Public interest in the Hopeman Memorial Chime presented to the University of Rochester by the children of the late Arendt Willem Hopeman as a memorial to their father justifies a more detailed description than has hitherto appeared in the press.

The music of these bells has already been heard by thousands of Rochester people during the summer, and especially since the opening of the new College for Men in September. The Friday morning program on Oct. 10 at the beginning of the dedication ceremonies was broadcast locally, and on Sunday afternoon, Oct. 12, the Largo from Dvořák's New World Symphony was nationally broadcast as part of a local advertising program, the rest of which was made up of so-called popular music of the sort that now infests the air. I t is to be hoped that future radio broadcasts, if any are planned, will be less incongruously designed.

This chime is said to be one of the largest and finest to be found in any university in the country. It was made at Watervliet, N.Y., by Meneely and Company, which has been engaged in the business of bell-founding since 1826. Albert C. Meneely, vice-president of the company, has given his personal attention to the installation and regulation of the chime, and has made numerous visits to Rochester to insure the best results.

The tower lantern of Rush Rhees Library, surmounting the imposing structure just opened to the public, is filled with the 17 bells, sus-
pended from heavy steel beams in several tiers one above another. Originally designed for a chime of 11 or 12 bells, it has been made to accommodate 17, by ingenious arrangement and careful economy of space. No room remains for even a single additional bell. Yet by skilful grouping this has been accomplished without sacrifice of musical quality.

The floor of the bell chamber is curved down in the center and up at the sides in the shape of a bowl, in order to throw the sound of the lower tier of bells up and out through the openings between the columns which surround the lantern. This floor is covered with several layers of waterproofing material, topped by a hard mastic composition which reflects rather than absorbs the sound. Since the entire space is open to the weather, conductors are provided to carry off rain and melting snow. The bells themselves are proof against dampness, being made of non-rusting bell-metal. Winter and Summer will have no effect upon their quality, except that expansion from summer heat and contraction from winter cold causes a very slight lowering and raising of pitch.

The clapper of each bell, held in position a short distance from the inner rim near the bottom, is attached by a chain running over a pulley to a heavy steel transmission wire passing through the floor to the solenoid room below. This wire is enclosed in a copper tube and properly shielded to prevent leakage where it passes through the bottom of the bell-chamber.

The lower end of the transmission wire is attached to the moving member of a heavy solenoid. The electromagnetic action of these solenoids, which demand a heavy electric current, is controlled by means of a transformer panel near the solenoid room, connected by electric
wires in conduits with the console in the bellman's room.

When a key is depressed on the keyboard of the console, an electric circuit is completed which operates a specially designed contactor in the transformer panel. There the current is stepped up from 110 to 220 volts and, setting up a magnetic field in the turns of the coil, pulls down against spring tension the heavy iron core of the solenoid, to the yoke of which is attached the bell pull-wire. This pulls the clapper against the inner surface of the bell at the thickest part of the tapering sound-bow or lower rim, a spring immediately pulling it back into its position near the rim.

The length of the stroke can be adjusted to vary slightly the force with which the bell is struck, and to take up slack as the wire stretches from repeated strains. The chimer cannot, however, vary the force of the stroke by any difference of touch on the key, nor can he dampen the sound by any kind of muffling device as on a piano or organ, so that soft and loud effects that may be observed are due only to differences in the position of the bells in the tower and to the effect of wind currents in transmitting the sound.

The two largest bells, low B flat and C, have larger solenoids and longer, slower stroke than the rest, and cannot be played quite so rapidly, so that slight variations of tempo in passages requiring these bells are due to the inherent mechanical features of the transmission.

When rapid tunes are played on the chime, giving an animated and cheerful effect to folk songs and dance movements, a listener too near the building will be conscious of some interference of one note with another. The reverberation of a bell lasts several seconds, and for reasons soon to be explained, this is agreeable at close range only in harmonious sequences of tones separated by minor thirds, fifths, or octaves.
Discordant intervals such as the second or the seventh will cause beats even if the two bells are sounded a full second or more apart. At a distance of a few hundred feet this interference of one bell's reverberation with the next bell struck is not noticeable.

The best place to listen to the chime is on the leeward side, which is generally to the east or northeast of the library, especially near the gymnasium and athletic field. There are other spots, however, dependant on the configuration of the ground and the direction of the wind, where equally good effects are obtained. The worst possible place to hear the chime is in the tower itself, whether in the bellman's room or on the railed balconies so popular with visitors because of the magnificent view. There all the bells seem to sound at once in a confused jungle of discordant tones, which at a distance resolves itself into fainter but more pleasing melody.

The quadrangle is not an especially favorable place, for the sound seems to float out above the tops of the buildings rather than to descend sharply to the ground level. Noise from switch engines across the river and from passing automobiles also mars the effect at that point.

It has been a matter of surprise to some who know how large and heavy these bells are that the volume of sound is not greater. No bell hung in a fixed position and struck with a clapper has anything like the volume that it has when swung so that it can be rotated like an ordinary church bell. But no such number of bells could be hung in a tower of given size if arranged for swinging, nor could tunes be played on such a chime from a keyboard by electric action.

The English custom of change-ringing on bells pulled by a company of ringers, each holding a rope attached to the mounting of one bell,
gives charming effects when skillfully done, but is little practised
in this country for obvious reasons. A chime like this one at the river
campus is capable of rendering varied and interesting music, but should
not be expected to rival in mere loudness a peal of bells swung over
with the clappers moving freely from side to side.

Neither is it physically possible for bells ranging from nearly four
tons to 300 pounds in weight to have absolutely uniform loudness. The
amplitude as well as the pitch of the vibrations varies with the diameter
and weight. It is the aim of the manufacturer to keep the quality of
tone as nearly uniform as possible within this limitation, but the low
notes of a tune will always come out more strongly than the higher. This
is the reason why passages running within the range of four or five tones,
either in the upper or in the lower register, will sound more uniform than
those covering an octave or more. But for the sake of variety some sacri-
ifice of uniformity in loudness seems to be justified.

It may be interesting to give here a table of the pitch, diameter and
weight of the several bells. The tenor bell, low B flat, is that used in
striking the hour when a concert happens to begin or end with the Westminster
quarters. Its strike-tone is that of the B flat below middle C. The
smallest bell, upper F, is of the pitch indicated by the upper line of the
treble staff.

<table>
<thead>
<tr>
<th>Pitch</th>
<th>Diameter</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>B flat</td>
<td>72 inches</td>
<td>7,800</td>
</tr>
<tr>
<td>C</td>
<td>64 inches</td>
<td>5,600</td>
</tr>
<tr>
<td>D</td>
<td>56 inches</td>
<td>4,000</td>
</tr>
<tr>
<td>E flat</td>
<td>54 inches</td>
<td>3,400</td>
</tr>
<tr>
<td>F</td>
<td>50 inches</td>
<td>2,800</td>
</tr>
<tr>
<td>G</td>
<td>48 inches</td>
<td>2,400</td>
</tr>
<tr>
<td>A flat</td>
<td>42 inches</td>
<td>1,600</td>
</tr>
<tr>
<td>A</td>
<td>38 inches</td>
<td>1,200</td>
</tr>
</tbody>
</table>
When we speak of the pitch of a bell, we mean the strike-tone that is most prominent immediately after the bell is struck. But a bell, like any other musical instrument, sounds not only one prominent tone but many others called partials, generated by partial vibrations of the metal. At different levels there are zones which vibrate in their own special frequency, each with its own nodes or points of minimum vibration. Struck at one point the bell will sound one of these components more distinctly than others.

Bell partials, however, do not form a harmonic series of simple ratios like those of a stringed instrument or an organ pipe. Shortly after the bell is struck a sensitive ear will hear the hum-note or fundamental, an octave below the strike-tone, the nominal or octave above it, and a minor third and fifth in the octave between the strike-tone and the nominal. In other words, if the bell is properly tuned, it sounds, all by itself, a minor chord, being so to speak, in tune with itself.

There are also less prominent upper partials in the second octave above the strike-tone, including a major third or tenth, which should not be sufficiently noticeable to cause unpleasant beats with the minor third in the octave below, and also certain discordant intervals such as the seventh, which can be detected by careful observation.

These partials are inherent in the nature of the bell, and give it its peculiar quality, mellow or harsh according as one or another pre-
dominates. Meneely and Company are among the few bell-founders in this
country who are tuning the first five partials of their bells, and to
this fact may be attributed the excellent musical qualities of the Hopeman
Memorial Chime.

During the tuning of these bells Harold Gleason of the Eastman School
of Music visited the foundry as a representative of the university in
order to insure the most accurate results. The bells are tuned to inter-
national pitch, 440 vibrations a second for middle A. The intervals be-
tween/several degrees of the scale are adjusted to equal temperament, so
that it is possible to play in other keys than the basic keys of B flat
and C for which the chime is primarily designed. This means that, as
on a piano or organ, the semi-tones are approximately equalized, the
thirds being slightly sharp and the fifths slightly flat, other intervals
being adjusted accordingly, so that modulation from one key to another is
possible. The octaves, on the other hand, are perfect octaves, that is,
upper C has exactly twice the frequency of lower C. The adjustment of
other intervals than the octave is the same as on a well tuned piano, and
is that to which our ears are accustomed.

Bells are capable of only a slight degree of tuning. The approximate
diameter and weight empirically determined for a certain pitch is employed
by the founder, the bell being cast a trifle heavier than the proper amount
in order that its pitch may be adjusted. This is done by shaving metal
from the inside at the proper point to raise or lower the pitch a frac-
tion of a semi-tone.

By tuning the first five partials is meant the adjustment, by removing
thin shavings of metal, of the hum-note or octave below, the nominal or
octave above, and the minor third and fifth, as well as the strike-tone
of the bell. The precise level at which the scraping process should be performed for tuning each partial is of course a technical secret of the trade. Students of theoretical acoustics have long tried to reduce bell-founding and bell-tuning to precise mathematical formulas, but while their researches are interesting to the practical manufacturer, the skill born of long experience seems still to be indispensable.

How delicate the acoustic measurements and the mechanical process must be to insure such a result will be understood by those accustomed to observe ordinary fitting processes such as grinding an automobile cylinder or fitting a piston. Here we are dealing with a costly mass of bell-metal in the making of which weeks have been consumed. A single error in tuning might ruin the work and send the bell back to be broken up and remelted.

It is no wonder that the old bell-founders of the middle ages placed mottos on their bells and invoked the blessing of the church on their handiwork.

Bells like those in the Hopeman chime are made of 77 per cent copper and 23 per cent tin, melted in great furnaces and poured into moulds which have to be made individually for each new bell. No such thing as mass production is possible for fine bells designed for a chime or carillon, though common bells made for schools, factories and ships are of course turned out by quicker and more standardized methods. In designing a chime the relative sizes and weights of the several bells must be carefully proportioned, individual patterns made, and the whole process from making the moulds to tuning the bell carefully supervised.

The shape of a modern bell, in every detail including the precise curvature of the sides, the height of the shoulder, the thickness at the waist and at the sound-bow, is regulated in accordance with a pattern
in which the diameter at the mouth of the bell is the basis from which all other measurements are calculated. Older bells have different shapes, taller and straighter in proportion to the width, or with individual peculiarities of their own, but to reproduce the rich tone quality of some of these by merely copying their shape would lead to failure. Experience rather than abstract theory accounts for the shape prevailing at present.

Some people are interested to know what is the difference between a chime and a carillon. The term chime is generally applied to a ring of eight to twelve bells tuned to the notes of the diatonic scale, with perhaps a sharp fourth and a flat seventh; a smaller group of three or four bells to ring the quarters being called a peal. A carillon, on the other hand, consists of at least 25 bells, or two complete chromatic octaves, and may and often does include 40 or 50 bells. The new carillon in the Riverside Church, New York, one of the largest in the world, has 72 bells.

The Hopeman Memorial Chime has, added to the 12 tones of its diatonic range of an octave and a fifth (key of B flat to upper F), five bells not belonging to the key of B flat, namely, lower and upper E natural, A flat, upper B natural, and upper D flat. These added bells make it possible to play tunes in C, F, E flat and A flat, and the related minor keys.

It has, therefore, something of the quality of a carillon in the degree of variety available, but has not the minimum range of two octaves conventionally required for classification as a carillon. We call it a chime, meaning the collection of bells, and the music it produces is called chimes. This distinction between the singular and the plural is well supported by usage.
The university bellman has collected from many sources upwards of 500 tunes, nearly all of which have had to be transposed to available keys. These are transcribed in manuscript notebooks to which additions are constantly being made. They contain not only hymn tunes, chorales and sacred music suitable for Sunday afternoon concerts, but folk songs, grave and gay, Negro spirituals, old English melodies, old French gavottes, college songs of Rochester and many other colleges, and themes and melodies from orchestral, choral and operatic music.

Some of these are experimental and will doubtless be discarded after trial demonstrates that the adaptation is impracticable. There are a good many beautiful melodies that cannot be played even with 17 bells, because either of key changes or high notes beyond the range of the chime. But to restrict the repertory solely to folk songs and hymns seems too conservative a course.

Monotony is the worst thing about chime music. Even some of the most famous carillons of Europe are automatically played by a mechanism like that of a music-box, repeating the same tune over day after day for months, until the carillonneur sees fit to change the pins in the drum. This may be pleasing to the tourist, but might prove wearing to the neighbors.

The Hopeman chime will as a rule be played for half an hour on Sunday afternoons from 5 to 5:30 for the benefit of citizens who cannot hear it on other days. In addition it will generally be played, for the college community, on one weekday afternoon, for the present, usually Thursday, from 5 to 5:30, using a lighter class of music. Occasional use in connection with athletic events on Saturday, or on other days by special arrangement, may lead to the omission of the Thursday concert.
Chime music should not be overdone. We can have too much of a good thing.

During the past few weeks, when large groups of people have been visiting the campus for inspection, the chimes have been played frequently upon special request, and on such occasions lively tunes and college glee seemed appropriate, along with more sedate music. It is with regret that the bellman hears that even once by unfortunate coincidence such use of the chimes has jarred unpleasantly upon those attending funerals in Mount Hope. Nothing could be farther from his purpose than to incur thoughtful or even from criticism either from thoughtless strangers by failure to observe proprieties of times and places.

In conclusion, the gracious thought of the members of the Hopeman family in presenting this beautiful gift to the college which their firm has built deserves the gratitude of every one who lives within the sound of the chimes. They are meant to give pleasure. To many who have no other relation to the university they can bring now and then a kind of university extension beyond the reach of classroom instruction. Whether they ring, "Hark, Hark, the Lark at Heaven's Gate Sings" or some rollicking old tune like "The Vicar of Bray," whether they tinkle lightly through "Country Gardens" or intone "Deep River," they will be broadcasting something not found in books.

Many people take pleasure in music only when they recognize familiar tunes, and for them the old favorites will be included. Others delight in the strange old minor melodies and irregular rhythms of the ancient music of the Latin and Russian churches, and like a piece all the better of it is new to them, though it may be centuries old. The pleasure of recognition and the pleasure of surprise, as they have been called, may
both be realized if the wide and varied use made of the chime does not prove to be too catholic for public taste.

Like the gay and frolicsome carillon tunes of some of the bell-towers in Belgium and Holland and Denmark, the Hopeman Chime will now and then sound forth cheerful, tripping melodies that may exhilarate the gaiety of holiday moods. Quieter songs may tranquilize moments of troubled thought. A deep and solemn chant of things quite outside time and space may bring beauty even into the time of sickness and the hour of death.

"Forlorn - the very word is like a bell," exclaims John Keats. It is possible that the very bell may be like a word, and the word will be remembrance. Remembrance of ancient beauty, of forgotten happiness and happiness to come, of absent friends, and of all things beautiful. Remembrance of good men gone, and good men still with us. Remembrance of youth and love, of college days and holidays and all days that were like a song.

Part of the secret of a good chime is in the foundry, part is in the tune, and part is in the wind, but the most is in the imagination of the listener. Seventeen tons of metal hanging up there at the college by the river will never make music except as their sound, floating away into the unknown, finds here and there a waiting ear.