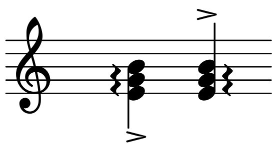
Flexible architecture

When we started, we wrote the LilyPond program entirely in the C++ programming language; the program's functionality was set in stone by the developers. That proved to be unsatisfactory for a number of reasons:

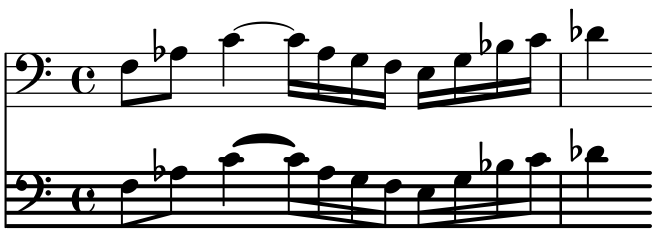
- When LilyPond makes mistakes, users need to override formatting decisions. Therefore, the user must have access to the formatting engine. Hence, rules and settings cannot be fixed by us at compile-time but must be accessible for users at run-time.
- Engraving is a matter of visual judgment, and therefore a matter of taste. As knowledgeable as we are, users can disagree with our personal decisions. Therefore, the definitions of typographical style must also be accessible to the user.
- Finally, we continually refine the formatting algorithms, so we need a flexible approach to rules. The C++ language forces a certain method of grouping rules that cannot readily be applied to formatting music notation.

These problems have been addressed by integrating an interpreter for the Scheme programming language and rewriting parts of LilyPond in Scheme. The current formatting architecture is built around the notion of graphical objects, described by Scheme variables and functions. This architecture encompasses formatting rules, typographical style and individual formatting decisions. The user has direct access to most of these controls.

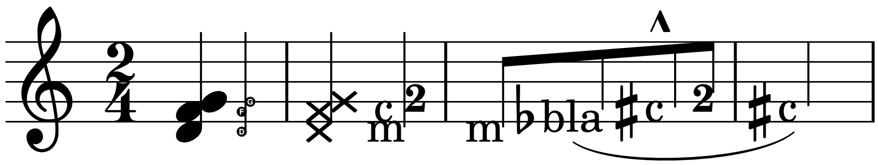
Scheme variables control layout decisions. For example, many graphical objects have a direction variable that encodes the choice between up and down (or left and right). Here you see two chords, with accents and arpeggios. In the first chord, the graphical objects have all directions down (or left). The second chord has all directions up (right).



The process of formatting a score consists of reading and writing the variables of graphical objects. Some variables have a preset value. For example, the thickness of many lines – a characteristic of typographical style – is a variable with a preset value. You are free to alter this value, giving your score a different typographical impression.

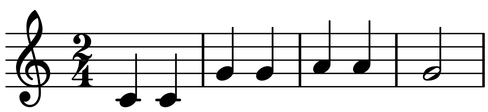


Formatting rules are also preset variables: each object has variables containing procedures. These procedures perform the actual formatting, and by substituting different ones, we can change the appearance of objects. In the following example, the rule governing which note head objects are used to produce the note head symbol is changed during the music fragment.

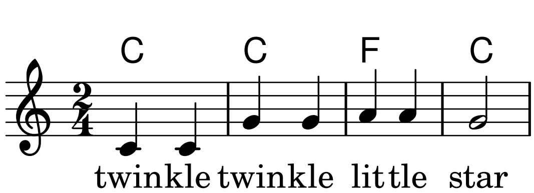


1.5 Putting LilyPond to work

We have written LilyPond as an experiment of how to condense the art of music engraving into a computer program. Thanks to all that hard work, the program can now be used to perform useful tasks. The simplest application is printing notes.



By adding chord names and lyrics we obtain a lead sheet.

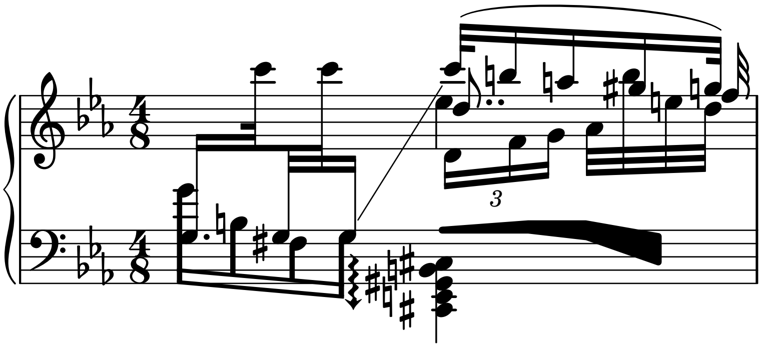


Polyphonic notation and piano music can also be printed. The following example combines some more exotic constructs.

Screech and boink

Random complex notation

Han-Wen Nienhuys



The fragments shown above have all been written by hand, but that is not a requirement. Since the formatting engine is mostly automatic, it can serve as an output means for other programs that manipulate music. For example, it can also be used to convert databases of musical fragments to images for use on websites and multimedia presentations.

This manual also shows an application: the input format is text, and can therefore be easily embedded in other text-based formats such as LaTeX, HTML, or in the case of this manual, Texinfo. Using the `lilypond-book` program, included with LilyPond, the input fragments can be replaced by music images in the resulting PDF or HTML output files. Another example is the third-party OOoLilyPond extension for OpenOffice.org or LibreOffice, which makes it extremely easy to embed musical examples in documents.

For more examples of LilyPond in action, full documentation, and the software itself, see our main website: www.lilypond.org.

1.6 Engraved examples (BWV 861)

This section contains four reference engravings and two software-engraved versions of Bach's Fugue in G minor from the Well-Tempered Clavier, Book I, BWV 861 (the last seven measures).

Bärenreiter BA5070 (Neue Ausgabe Sämtlicher Werke, Serie V, Band 6.1, 1989):

Bärenreiter BA5070 (Neue Ausgabe Sämtlicher Werke, Serie V, Band 6.1, 1989), an alternate musical source. Aside from the textual differences, this demonstrates slight variations in the engraving decisions, even from the same publisher and edition:

Breitkopf & Härtel, edited by Ferruccio Busoni (Wiesbaden, 1894), also available from the Petrucci Music Library (IMSLP #22081). The editorial markings (fingerings, articulations, etc.) have been removed for clearer comparison with the other editions here:

Bach-Gesellschaft edition (Leipzig, 1866), available from the Petrucci Music Library (IMSPL #02221):

Finale 2008:

LilyPond, version 2.24.3:

2 Irodalomjegyzék

Here are lists of references used in LilyPond.

2.1 Short literature list

If you need to know more about music notation, here are some interesting titles to read.

Ignatzek 1995

Klaus Ignatzek, Die Jazzmethode für Klavier. Schott's Söhne 1995. Mainz, Germany ISBN 3-7957-5140-3.

A tutorial introduction to playing Jazz on the piano. One of the first chapters contains an overview of chords in common use for Jazz music.

Gerou 1996

Tom Gerou and Linda Lusk, Essential Dictionary of Music Notation. Alfred Publishing, Van Nuys CA ISBN 0-88284-768-6.

A concise, alphabetically ordered list of typesetting and music (notation) issues, covering most of the normal cases.

Gould 2011

Elaine Gould, Behind Bars: the Definitive Guide to Music Notation. Faber Music Ltd. ISBN 0-571-51456-1.

Hals über Kopf: Das Handbuch des Notensatzes. Edition Peters. ISBN 1843670488.

A comprehensive guide to the rules and conventions of music notation. Covering everything from basic themes to complex techniques and providing a comprehensive grounding in notational principles.

Read 1968

Gardner Read, Music Notation: A Manual of Modern Practice. Taplinger Publishing, New York (2nd edition).

A standard work on music notation.

Ross 1987 Ted Ross, Teach yourself the art of music engraving and processing. Hansen House, Miami, Florida 1987.

This book is about music engraving, i.e., professional typesetting. It contains directions on stamping, use of pens and notational conventions. The sections on reproduction technicalities and history are also interesting.

Schirmer 2001

The G.Schirmer/AMP Manual of Style and Usage. G.Schirmer/AMP, NY, 2001. (This book can be ordered from the rental department.)

This manual specifically focuses on preparing print for publication by Schirmer. It discusses many details that are not in other, normal notation books. It also gives a good idea of what is necessary to bring printouts to publication quality.

Stone 1980

Kurt Stone, Music Notation in the Twentieth Century. Norton, New York 1980.

This book describes music notation for modern serious music, but starts out with a thorough overview of existing traditional notation practices.

2.2 Long literature list

University of Colorado Engraving music bibliography

- Willi Apel. **The notation of polyphonic music, 900-1600**. Cambridge, Mass, 1953. Musical notation.
- Ernest Austin. **The Story of Music Printing**. Lowe and Brydone Printers, Ltd., London. subject: history of music printing and engraving.
- Anna Maria Busse Berger. **Mensuration and proportion signs : origins and evolution**. Clarendon Press, Oxford, England, 1993. subject: early notation.
- Roger Bowers. **Music & Letters**, volume 73. August 1992. Some reflection upon notation and proportion in Monteverdi's mass and vespers.
- Paul Brainard. **Current Musicology**. Number 50. July-Dec 1992. Proportional notation in the music of Schutz and his contemporaries in the 17th Century.
- Carl Brandt and Clinton Roemer. **Standardized Chord Symbol Notation**. Roerick Music Co., Sherman Oaks, CA. subject: musical notation.
- Earle Brown. **Musical Quarterly**, volume 72. Spring 1986. The notation and performance of new music.
- John Cage. **Notations**. Something Else Press, New York, 1969. Music, Manuscripts, Facsimiles. Facsimiles of holographs from the Foundation for Contemporary Performance Arts, with text by 269 composers, but rearranged using chance operations.,V).
- J Carter. **New Paths in Book Collecting**. London, 1934. subject: history of music printing and engraving.
- F. Chrsander. **A Sketch of the HIstory of Music printing, from the 15th to the 16th century**. 18??. subject: history of music printing and engraving.
- Henry Cowell. **Our Inadequate Notation**. *Modern Music*, 4(3), 1927. subject: 20th century notation.
- Henry Cowell. **New Musical Resources**. Alfred A. Knopf, Inc., New York, 1930. subject: 20th century notation.
- O.F. Deutsch. **Music Publishers' Numbers**. London, 1946. subject: history of music printing and engraving.
- Suzanne Eggleston. **Notes**. *New periodicals*, 51(2):657(7), Dec 1994. A list of new music periodicals covering the period Jun.-Dec. 1994. Includes aims, formats and a description of the contents of each listed periodical. Includes Music Notation News.
- Hubert Foss. **Music Printing**. Practical Printing and Binding. Oldhams Press Ltd., Long Acre, London. subject: musical notation.
- Jean Charles Francois. **Writing without representation, and unreadable notation.**. *Perspectives of New Music*, 30(1):6(15), Winter 1992. subject: Modern music has outgrown notation. While the computer is used to write down music with accuracy never before achieved, the range of modern sounds has surpassed the relevance of the computer...
- David Fuller. **The Journal of Musicology**, volume 7. Winter 1989. Notes and inegales unjoined: defending a definition. (written-out inequalities in music notation).
- Virginia Gaburo. **Notation**. Lingua Press, La Jolla, California, 1977. A Lecture about notation, new ideas about.
- Keith A Hamel. **A design for music editing and printing software based on notational syntax**. *Perspectives of New Music*, 27(1):70(14), Winter 1989.
- Archibald Jacob. **Musical handwriting : or, How to put music on paper : A handbook for all musicians, professional and amateur**. Oxford University Press, London, 1947. subject: Musical notation.

- Harold M Johnson. **How to write music manuscript an exercise-method handbook for the music student, copyist, arranger, composer, teacher**. Carl Fischer, Inc., New York, 1946. subject: Musical notation –Handbooks, manuals.
- David Evan Jones. **Perspectives of New Music**. 1990. Speech extrapolated. (includes notation).
- H King. **Four Hundred Years of Music Printing**. London, 1964. subject: history of music printing and engraving.
- A.H King. **The 50th Anniversary of Music Printing**. 1973.
- O Kinkeldey. **Music And Music Printing in Incunabula**. *Papers of the Bibliographical Society of America*, xxvi:89-118, 1932. subject: history of music printing and engraving.
- D.W. Krummel. **Graphic Analysis in Application to Early American Engraved Music**. *Notes*, xvi:213, 9 1958. subject: history of music printing and engraving.
- D.W Krummel. **Oblong Format in Early Music Books**. *The Library*, 5th ser., xxvi:312, 1971. subject: history of music printing and engraving.
- Jeffrey Lependorf. **?**. *Perspectives of New Music*, 27(2):232(20), Summer 1989. Contemporary notation for the shakuhachi: a primer for composers. (Tradition and Renewal in the Music of Japan).
- G.A Marco. **The Earliest Music Printers of Continental Europe: a Checklist of Facsimiles Illustrating Their Work**. Charlottesville, Virginia, 1962. subject: history of music printing and engraving.
- K. Meyer and J O'Meara. **The Printing of Music, 1473-1934**. *The Dolphin*, ii:171–207, 1935. subject: history of music printing and engraving.
- Raymond Monelle. **Comparative Literature**, volume 41. Summer 1989. Music notation and the poetic foot.
- A Novello. **Some Account of the Methods of Musick Printing, with Specimens of the Various Sizes of Moveable Types and of Other Matters**. London, 1847. subject: history of music printing and engraving.
- C.B Oldman. **Collecting Musical First Editions**. London, 1934. subject: history of music printing and engraving.
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